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Message from Keynote Speaker

In this speech, I would like to share insights from our recent research on how ESG risk performance has shaped both the financial stability and at times, the fragility of European banks. Over the past decade, the banking sector has navigated repeated waves of uncertainty and crisis, and ESG considerations have become increasingly central to measuring resilience.

Our analysis examined how a bank's financial performance aligns with its net ESG returns. This comparison revealed an important pattern: when the gap between financial performance and ESG returns was wide, banks generally demonstrated stronger resilience. However, when that difference narrowed or approached zero, it often signaled rising vulnerability and pressure within the system.

This research is based on annual data from 2010 to 2024 years defined by global disruptions, structural shifts, and an evolving regulatory landscape. Using quantile regression, we explored how ESG risk performance behaves under various levels of uncertainty and stress.

The findings were clear: global uncertainty continues to influence both ESG outcomes and the overall stability of European banks. In other words, sustainability pressures and financial resilience are no longer separate conversations, they are deeply interconnected.

As we move forward, the financial sector must recognize that ESG is not merely a compliance requirement or a reputational tool. It is an integral element of long-term stability. My hope is that this keynote helps spark further dialogue on how we can strengthen the link between sustainable practices and financial robustness.

Thank you.

Associate Professor Sandra Kendo

Université catholique de Lille, France

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Abstract

The 2025 International Conference on Innovation, Management, Education, and Technology (ICIMET), held on 8–9 November 2025 in China, served as a dynamic platform for scholars, practitioners, and policymakers to engage in meaningful dialogue and knowledge exchange. Under the overarching theme “Transforming Our World: A Collaborative Approach to Creativity, Management, Education, Technology & Sustainable Finance,” the conference aimed to inspire innovative thinking and promote interdisciplinary collaboration across diverse fields. It emphasized the integration of creativity, technological advancement, effective management strategies, educational innovation, and sustainable financial practices to address global challenges and shape a more resilient future. By fostering cross-disciplinary interaction and showcasing emerging research and practices, ICIMET 2025 contributed to the development of transformative solutions that advance sustainable growth and social progress worldwide.

Opening Ceremony Schedule

**“The International Conference on Management, Innovation,
Education and Technology (ICIMET) 2025”**

8th-9th October 2025

**at Wealth Center, Gaoxin Phase III, Xi'an City,
Shaanxi Province, China**

Online Via Zoom Application

ID: 945 6711 4971 Passcode: 500501

Date	Time	Activities	Place
8 th November 2025	09:00 - 9:15 AM	Registration	Wealth Center, Gaoxin Phase III, Xi'an City, Shaanxi Province, China
	09:16 - 09:45 AM	<u>Keynote Speeches By:</u> <i>Liu Min (PhD)</i> <i>Chairperson</i> <i>XI'AN Mingde Institute of Technology, China</i>	
	09:46 - 10:15 AM	<u>Keynote Speeches By:</u> <i>Shiying Wang (PhD)</i> <i>Associate Professor</i> <i>ABa Teachers College, China</i>	
	10:16 - 10:30 AM	<u>Keynote Speeches By:</u> <i>Sandra Kendo (PhD)</i> <i>Associate Professor</i> <i>Université Catholique de Lille, France</i>	
	12:00 - 04:00 PM	Online Presentation Sessions	
9 th November 2025	09:00 AM - 04:00 PM	Online Presentation Sessions	

Table of contents

Serial	Title	Page
1	Online Education Service Quality Management of Chengdu University in Sichuan <i>Qin Zhang¹, Dr. Nuntiya Noichun²</i>	1
2	The Effect of Digital Capability, Supply Chain Resilience, and Value Co-Creation on the Competitive Advantage of Agricultural Enterprises <i>Sihan Wang¹, Tawee Jamjumrus²</i>	9
3	Total Quality Management and Its Role in Enhancing Customer Satisfaction in the Chinese Catering Industry: A Case Study of Haidilao Chengdu <i>Fei Li¹, Pordee Sukpun²</i>	21
4	Digital Transformation in Strategic Enrollment Management: A Study of Universities in Yunnan Province <i>Qingqing Liu</i>	32
5	Building an Effective Innovation Ecosystem in Higher Education: Insights from Triple Helix and Organizational Learning Theory <i>Sun Mengtao¹, Nuntiya Noichan²</i>	42
6	Consumer Perceptions and Localization Strategies of Chinese New Energy Vehicle (NEV) Brands in the Thai Market: A Conceptual Framework <i>Xin Ren</i>	48
7	Navigating Cross-Cultural Higher Education Administration in an Era of Technological Disruption <i>Yunhan Gao¹ & Suttipong Boonphaduang²</i>	58
8	Teaching Quality Influencing Factors of English Teachers in Universities: Insights into Cross-cultural Teaching <i>Li Ju¹, Nuntiya Noichun²</i>	68
9	Digitalization empowers the development of the sports industry in China <i>DongZhu Huang¹, Dr. Anuchit Kulwanich²</i>	79
10	Research Path on Brand Loyalty of Qingyuan Dragon Boat Events <i>ChuHong Tan¹, Dr. Anuchit Kulwanich²</i>	90
11	Research on the Issues in Lijiang Tourism Apps <i>Shi Linke¹ & Supawadee Juysukha²</i>	96

Serial	Title	Page
12	Labor Market Changes under the Intelligent Revolution: Skill Demand Shifts and the Construction of a Lifelong Learning System <i>Kai Dou¹ & Duangsamorn Rungsawanpho²</i>	106
13	The Green Development of the "Belt and Road" Initiative: An Impact Assessment on the Sustainable Development of Countries along the Routes <i>Kai Dou¹ & Duangsamorn Rungsawanpho²</i>	114
14	Investigation and Analysis of the Characteristics and Influencing Factors of Carbapenem-resistant Enterobacteriaceae Infection in Intensive Care Unit Patients of a Three-class Hospital in Gansu Province <i>Jing Yang¹, Sarisak Soontornchai², Li Linjing³</i>	123
15	Differences and Integration Promotion of Multi ethnic Mixed Elderly Care in Plateau Regions of China: A Case Study of Area in Kunming, Yunnan Province <i>Fangli Ma¹, Siriluck ji² & Hongyong Fu³</i>	143
16	Exploration on the teaching mode of higher vocational football education in the era of mathematical intelligence <i>Chen Jia Xing¹, Nuttavut Phonsri²</i>	155
17	Application and optimization strategy of supply chain digital transformation in Enterprises <i>Peng Zan¹, Preecha Wararatchai²</i>	166
18	Key Success Factors of Online Business: A Case Study of Lazada in Southeast Asia <i>Majun Xin¹, Nattarikarn Kaewkorath²</i>	187
19	Key factors for the success of e-commerce online businesses in Southeast Asia based on the Lazada case: Data analysis and conclusion verification <i>Majun Xin¹, Nattarikarn Kaewkorath²</i>	193
20	The Impact of Capital Structure on Firm Performance: A Case Study of the E-Commerce Industry <i>Haocheng Yang¹, Dr. Sittachai Thammasane²</i>	203
21	The Impact of Capital Structure on Firm Performance: A Comparative Empirical Analysis of Amazon and Alibaba <i>Haocheng Yang¹, Dr. Sittachai Thammasane²</i>	212

Serial	Title	Page
22	The Impact of Synergy Between Service Marketing Mix and 5S System on Cost Control in E-commerce Enterprises: An Empirical Analysis Based on Chinese Enterprises <i>Benlan Yang¹, Preecha Wararatchai²</i>	219
23	Lean Financial Management and Comprehensive Budgeting Synergy in Manufacturing Enterprises: Theoretical Framework and Conceptual Model <i>Benlan Yang¹, Preecha Wararatchai²</i>	228
24	China's International Communication Strategies from the Perspective of Cross-Cultural Discursive Adaptation - An Audiovisual Narrative Analysis Based on Short Videos <i>Yingzhe Wang¹, Dr. Nititorn Ounpipat²</i>	237
25	The Impact of Artificial Intelligence-Driven Personalized Marketing Strategies in China on Consumer Behavior <i>Liting Yang</i>	244
26	The Relationship between Product Design Innovation and Corporate Value in the Smartphone Market (2020–2025) <i>Yi Jin</i>	253
27	Localization Strategies and Performance Outcomes of Chinese New Energy Vehicle Brands in Thailand: Comparative Case Studies of BYD, MG, and GWM <i>Minghui Cai</i>	266
28	Green Legacy of Major Sports Events: From Carbon Neutrality to Sustainable Operations-Take the Olympics and World Cup as Examples <i>MinHao Zhong¹, Dr.Nuttavut Phonsri²</i>	279
29	From The Screen to The Internet: Asian Action Movies for Nearly 20 Years Research on Asian Cultural Communication <i>Chao Chen</i>	284
30	Digital Sensibility and Human Warmth: Exploring the Integration of 3D Modeling and Traditional Sculpture in The Third Consciousness <i>Hongxi Hu¹, Noppadon Sangwalpetch²</i>	295
31	Investigating the Interconnections Among Internal Marketing, Employee Loyalty, and Service Quality in China's Commercial Banking Sector: Conceptual Study <i>Zecheng Ren¹ & Chumpon Rodjam²</i>	313

Serial	Title	Page
32	Building Better Service: How Internal Marketing and Employee Loyalty Shape Quality in China's Commercial Banks <i>Zecheng Ren¹ & Chumpon Rodjam²</i>	320
33	The history and development of Huidong Fishing Songs <i>Ziqi Wang^{1*}, Phakamas Jirajarupat² & Xiaodong Hu³</i>	327
34	Research on Sustainable Business Model Innovation in Electronic Information Manufacturing Industry: A Case Study of Guangdong and Guangxi Regions <i>Mingshan Li¹, Muhammad Shahid Khan² & Chumpon Rodjam³</i>	339
35	Strategies for high-quality development of agricultural products export in Gansu Province - From the perspective of cross-border e-commerce empowerment <i>Lei Lei¹, Guo Jingjing²</i>	349
36	The impact of cross-border e-commerce on China's import and export trade under the background of RCEP <i>Lei Lei², Guo Jingjing²</i>	357
37	A Theoretical Framework Linking Teaching Audits to Sustainable Development in Universities in Yunnan <i>Wu Longbiao¹, Suttipong Boonphadung²</i>	364
38	The Impact of Artificial Intelligence Literacy and Perception on College Students' Adoption of AI Technology: A Blended Study Based on Multimedia Classrooms <i>Yu Xiang¹ and Samanan Rattanasirivilai²</i>	376
39	The Role of Autonomous Driving Technology in Shaping Future Urban Mobility: A Case Study of Waymo <i>Yangling Tingyu</i>	382
40	The Role of Circular Economy Business Models in Achieving Urban Sustainability: A Case Study of Philips' Lighting-as-a-Service <i>Yangling Tingyu</i>	395
41	Teachers' Qualities for Art Higher Education in Yunnan Province <i>Yi Xiong^{1*} & Nuntiya Noichun²</i>	410

Serial	Title	Page
42	Research on Factors Affecting Personal Promotion of Employee in Yunnan Manufacturing Enterprises <i>Muning Huang</i>	416
43	The Practice and Effect of The Synergy Mechanism of China's Four Level Medical System in The Prevention and Treatment of Diabetes Patients <i>Haipeng Ouyang¹, Dr. Supalak Fakkham², Dr. Sarisak Soontornchai³</i>	432
44	Challenges and Strategies of Faculty Compensation Management in Chinese Private Universities: A Case Study of Baiyun University <i>Li Yucui¹, Suttipong Boonphadung²</i>	438
45	Beyond Compensation: Psychological Pathways to Faculty Motivation in Chinese Private Universities—An Empirical Study of Self-Determination Theory Localization <i>Liu Junjie¹, Ganratchakan Lertamornsak²</i>	448
46	Challenges and Strategies in Home-School-Community Partnerships: A Case Study from China <i>Wu Chufen¹, Ganratchakan Lertamornsak²</i>	459
47	Problems and Optimization of Faculty Incentive Mechanisms in Chinese Private Universities: A Case Study of Guangdong Xinhua University from the Perspective of Equity Theory <i>Zhou Haodong¹, Thada Siththada²</i>	473
48	Concept About Coordination and Motivation in Educational Management <i>Zhang Jing¹, Thada Siththada²</i>	484
49	Immersive Wedding Space: A Theoretical Framework Linking Spatial Construction, Narrative Logic, and Emotional Experience <i>QinYao Chen¹, Noppadon Sangwalpetch²</i>	493
50	Cross Cultural Poster Design Strategies: A Case Study of Movie Posters <i>Long Yifei¹ & Supawadee Juysukha²</i>	509
51	The Mediating Role of Firm Creativity in The Relationship Between AI-Based Human Capital Development and Sustainable Firm Performance <i>Song Sun¹, Chumpon Eakolarn² & Muhammad Shahid Khan³</i>	522

Serial	Title	Page
52	Innovation Management of Human Resources in Casual Economy Based on Dynamic Matching Mechanism Between Platform Organization and Freelancer <i>Song Sun¹, Chumpon Eakolarn² & Muhammad Shahid Khan³</i>	528
53	Poster Designing Based on Visual Communicated Perception <i>Cao JunJie¹, Manus Kaewbucha², Chalisa Apiwathnasorn^{3*}</i>	536
54	Exploring a New Teaching Framework for Photography Education Powered by Artificial Intelligence <i>Shuya Gao¹, Manus Kaewbucha² & Nut Chiangthong³</i>	548
55	The Handicraft Design Inspired by Vincent Van Gogh <i>Yuan Wang¹, Manus Kaewbucha² & Chalisa Apiwathnasorn³</i>	565
56	Instructional Design of Aesthetic Education Course for Vocational College Education Using AIGC <i>Xie Cuiying¹, Dr. Krisada Daoruang²</i>	574
57	Applying Wang Xizhi's Calligraphy Style into Contemporary Accessories Ornaments Design <i>Siyu Xiong¹, Manus Kaewbucha², Nut Chiangthong³</i>	585
58	Research on the Current Situation of College Students' Participation in Cheerleading in Lijiang <i>Shuqing Zhang¹, Khun Nui²</i>	602
59	Analysis of The Impact Mechanism of Hotel Service Quality on Customer Satisfaction Based on Online Reviews <i>Yongbo Liu¹, Panida Ninaroon² & Muhammad Shahid Khan³</i>	611
60	The Impact of New Generation Hotel Employees' Perception of "Work-Life Balance" on Their Service Quality <i>Wanqi Zhang¹, Panida Ninaroon² & Muhammad Shahid Khan³</i>	620
61	Green Talent Management and Green Performance: A Conceptual Framework Mediated by Green Organizational Culture and Green Organizational Citizenship Behavior, Moderated by Green Leadership <i>Jinbo Han¹, Panida Ninaroon² & Muhammad Shahid Khan³</i>	629

Serial	Title	Page
62	Reconstruction of Incentive Mechanism of Human Resource Strategic Management in Digital Transformation -- Taking Dynamic Evaluation of Employee Performance as Intermediary Variable <i>Hao Zhou¹, Muhammad Shahid Khan² & Wilai Phungpol³</i>	640
63	Talent Management and Organizational Performance: An Empirical Study Based on The Icte Framework and Chinese Enterprises <i>Cheng Li¹, Pachoke Lert-asavapatra² & Muhammad Shahid Khan³</i>	649
64	Talent Management and Performance: A Conceptual Framework for Organizational Excellence in Cross-Cultural Teams <i>Cheng Li¹, Pachoke Lert-asavapatra² & Muhammad Shahid Khan³</i>	655
65	Research on The Impact Mechanism of Strategic Human Resource Management on Enterprise Innovation Performance - Based on The Background of Digital Transformation: The Mediating Role of Knowledge Sharing <i>Tielin Wang¹, Wilai Phungpol² & Muhammad Shahid Khan³</i>	661
66	The Impact of Luckin Coffee Brand Trust on Repurchase Intentions Among University Students: A Case Study in Shanghai, China <i>KaiFan Liu¹ and Dr.Nantachit Kochakasettrin²</i>	668
67	The Mediating Role of Innovation Ability: Pathways to Succession Success in Shenzhen Family Enterprises <i>Xiaoxia Chen¹, Chaithanaskorn Phawitpiriyakliti², Chukui Chen³, Sid Terason⁴, Hongchun Zheng⁵</i>	678
68	Leadership Styles and Generation Y Employees' Performance in Chinese Organizations: A Conceptual Study <i>Lin Han¹, Pachoke Lert-asavapatra²</i>	696
69	Factors Influencing Tourism Industry Success in Zhejiang Province, China: A research concept <i>Yan He¹ & Chalernpol Tapsai²</i>	703
70	How Do AI Tools Improve the Production of Homestay OGC? - A Case Study on Homestay Content Production Modes and Operational Reflections Based on the S-O-R (Stimulus-Organism-Response) Theory <i>Yunhui Wang</i>	713

Serial	Title	Page
71	Early Prediction of Alzheimer's Disease Based on Multi-Task Learning Networks <i>Yun Long¹, Pimporn Thongmuang¹, Sarisak Soontornchai³</i>	725
72	Research on Risks and Training Model of Cross-border E-commerce Majors in 'Order-based' Mode in Higher Education Institutions of Nanning City <i>Youyon Gan</i>	730
73	Exploration on the Application of Sharing Economy Model in the Field of Electric Construction Machinery <i>Yuanyuan Sun</i>	739
74	Relationships among Work Motivation, HRM Practices, and Personnel Performance in Chinese Vocational Institutions <i>Shu Huang¹, Xin Liu², Thanasuwit Thabhiranrak³</i>	763
75	The Analyze of Vocal Music for Celebration from Shan bei Folk Song <i>Zhang Li¹, Pramote Phokha², Nut Chiangthong^{3*}</i>	775
76	Study of Anhui Ethnic Arts and Music Culture for The Promotion and Dissemination of Cultural Information <i>Xingmin Sun¹, Krisada Daoruang^{2*}</i>	793
77	Digital Workflows and Professional Boundaries: A Study of WeChat Communication among Hainan Media Practitioners <i>Peng Wang¹, Dr. Prakaikavin Srijinda²</i>	808
78	Teaching design of primary school art teacher in a private art training institution in Hangzhou <i>Teng Xuefu¹, Krisada Daoruang^{2*}</i>	821
79	Reviving Tang Dynasty Art in Modern Mooncake Packaging Design A Cultural Heritage Innovation Approach <i>Huang Pengpeng¹, Dr. Manus Kaewboucha² & Dr. Nut Chiangthong³</i>	833
80	Experiential Mechanisms in Real-Time Digital Retailing: The Mediating Role of Immersive Engagement in Shaping Consumer Purchase Intention <i>Xinghua Sun</i>	849
81	Research on the Integrated Development of Marathon Sports and Sports Tourism: A Case Study of Dali City, Yunnan Province <i>Yuan Yun Li¹, Dr. Dr. Nuttavut Phonsri²</i>	859

Serial	Title	Page
82	Psychological Flexibility as a Mediator Between Perceived Stress and Sleep Quality in Patients with Diabetic Nephropathy: A Case Study in Liuzhou, Guangxi Zhuang Autonomous Region <i>Liu Huang¹, Dr. Siriluck Jittrabiab², Dr. Thanawat Imsomboon³, Dr.Sarisak Soontornchai⁴</i>	865
83	Artificial Intelligence Application for Students' Learning in Harbin Institute of Technology, China <i>Li Yifan¹, Dr. Nithipattara Balsiri²</i>	872
84	Effective School Management of Kindergarten Environment Development in Fangcao No.3 Kindergarten, China <i>Lijun Tang¹, Dr Nithipattara Balsiri²</i>	882
85	Personal, Family, and Social Factors Influencing Beijing High School Students' Decision to Study in Thailand <i>Jiixin Li¹, Duangsamorn Rungsawanpho²</i>	888
86	Cross-Cultural Adaptation Challenges and Coping Strategies for Chinese Students Studying in Thailand <i>Jiixin Li¹, Duangsamorn Rungsawanpho²</i>	894
87	The Communication Strategies for Enhancing the Cultural Value of Chinese Opera Performance Through the Tiktok Platform in China <i>Jiayu Yuan¹, Somsak Klaysung²</i>	901
88	A Study of Key Factors Shaping Chinese Customers' Purchase Intentions toward Imported Goods in the Context of E-Commerce: A Conceptual Study <i>Zeyuan Li¹, Dr. Pachoke Lert-asavapatra²</i>	908
89	A Study of Key Factors Influencing Chinese Consumers' Intentions to Purchase Imported Products through E-Commerce Channels <i>Zeyuan Li¹, Dr. Pachoke Lert-asavapatra²</i>	915
90	Fog Computing for Efficient IoT Data Aggregation, Processing, and Real-Time Analytics at the Edge of the Network <i>Sohaib Ahmad Khalil¹, Mohsin Mahmood²</i>	925

Online Education Service Quality Management of Chengdu University in Sichuan

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Abstract

This study aims to investigate and analyze the current situation of online education service quality management at Chengdu University in Sichuan, identify major challenges, and propose targeted strategies to enhance overall quality, learning experiences, and teaching effectiveness. The research focuses on faculty and management staff, combining a quantitative survey with qualitative semi-structured interviews to obtain comprehensive data. The findings reveal that while Chengdu University has established a basic framework for online education service quality management, significant improvements are needed in areas such as student interaction, platform user experience, and system stability. The study highlights the importance of adopting a student-centered approach, enriching interactive teaching formats, and fostering online learning communities, alongside sustained technological investment to optimize platform functionality. Furthermore, it proposes strengthening teacher training and motivation systems to enhance instructional design and tutoring capabilities, as well as establishing a comprehensive quality monitoring and continuous improvement mechanism involving multiple stakeholders. This research offers valuable empirical evidence and practical recommendations for advancing online education service quality management in Chinese provincial universities.

Keywords: Online education; Service quality; Quality assurance.

1. Introduction

The ubiquity of digital education has firmly established online learning as a cornerstone of higher education. For regional comprehensive and applied universities, the caliber of online education services is pivotal to talent development, institutional prestige, and the advancement of educational equity. Chengdu University, a key representative in Sichuan Province, offers a multifaceted online education portfolio encompassing course resource development, platform technical support, teacher-student interaction management, and learning outcome assessment. Nevertheless, it grapples with industry-wide persistent challenges, such as outdated course content, recurrent technical malfunctions, delayed instructor feedback, and insufficient learning oversight. (Changhong Lu, 2017; Chenyao Du., & Xihua Zhou, 2023)

This study on Chengdu University's online education service quality holds substantial significance across four critical dimensions. Firstly, from an educational practice standpoint, implementing systematic quality management is poised to directly enhance student learning experiences and efficacy. Secondly, institutionally, superior service quality is a linchpin for talent retention, building a distinct brand identity, and fostering the expansion of continuing

education and international collaborations. Thirdly, industrially, the insights gleaned from Chengdu University can serve as a valuable benchmark and practical model for peer comprehensive applied universities in Sichuan confronting analogous hurdles. Lastly, academically, this focus addresses a notable gap in current scholarship, which has predominantly centered on national platforms and elite institutions. (Miao Chen, 2024; Minger Jian, 2022; Pei Huang, 2022)

Despite the burgeoning research on online education, the extant literature remains skewed towards MOOCs and top-tier universities, leaving the service quality management of regional comprehensive applied universities under-explored. This study seeks to bridge this gap by investigating Chengdu University, with a focus on three under-researched areas: the optimization of online courses tailored for applied majors, the integration of regional cultural and industrial characteristics into service design, and the formulation of customized institutional evaluation frameworks. (Qiao Yi. & Siyang Mei, 2023)

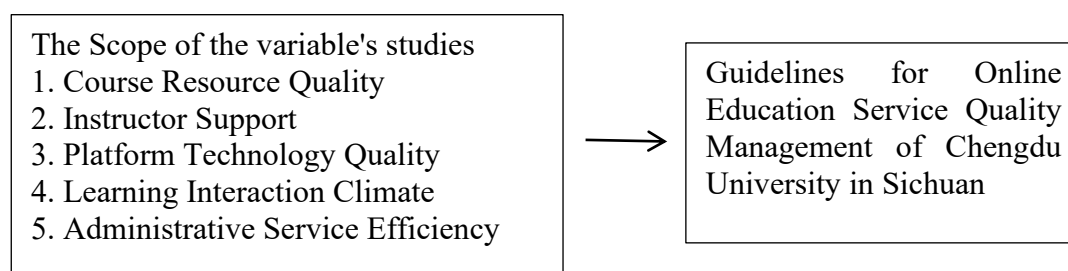
Against this backdrop, this study examines the current state, core challenges, and actionable optimization strategies for online education service quality at Chengdu University. It addresses four targeted research questions: (1) What are the specific characteristics and inherent deficiencies of Chengdu University's current online education services? (2) How do the service needs differ among distinct student cohorts, particularly undergraduates and continuing education learners? (3) What are the viable and prioritized pathways to enhance service quality, with a focus on course resources, platform stability, and interactive efficacy? (4) How to construct a tailored service quality evaluation system that integrates perspectives from multiple stakeholders and aligns with the university's applied mission? By answering these questions, this study aims to deliver actionable solutions for Chengdu University and enrich the theoretical discourse on online education quality management in regional universities. (Qingyan Zhou, 2022; Tong Liu, 2021; Xiao Luo, 2022; Xiao Yan, 2021)

2. Objectives

1. To study the level of the Online Education Service Quality Management of Chengdu University in Sichuan.
2. To propose the Online Education Service Quality Management of Chengdu University in Sichuan.

3. Conceptual framework

Figure 1: Conceptual framework



4. Literature review

Qiu Zhaomin (2020) found in relevant research that the objectivity and impartiality of teacher evaluations significantly affect students' willingness to continue using online learning websites. This study emphasizes that fairness in the teaching evaluation process is crucial in the quality dimension of online education services. If the evaluation system is unreasonable and the teacher's evaluation is biased, it will directly reduce students' trust in online learning services and affect their continued learning enthusiasm. It supplements the consideration of the "teaching evaluation" dimension in the quality assessment of online education services.

Vahid Baradaran (2023) pointed out in "Development of Fuzzy Exploratory Factor Analysis for Designing an E-learning Service Quality Assessment Model" that providing necessary information infrastructure and financial support for online learners in developing countries can significantly improve learners' perception of the quality of online learning services. Taking online education projects in some African countries as cases, it was found that improving network bandwidth and providing subsidies for learning equipment significantly increased students' satisfaction with course loading speed and ease of accessing learning resources. This provides practical directions for solving the quality problems of online education services in developing countries and regions.

Godwin J. Udo (2022) pointed out in "Using SERVQUAL to Assess the Quality of E-learning Experience" that the quality of online teaching services has a significant indirect impact on learners' willingness to continue online learning behavior. Based on the SERVQUAL model, this study evaluates the quality of online teaching services from five dimensions: tangibility, reliability, responsiveness, assurance, and empathy. It is found that when teaching services perform well in all five dimensions, students are more willing to continue participating in online learning, emphasizing the importance of collaborative improvement in all dimensions of teaching service quality.

Muhammad Amand Uppal (2021) pointed out in "Factors Determining E-learning Service Quality: ELQ Factors" that assurance, responsiveness, tangibility, online learning web pages, and online course content to some extent determine the quality of online learning services. Its research emphasizes that online learning web pages, as an interactive window between students and courses, have tangible features such as reasonable layout and convenient operation, which will significantly affect students' perception of service quality; At the same time, the accuracy and timeliness of course content, as well as the "guarantee" of teachers providing learning support, are key elements in maintaining high-quality services.

Long Pham (2020) found through survey research in "Development and Validation of an Instrument to Measure Student Perceived E-learning Service Quality" that the quality of online learning services is influenced by the quality of online learning systems, online teachers and course resources, and online learning management and support services, with the impact of online learning system quality being the most significant. Research has shown that a stable online learning system is the foundation. If the system frequently experiences problems such as lagging and crashing, even if the course resources are of high quality, students will find it difficult to have a good experience; The teaching ability of teachers, the practicality of course content, and the learning support provided by management departments (such as timely feedback on student issues) collectively constitute key factors affecting service quality.

5. Methodology

5.1 Research method

This study adopts a research method that combines quantitative and qualitative analyses to comprehensively investigate the current status, core challenges, and optimization strategies of Online Education Service Quality Management at Chengdu University in Sichuan.

By integrating these two methodological approaches, the study ensures both breadth and depth of understanding: the quantitative data reveal patterns and overall levels of service quality, while the qualitative interviews provide nuanced explanations and strategic insights. The findings from both sources were triangulated to formulate practical recommendations for improving the online education service quality management system at Chengdu University.

5.2 Population and sample

5.2.1 Population used in the research

The population used in this research was teachers of Chengdu University, with a total of 120 teachers. (Chengdu University, 2024).

5.2.2 The sample used in the research

The sample group used 92 teachers were which the researcher has determined the sample size by using the schedule of the sample size of Krejcie & Morgan, 1970, p. 607-610.

5.2.3 Key informants in the interview

The sample group used in the interviews in this research consisted of 5 faculty members at of the Chengdu University. (Purposive Sampling).

5.3 Research tools

Tools used in this research It is a questionnaire about the Online Education Service Quality Management of Chengdu University in Sichuan, divided into 2 sections as follows:

Sub-Section 1

The questionnaires on the personal status of the respondents. It was in the form of a checklist to ask for basic information of the respondents, namely 1) Gender of respondents 2) Age of respondents 3) Respondent's highest educational background and 4) The work experience of the respondents 5) The work establishment status.

Sub-Section 2

Researchers developed a questionnaire on the quality management of online education services at Chengdu University in Sichuan Province, covering five aspects of OESQM with a total of 40 items, and scored them on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree).

1) Course Resource Quality	A total of 8 items
2) Instructor Support	A total of 8 items
3) Platform Technology Quality	A total of 8 items
4) Learning Interaction Climate	A total of 8 items

5) Administrative Service Efficiency A total of 8 items

The second part of the questionnaire is a 5-level estimation scale.

5 means management is highest level.

4 means management is high level.

3 means management is moderate level.

2 means management is low level.

1 means management is lowest level.

6. Research Conclusion

The implementation status of Online Education Service Quality Management of Chengdu University in Sichuan, namely 1) Course Resource Quality 2) Instructor Support 3) Platform Technology Quality 4) Learning Interaction Climate and 5) Administrative Service Efficiency. The Details is shown in Table 1.

The results of the mean and standard deviation analysis of Online Education Service Quality Management of Chengdu University in Sichuan are smooth ($\bar{x}=3.73$, S.D. =0.87). The results of the data indicate that Instructor Support are the most important aspect of Online Education Service Quality Management of Chengdu University in Sichuan. In addition, Platform Technology Quality, Learning Interaction Climate, Administrative Service Efficiency were also considered important for Online Education Service Quality Management of Chengdu University in Sichuan. However, Course Resource Quality seems to be lacking in some aspects. From Table 1.

Table 1

Results analysis of mean and standard deviation the Online Education Service Quality Management of Chengdu University in Sichuan.

Online Education Service Quality Management of Chengdu University in Sichuan	n = 92		Interpretation
	$\bar{x}$	S.D.	
1. Course Resource Quality	3.60	0.81	High level.
2. Instructor Support	3.84	0.86	High level.
3. Platform Technology Quality	3.83	0.89	High level.
4. Learning Interaction Climate	3.72	0.90	High level.
5. Administrative Service Efficiency	3.64	0.90	High level.
Total	3.73	0.87	High level

7. Research discussion

The findings of this study indicate that students' evaluations of online education quality have evolved beyond the initial basic requirement of technological accessibility (whether classes can proceed smoothly), shifting toward a pursuit of a comprehensive learning experience. The teaching design capabilities of instructors, the interactive fluidity of the platform, the academic depth of resources, the sense of belonging fostered through interactions, and the convenience of administrative services collectively constitute the essence of “quality” in students' minds. This finding aligns with the latest perspective on online education quality,

which emphasizes that quality centers on creating educational experiences that foster cognitive presence, pedagogical presence, and social presence. Chengdu University's practices demonstrate that while its technological infrastructure and content provision meet standards, there remains significant room for improvement in creating deep, socialized learning experiences.

This study concludes that Chengdu University's online education services have successfully transitioned beyond the phases of “scale expansion” and “infrastructure development,” now entering the critical “quality enhancement” and “experience optimization” phase. Future quality management must adopt holistic and systemic thinking to break down silos and strengthen top-level design. Specific strategies should include: - Establishing a cross-departmental quality coordination body to unify planning and coordination across all online education service segments. Investing in instructor development through systematic training and integrating online teaching competencies into evaluation frameworks. Advancing technological integration to build a unified platform featuring single sign-on, data sharing, and operational synergy. Establishing routine, data-driven quality monitoring and feedback mechanisms to enable continuous service iteration. Ultimately, the goal of online education quality management is to construct a student-centered, self-optimizing, dynamic, and vibrant smart education ecosystem where all elements collaborate efficiently.

8. Suggestion

Recommendation 1: Strengthen Instructor Support

The university should reinforce continuous professional development in online pedagogy, instructional design, and technology integration. In addition, it is essential to establish incentive and evaluation mechanisms that directly link teaching performance with online education quality and student satisfaction, thereby motivating faculty to engage actively in high-quality online teaching.

Recommendation 2: Optimize Platform Technology

Priority should be given to system stability, user-friendliness, and seamless integration with academic processes, rather than pursuing excessive technical features. Furthermore, the adoption of learning analytics is recommended to monitor interaction data and student performance in real time, supporting evidence-based decision-making for continuous improvement.

Recommendation 3: Enhance Course Resource Development

It is necessary to develop modular, high-quality, and interactive course materials supported by an iterative “create–evaluate–optimize” cycle. This process continuously refines content based on student feedback and data insights, ensuring that online learning materials remain relevant, engaging, and effective.

Recommendation 4: Enrich the Learning Interaction Environment

The university should provide structured interaction opportunities, including group projects, peer reviews, and real-time discussions, to foster a stronger sense of academic community. For large-scale courses, the deployment of digital teaching assistants or learning facilitators is recommended to ensure responsiveness and personalized support for students.

Recommendation 5: Improve Administrative Service Processes

A “one-stop” online service platform should be established to integrate academic,

administrative, and IT support, thereby reducing students' administrative burden. This should be complemented by a case manager system to ensure accountability and effective cross-departmental coordination, enhancing the overall efficiency and user experience of online education services.

Overall, the proposed model highlights a strategic shift from simple “functional implementation” to “experience optimization,” aiming to build a student-centered, integrated, and continuously improving online education ecosystem at Chengdu University.

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The Effect of Digital Capability, Supply Chain Resilience, and Value Co-Creation on the Competitive Advantage of Agricultural Enterprises

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Abstract

This study examines how digital capabilities enhance competitive advantage in agricultural enterprises in China's southwestern provinces (Yunnan, Guizhou, Sichuan), using PLS-SEM analysis of 345 survey responses. Digital capability, encompassing infrastructure, technology, organizational aggregation, and platform management, significantly drives competitive advantage ($\beta=0.631$, $p<0.001$), primarily through supply chain resilience ($\beta=0.335$, $p<0.001$), which mediates 75% of the impact by enabling disruption management and operational continuity. Value co-creation, involving intra-firm, customer, and supplier collaboration, contributes a smaller mediation effect ($\beta=0.109$, $p<0.001$). Resource integration amplifies value co-creation, market dynamics enhance resilience, while excessive digital market search may hinder collaboration. The findings extend Resource-Based View and dynamic capabilities theories, emphasizing resilience as a meta-capability. Enterprises should prioritize adaptive and collaborative capabilities, tailored to context. Governments should support holistic capability development and regulatory harmonization. This study highlights a paradigm shift toward integrated capability development for sustainable competitive advantage in agriculture.

Keywords: Digital Capability, Supply Chain Resilience, Value Co-Creation, Competitive Advantage, Agricultural Enterprises

1. Introduction

The digital transformation of traditional industries represents one of the most significant economic shifts of the 21st century, with agricultural enterprises facing particularly acute pressures to modernize their operations while maintaining competitive viability (Klerkx et al., 2019). Despite agriculture's fundamental importance to global food security and economic stability, the sector has historically lagged in digital adoption compared to manufacturing and service industries (Rotz et al., 2019). This digital divide creates both existential threats and transformative opportunities for agricultural enterprises navigating increasingly volatile markets, complex supply chains, and evolving stakeholder expectations.

Recent global disruptions, including the COVID-19 pandemic and geopolitical tensions, have exposed critical vulnerabilities in agricultural supply chains while simultaneously accelerating digital adoption across the sector (Hobbs, 2020). Agricultural enterprises that successfully leverage digital capabilities have demonstrated superior performance in

maintaining operational continuity, coordinating with stakeholders, and adapting to rapidly changing market conditions (Sharma et al., 2020). However, the mechanisms through which digital investments translate into sustainable competitive advantages remain poorly understood, particularly in traditional agricultural contexts where relationship-based business models and resource constraints create unique implementation challenges.

This study addresses these theoretical and practical gaps by investigating a fundamental question: How do digital capabilities influence competitive advantage in agricultural enterprises, and what mediating mechanisms facilitate this relationship? We propose that digital capability's impact on competitive advantage operates through two distinct yet complementary pathways: supply chain resilience and value co-creation. Supply chain resilience enables enterprises to withstand disruptions and maintain operational continuity (Christopher and Peck, 2004), while value co-creation facilitates collaborative innovation with stakeholders (Vargo and Lusch, 2016). Understanding these dual pathways is critical for both theoretical advancement and practical guidance.

2. Theoretical & Hypotheses

Digital capabilities—defined as an organization's ability to leverage digital resources, technologies, and competencies to sense opportunities, seize value, and reconfigure resources—are conceptualized here as a dynamic capability comprising digital infrastructure, technology application, organizational aggregation, and platform management (Teece, 2007; Warner & Wäger, 2019). Grounded in the Resource-Based View (Barney, 1991), digital capabilities are valuable, rare, inimitable, and non-substitutable (VRIN), yet require continuous renewal to remain effective in fast-changing environments (Nambisan, 2017). Empirical research confirms that digital capabilities enhance decision-making and operational efficiency (Mikalef & Pateli, 2017) and, in agriculture, improve precision farming, supply-chain coordination, and market intelligence (Kamilaris et al., 2017).

Supply-chain resilience—the ability to prepare for, respond to, and recover from disruptions—is characterized by flexibility, visibility, collaboration, and risk management (Ponomarev & Holcomb, 2009). Digital capabilities strengthen resilience by enabling real-time data sharing (Dubey et al., 2019), predictive analytics (Ivanov & Dolgui, 2020), resource redeployment, and ecosystem coordination (Parker et al., 2017). Resilient supply chains sustain service levels during disruptions and enhance firms' reputation and competitiveness (Wieland & Wallenburg, 2013), which is particularly vital in agriculture where disruptions often propagate across production cycles.

Value co-creation—the collaborative process of jointly creating value with stakeholders (Prahalad & Ramaswamy, 2004)—includes intra-firm, customer, and supplier co-creation. Digital platforms and analytics facilitate connectivity, data sharing, and innovation (Nambisan & Baron, 2019), enhancing responsiveness, innovation capacity, and stakeholder loyalty (Cossío-Silva et al., 2016).

Contextual factors moderate these relationships. Resource integration capability strengthens digital capability's effect on co-creation (Sirmon et al., 2011). Market environment dynamics enhance the strategic value of resilience in moderately volatile contexts (Jansen et

al., 2006). However, excessive digital market search can lead to information overload and weaken co-creation (Dong & Yang, 2020).

Hypotheses:

H1 Digital capability has a positive impact on Competitive advantage of enterprises.

H2 Supply chain resilience has a positive impact on the Competitive advantage of enterprises.

H3 Value Co-Creation has a positive impact on the Competitive advantage of enterprises.

H4 Digital capability has a positive impact on the Supply chain resilience.

H5 Digital capability has a positive impact on the Value Co-Creation.

H6 Digital Market Search Positively Moderates the Relationship between Digital Capability and Value Co-Creation.

H7 Market environment dynamics Positively Moderates the Relationship between Supply chain resilience and Competitive Advantage of Enterprises.

H8 Resource integration capability Positively Moderates the Relationship between Digital capability and Value Co-Creation.

H9 There is a significant mediating effect of Supply chain resilience between Digital capability and Competitive advantage of enterprises.

H10 There is a significant mediating effect of Value Co-Creation between Digital capability and Competitive advantage of enterprises.

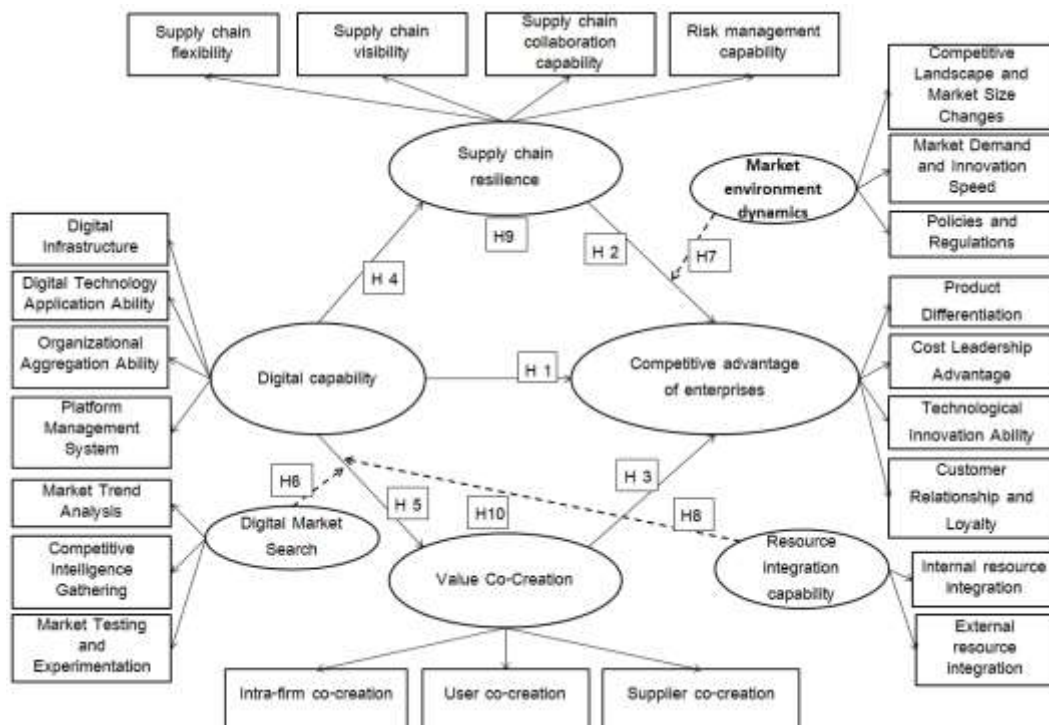


Figure 1: Framework-Relationship model

3. Methodology

3.1 Research Context and Sample

This study examines agricultural enterprises in China's southwestern provinces (Yunnan, Guizhou, and Sichuan), a region characterized by diverse agricultural systems, varying levels of economic development, and significant digital transformation initiatives. The agricultural sector in these provinces encompasses traditional farming, modern agribusiness, and emerging agricultural technology companies, providing rich variation for testing our theoretical framework.

Our sampling frame consisted of agricultural enterprises meeting three criteria: (1) minimum five years of operations to ensure organizational maturity, (2) engagement in agricultural production, processing, or services as primary business activities, and (3) employment of at least 10 full-time employees to ensure sufficient organizational complexity. We identified 863 eligible enterprises through government databases, industry associations, and business directories.

Data collection occurred between January and December 2024 through a quantitative methods approach. The research involved surveying senior and middle managers responsible for strategic planning, operations, and technology implementation. We distributed electronic questionnaires via established wenjuanxing platforms. After removing incomplete responses and conducting quality checks, we obtained 345 valid responses, representing a 40% response rate.

The sample exhibits diverse characteristics: 67.8% private enterprises, 29.6% state-owned/collective enterprises, and 2.6% foreign-invested or joint ventures. Enterprise age ranges from 5 to over 20 years, with 40% in the 5-10 year category. The sample includes agricultural production (42.3%), technology R&D (25.8%), agricultural services (18.6%), and input suppliers (13.3%). This diversity ensures broad generalizability of findings across different agricultural enterprise types.

3.2 Measurement Development

All constructs were measured using multi-item scales adapted from established literature and refined through expert consultation and pilot testing. Items were assessed on five-point Likert scales ranging from 1 (strongly disagree) to 5 (strongly agree).

Digital Capability was measured through 16 items across four dimensions based on Warner and Wäger (2019) and Mikalef et al. (2019): digital infrastructure (3 items), technology application ability (2 items), organizational aggregation capability (2 items), and platform management systems (2 items). Sample items include "Our enterprise has robust digital infrastructure supporting business operations" and "We effectively leverage digital platforms to coordinate with stakeholders."

Supply Chain Resilience encompassed 16 items across four dimensions adapted from Chowdhury and Quaddus (2017): flexibility (3 items), visibility (2 items), collaboration capability (2 items), and risk management (2 items). Representative items include "Our supply chain can quickly adapt to demand changes" and "We have effective risk identification and mitigation systems."

Value Co-Creation was assessed through 12 items covering three dimensions based on Ranjan and Read (2016): intra-firm co-creation (3 items), user co-creation (2 items), and supplier co-creation (2 items). Sample items include "Different departments actively collaborate to create value" and "We engage customers in product development processes."

Competitive Advantage was measured using 12 items across four dimensions adapted from Porter (1985) and Newbert (2008): product differentiation (2 items), cost leadership (2 items), technological innovation (2 items), and customer loyalty (2 items). Items include "Our products are clearly differentiated from competitors" and "We maintain strong customer relationships."

Moderating variables were measured using established scales: Resource Integration Capability (4 items, Sirmon et al., 2011), Market Environment Dynamics (6 items, Jansen et al., 2006), and Digital Market Search (6 items, Dong and Yang, 2020).

3.3 Analytical Approach

We employed partial least squares structural equation modeling (PLS-SEM) using SmartPLS 4.0 software for hypothesis testing. PLS-SEM is appropriate for complex models with multiple relationships and does not require multivariate normality assumptions (Hair et al., 2019). The analysis proceeded in two stages: assessment of the measurement model followed by structural model evaluation.

Measurement model quality was evaluated through reliability (Cronbach's α , composite reliability), convergent validity (average variance extracted), and discriminant validity (Fornell-Larcker criterion, HTMT ratios). Structural model assessment included path coefficients, explained variance (R^2), predictive relevance (Q^2), and effect sizes (f^2).

Mediation effects were tested using bootstrapping procedures with 5,000 resamples to generate confidence intervals. Moderation effects were examined through interaction terms using the two-stage approach recommended for PLS-SEM. Common method bias was assessed using Harman's single-factor test and marker variable techniques.

4. Results

4.1 Reliability and Validity Analysis

4.1.1 Reliability

The structural reliability demonstrates strong psychometric properties across all seven primary constructs. Digital Market Search exhibits the highest reliability performance with Composite Reliability (CR) of 0.944 and Average Variance Extracted (AVE) of 0.782, indicating robust measurement precision. The factor loadings range from 0.853 to 0.929, with MT1 achieving the strongest loading at 0.929, reflecting superior indicator performance within market trend analysis capabilities.

Digital Capability demonstrates exceptional reliability (CR=0.952, AVE=0.729). This suggests digital infrastructure serves as the most critical component of overall digital capability. Supply Chain Resilience and Value Co-Creation maintain comparable reliability levels (CR=0.938 and 0.919 respectively), both achieving AVE values of 0.675, indicating adequate convergent validity.

Resource Integration Capability shows moderate reliability (CR=0.883, AVE=0.741). Market Environment Dynamics presents the lowest AVE at 0.587, approaching the minimum threshold, while maintaining acceptable composite reliability (CR=0.858).

Competitive Advantage of Enterprises achieves satisfactory reliability (CR=0.906, AVE=0.607). The ρ_a values consistently exceed 0.870 across all constructs, confirming

internal consistency reliability. These results validate the measurement model's adequacy for subsequent structural equation modeling analysis.

4.1.2 Discriminant Validity (HTMT)

Heterotrait-Monotrait (HTMT) ratio assessment, discriminant validity demonstrates satisfactory construct differentiation with all values below the 0.85 threshold. Market Environment Dynamics exhibits the highest HTMT ratio with Resource Integration Capability (0.864), approaching but not exceeding critical limits, suggesting substantial conceptual overlap between environmental dynamics and integration processes.

Competitive Advantage of Enterprises shows moderate associations, particularly with Market Environment Dynamics (0.824), Supply Chain Resilience (0.818), and Value Co-Creation (0.820), indicating these capabilities serve as critical mediating mechanisms. Digital Market Search maintains balanced ratios, with strongest connections to Market Environment Dynamics (0.817) and Resource Integration Capability (0.802).

Digital Capability exhibits the most conservative HTMT profile, with all values below 0.80, demonstrating robust discriminant validity while maintaining meaningful theoretical relationships with other constructs.

4.2 Structural Model

Based on Table 1's path coefficient analysis, the structural relationships reveal significant direct and moderating effects within the proposed model. Digital Capability demonstrates the strongest direct relationship with Supply Chain Resilience ($\beta=0.914$, $t=77.171$, $p<0.001$), indicating that digital transformation fundamentally enhances organizational resilience capabilities. This exceptionally high coefficient suggests digital infrastructure and technological applications serve as critical foundations for supply chain adaptation mechanisms.

Supply Chain Resilience emerges as a crucial mediator, exhibiting substantial impact on Competitive Advantage of Enterprises ($\beta=0.367$, $t=8.439$, $p<0.001$). Value Co-Creation similarly influences competitive positioning ($\beta=0.322$, $t=6.935$, $p<0.001$), while Digital Capability maintains a moderate direct effect ($\beta=0.186$, $t=4.410$, $p<0.001$). Digital Capability also significantly drives Value Co-Creation ($\beta=0.340$, $t=6.396$, $p<0.001$), suggesting digital capabilities facilitate collaborative value creation processes.

The moderation effects present mixed results. Resource Integration Capability positively moderates the Digital Capability-Value Co-Creation relationship ($\beta=0.111$, $t=2.284$, $p=0.022$), indicating that integration competencies amplify digital capabilities' value creation potential. Market Environment Dynamics significantly moderates Supply Chain Resilience's impact on competitive advantage ($\beta=0.043$, $t=4.564$, $p<0.001$), though the effect magnitude remains modest.

Digital Market Search demonstrates a marginally significant negative moderation effect on Digital Capability-Value Co-Creation linkage ($\beta=-0.096$, $t=1.922$, $p=0.055$), suggesting potential interference between market intelligence activities and collaborative value creation processes.

Table 1: Path coefficients

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values
Digital capability -> Competitive advantage of enterprises	0.186	0.186	0.042	4.410	0.000
Digital capability -> Supply chain resilience	0.914	0.914	0.012	77.171	0.000
Digital capability -> Value Co-Creation	0.340	0.341	0.053	6.396	0.000
Supply chain resilience -> Competitive advantage of enterprises	0.367	0.366	0.043	8.439	0.000
Value Co-Creation -> Competitive advantage of enterprises	0.322	0.322	0.046	6.935	0.000
Resource integration capability x Digital capability -> Value Co-Creation	0.111	0.111	0.049	2.284	0.022
Market environment dynamics x Supply chain resilience -> Competitive advantage of enterprises	0.043	0.043	0.009	4.564	0.000
Digital Market Search x Digital capability -> Value Co-Creation	-0.096	-0.095	0.050	1.922	0.055

4.3 SmartPLS4 Results

4.3.1 Direct Effects

Based on Table 2's hypothesis testing results, the structural model demonstrates robust empirical support across the majority of proposed relationships. H1 receives strong confirmation, with Digital Capability exhibiting substantial total effect on Competitive Advantage of Enterprises ($\beta=0.631$, $t=12.617$, $p<0.001$). The large effect size ($f^2=0.863$) and tight confidence interval (0.531-0.723) validate digital capabilities' fundamental role in driving competitive outcomes.

H2 and H3 achieve significant support, confirming Supply Chain Resilience ($\beta=0.367$, $t=8.439$, $p<0.001$) and Value Co-Creation ($\beta=0.322$, $t=6.935$, $p<0.001$) as critical mediating mechanisms for competitive advantage. Both relationships demonstrate medium effect sizes and robust statistical significance, supporting the theoretical framework's mediation logic.

H4 receives exceptional empirical validation, with Digital Capability showing overwhelming influence on Supply Chain Resilience ($\beta=0.914$, $t=77.171$, $p<0.001$). This represents the strongest relationship within the entire model, accompanied by a very large

effect size ($f^2=5.079$), confirming digital transformation's foundational role in resilience development.

H5 gains significant support, demonstrating Digital Capability's moderate influence on Value Co-Creation ($\beta=0.340$, $t=6.396$, $p<0.001$). The medium effect size ($f^2=0.175$) indicates meaningful predictive relevance for collaborative value creation processes.

The moderation hypotheses present mixed results. H6 receives marginal support, with Digital Market Search showing weak negative moderation on Digital Capability-Value Co-Creation relationship ($\beta=-0.096$, $t=1.922$, $p=0.055$). H7 achieves strong confirmation, as Market Environment Dynamics significantly moderates Supply Chain Resilience's competitive impact ($\beta=0.043$, $t=4.564$, $p<0.001$). H8 gains significant support, with Resource Integration Capability positively moderating Digital Capability-Value Co-Creation linkage ($\beta=0.111$, $t=2.284$, $p=0.022$).

4.3.2 Indirect Effects

To test the mediation hypothesis, we followed the recommendation of Preacher and Hayes (2004; 2008) by assessing indirect effects through bootstrapping. If the confidence interval does not straddle 0, then we can conclude that there is a significant mediation effect. Based on Table 1's effects analysis, both mediation pathways demonstrate statistically significant relationships, confirming the theoretical framework's dual mediation structure. The Supply Chain Resilience pathway exhibits substantially stronger mediation effects ($\beta=0.335$, $t=8.388$, $p<0.001$) compared to the Value Co-Creation pathway ($\beta=0.109$, $t=4.885$, $p<0.001$), indicating that resilience mechanisms serve as the primary conduit through which digital capabilities influence competitive advantage.

The Supply Chain Resilience mediation pathway accounts for approximately 75% of the total indirect effect, with confidence intervals ranging from 0.257 to 0.414. This substantial mediation suggests that digital transformation initiatives primarily enhance competitive positioning by strengthening organizational adaptive capabilities, risk management systems, and supply chain flexibility. Agricultural enterprises appear to derive competitive benefits from digital investments through improved operational resilience rather than direct technological advantages.

The Value Co-Creation mediation pathway, while smaller in magnitude, remains theoretically significant with confidence intervals spanning 0.069 to 0.157. This pathway represents approximately 25% of the total indirect influence, indicating that digital capabilities facilitate collaborative value creation processes that subsequently contribute to competitive advantage. The combination of internal, supplier, and user co-creation activities provides a complementary mechanism for translating digital investments into competitive outcomes.

These findings validate the dual mediation model, demonstrating that Digital Capability influences Competitive Advantage through two distinct yet complementary pathways. The dominance of the resilience pathway suggests that agricultural enterprises should prioritize building adaptive capabilities while simultaneously developing collaborative value creation competencies to maximize the competitive benefits of digital transformation initiatives.

Table 2: Hypothesis Testing Effects

Hypothesis	Relationship	Std Beta	Std Error	t-values	p-values	f ²	VIF
H1	Digital capability -> Competitive advantage of enterprises	0.631	0.630	12.617	0.000	0.863	2.116
H2	Supply chain resilience -> Competitive advantage of enterprises	0.367	0.366	8.439	0.000	0.211	3.432
H3	Value Co-Creation -> Competitive advantage of enterprises	0.322	0.322	6.935	0.000	0.195	3.315
H4	Digital capability -> Supply chain resilience	0.914	0.914	77.171	0.000	5.079	1.000
H5	Digital capability -> Value Co-Creation	0.340	0.341	6.396	0.000	0.175	3.350
H6	Digital Market Search x Digital capability -> Value Co-Creation	-0.096	-0.095	1.922	0.055	0.011	13.141
H7	Market environment dynamics x Supply chain resilience -> Competitive advantage of enterprises	0.043	0.043	4.564	0.000	0.152	1.108
H8	Resource integration capability x Digital capability -> Value Co-Creation	0.111	0.111	2.284	0.022	0.021	4.910
H9	Digital capability -> Supply chain resilience -> Competitive advantage of enterprises	0.335	0.334	8.388	0.000*		
H10	Digital capability -> Value Co-Creation -> Competitive advantage of enterprises	0.109	0.109	4.885	0.000*		

5. Conclusion and Recommendation

5.1 Conclusion

Digital capability drives competitive advantage in agricultural enterprises, extending beyond technology adoption to comprehensive organizational transformation. It primarily influences outcomes through indirect pathways, with supply chain resilience mediating three-quarters of its impact, enabling firms to handle market disruptions and maintain operational continuity. Value co-creation, facilitated by digital platforms, plays a secondary but significant role, though less impactful than resilience. Successful digital transformation requires balancing adaptive resilience and collaborative capabilities.

Contextual factors shape outcomes, resource integration enhances value co-creation, while market volatility strengthens resilience's strategic value. However, excessive digital market search may hinder collaboration, requiring careful balance. Traditional financial metrics fail to capture long-term capability value, necessitating advanced performance measures.

Theoretically, this research enhances the Resource-Based View, dynamic capabilities, value co-creation, and supply chain management theories by highlighting resilience as a meta-capability and digital platforms' enabling role. Practically, agricultural enterprises should prioritize adaptive and collaborative capabilities, tailoring strategies to specific contexts. Digital transformation demands a paradigm shift, integrating digital capabilities with resilience and collaboration for sustainable competitive advantage across extended value networks, redefining capability development, performance measurement, and strategic management in digital environments.

5.2 Recommendation

5.2.1 Strategic Recommendations for Agricultural Enterprises

Agricultural enterprises should approach digital transformation as holistic capability development, not isolated technology projects. Competitive advantage arises from integrating digital capabilities, supply chain resilience, and value co-creation. Leaders should prioritize adaptive capabilities, focusing on risk management, supplier collaboration, supply chain visibility, and operational flexibility. Digital platforms should prioritize resilience over efficiency to build a foundation for value co-creation. Resource integration is key, requiring strong internal coordination through cross-functional teams, clear communication protocols, and governance structures for resource sharing. External partnerships with technology providers and research institutions should complement internal capabilities. The three-phase development pattern—foundation building, capability integration, and strategic orchestration—guides transformation. Enterprises should establish basic digital infrastructure first, then focus on process redesign and change management, and finally dynamically reconfigure capabilities to adapt to market changes. Each phase demands tailored management approaches to avoid rushing development.

5.2.2 Policy Recommendations for Government and Industry

Government policies should promote comprehensive capability development, not just technology adoption, through multi-year funding that accounts for long-term benefits. Policies should enable cross-industry collaboration via platforms connecting agricultural enterprises with technology firms and research institutions. Industry associations and government agencies should act as ecosystem orchestrators, facilitating network development through industry forums, knowledge-sharing platforms, and mentorship programs linking advanced and early-stage enterprises. Harmonizing regulations across provinces will reduce compliance burdens, allowing consistent digital transformation strategies and efficient resource use. Standardized regulations will simplify capability development for enterprises operating in multiple regions, supporting more effective digital transformation.

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Total Quality Management and Its Role in Enhancing Customer Satisfaction in the Chinese Catering Industry: A Case Study of Haidilao Chengdu

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Abstract

Total Quality Management (TQM) plays a crucial role in enhancing service quality within the catering industry, directly influencing customer satisfaction and sustainable competitive advantage. This study investigates the impact of TQM practices on customer satisfaction at Haidilao Chengdu, a leading Chinese hotpot chain renowned for its innovative service model. Utilizing a quantitative approach, data were collected via questionnaires from 400 Haidilao consumers and analyzed using multiple regression techniques. Results reveal that all key TQM dimensions—including Customer Focus, Employee Involvement, Process Management, and Systematic Management—significantly affect customer satisfaction, explaining approximately 61.3% of the variance in customer satisfaction scores. Notably, Customer Focus and Employee Involvement emerged as the strongest predictors. These findings underscore the importance of integrating comprehensive TQM practices in catering operations to meet evolving consumer demands. The study offers valuable insights for foodservice managers aiming to optimize quality management strategies, improve customer experiences, and sustain long-term competitive advantage in the dynamic Chinese catering market.

Keywords: Total Quality Management; Customer Satisfaction; Catering Industry

1. Introduction

1.1 Background and Context

Customer satisfaction is a critical determinant of success and sustainability in the global foodservice industry. In today's highly competitive catering environment, meeting customer expectations extends beyond product delivery to encompass comprehensive strategies for differentiation and long-term profitability. Worldwide, the foodservice market has undergone significant transformation driven by shifting consumer preferences, technological innovations, and intensified brand competition to secure customer loyalty. This trend is particularly pronounced in China, where rapid economic growth, urbanization, and increased consumer sophistication have rendered the catering sector one of the most dynamic and fast-evolving industries. High customer satisfaction directly contributes to consumer loyalty, brand equity, and profitability, with research consistently showing that satisfied customers demonstrate greater repurchase intentions, positive word-of-mouth, and willingness to pay premium prices (Kandampully et al., 2018; Othman et al., 2020). Consequently, catering businesses worldwide strongly invest in service quality improvement, workforce training, operational efficiency, and overall customer experience enhancement.

The COVID-19 pandemic posed unprecedented challenges, accelerating structural changes and redefining consumer expectations. Post-pandemic recovery focuses on two pivotal dimensions: digitalization and experiential innovation. Digital tools—including smart ordering systems, online reservations, and contactless payment—have become essential for operational sustainability and customer convenience. Simultaneously, the emerging “experience economy” underscores consumers' growing desire for emotional engagement, personalized human interactions, and immersive service environments (Kim & Lee, 2022). The integration of these elements is vital for

catering operators seeking to rebuild trust and stimulate demand.

Within this context, Haidilao Chengdu exemplifies industry excellence. Founded in 1994 and headquartered in Chengdu, Haidilao is distinctive for its pioneering commitment to exceptional service quality and innovative customer engagement. It combines premium ingredients with “service theatricalization” strategies such as complimentary manicures, intelligent queue management, and digital ordering platforms. These approaches have enabled Haidilao to consistently achieve high customer satisfaction and maintain market leadership despite intense competition (Zhang et al., 2021; Chengdu Consumer Council, 2023). Haidilao’s broad application of Total Quality Management (TQM) principles—including customer focus, employee empowerment, systematic process management, and supplier collaboration—forms a foundation for its sustained service excellence.

Despite Haidilao’s success and growing academic attention to its operational model, empirical studies analyzing the influence of individual TQM dimensions on consumer satisfaction within China’s catering context remain scarce. While TQM is well-studied across manufacturing and service sectors globally, detailed, data-driven evaluation of its components in large-scale, experiential-heavy catering operations is limited. Moreover, existing research often emphasizes service quality or marketing mix effects on satisfaction, neglecting the multi-dimensional and integrative nature of TQM. This study aims to address this gap by empirically assessing TQM’s role in shaping customer satisfaction at Haidilao Chengdu, providing nuanced insights into the relative impacts of distinct quality management practices.

1.2 Research Objectives

Recognizing quality management’s pivotal role in enhancing customer experience, this study systematically examines the influence of various TQM dimensions on consumer satisfaction at Haidilao Chengdu. Specifically, the objectives are to:

- 1) Evaluate the effects of key TQM dimensions—including Customer Focus, Employee Involvement, Process Management, Continuous Improvement, Data-Driven Decision Making, Prevention Focus, Supplier Collaboration, and Systematic Management—on Haidilao consumers’ satisfaction.
- 2) Quantify the relative importance and predictive power of each TQM dimension in explaining variations in customer satisfaction.
- 3) Provide evidence-based recommendations for catering managers to optimize quality management strategies and improve customer satisfaction in competitive foodservice markets.

These objectives aim to enrich academic understanding of TQM’s application in catering contexts while offering practical guidance for translating quality principles into enhanced service delivery.

1.3 Research Significance

This study contributes to both theoretical and practical domains within foodservice and quality management.

- 1) It provides catering industry leaders, especially in China, with robust empirical evidence to guide targeted investments in TQM dimensions that drive customer satisfaction. As competition intensifies and customer demands evolve rapidly, the findings support operators in balancing operational efficiencies with personalized care and innovation. Haidilao Chengdu’s position as a market leader offers a valuable benchmark for best practices applicable to domestic and international

foodservice brands.

2) The research fills a critical gap by unpacking the complex interplay between TQM practices and customer satisfaction in a culturally rich, experience-centric catering environment. By dissecting TQM into interconnected yet distinct dimensions, the study advances quality management literature beyond generic service quality constructs. It integrates classical TQM frameworks (Dahlgaard-Park, 2012) with contemporary service marketing theories and empirical data, presenting a comprehensive, pragmatic model for further inquiry and practice.

3) The study responds to calls for localized empirical investigations in emerging economies, where traditional cultural values and modern management approaches interplay uniquely. The results enrich cross-cultural service management theory and contextualize TQM's relevance within rapidly growing, innovation-driven urban centers like Chengdu, renowned for gastronomic leadership.

In summary, this research rigorously analyzes Total Quality Management's implementation at Haidilao Chengdu and its impact on customer satisfaction, delivering vital insights for academics, practitioners, and policymakers committed to fostering sustainable excellence in the catering industry.

2. Research Scope

2.1 Population and Sampling

The focal population of this study comprises consumers who have dined at Haidilao hotpot restaurants located in Chengdu, Sichuan Province, China, within the period from February 2024 to February 2025. Chengdu, recognized as China's gastronomic hub and the birthplace of Haidilao, represents a strategic locale for examining consumer satisfaction in the hotpot catering sector. The study deliberately targets this population due to Haidilao's significant market presence and pioneering integration of Total Quality Management (TQM) practices within its service operations.

As the exact size and characteristics of the customer population were unknown and dynamic, the sample size was determined using Cochran's formula for infinite populations. This robust statistical method provides an optimal sample size with consideration for desired confidence levels and marginal error, enhancing the representativeness of the sample. Specifically, a confidence level of 95% ($Z = 1.96$) and a margin of error of $\pm 5\%$ were employed. Given an assumed response proportion (p) of 50%—maximizing variance and ensuring conservativeness—the initial sample size calculation yielded 385 participants. To account for potential non-response, invalid questionnaires, and data anomalies, the sample size was prudently increased by approximately 10%, resulting in a target sample of 400 respondents.

2.2 Research Instrument

The principal research instrument in this study was a structured questionnaire developed based on an extensive literature review of Total Quality Management (TQM) theory and customer satisfaction constructs. The questionnaire was carefully designed to capture the multifaceted dimensions of TQM as applied to Haidilao's catering services, alongside measuring consumer satisfaction levels.

Respondents were asked to indicate their level of agreement with statements related to each TQM dimension using a five-point Likert scale, ranging from 1 ("Strongly Disagree") to 5 ("Strongly Agree"). This approach enabled quantitative assessment of nuanced attitudes and allowed for statistical analysis of the strength and direction of relationships between variables.

To ensure the instrument's validity and reliability, the questionnaire underwent a multi-stage development process. Initially, academic supervisors and domain experts reviewed the draft for content validity and contextual appropriateness within the Chengdu catering market. Subsequently, a pilot test involving 30 respondents with characteristics similar to the target sample was conducted. Reliability analysis using Cronbach's alpha was performed for each dimension and the overall questionnaire. Results demonstrated acceptable internal consistency, with Cronbach's alpha values exceeding the commonly accepted threshold of 0.70 across all TQM dimensions and consumer satisfaction measures. This validated the instrument's suitability for capturing reliable data in the full-scale study.

2.3 Variables and Conceptual Framework

2.3.1 Independent variables

- 1) Customer Focus: Emphasizes prioritizing customer needs, personalized services, and effective complaint resolution mechanisms.
- 2) Employee Involvement: Reflects the engagement, empowerment, and continual training of frontline staff involved in service delivery.
- 3) Process Management: Concerns standardized procedures for food preparation, hygiene, and service operations to ensure consistency and quality.
- 4) Continuous Improvement: Highlights the organization's commitment to ongoing service enhancements driven by feedback and innovation.
- 5) Data-Driven Decision Making: Involves the usage of consumer data analytics and technological tools to inform service optimization.
- 6) Prevention Focus: Represents proactive measures to mitigate risks, avoid errors, and ensure food safety.
- 7) Supplier Collaboration: Includes joint initiatives with suppliers to maintain ingredient quality and supply chain integrity.
- 8) Systematic Management: Pertains to coordinated quality management systems, documentation, and adherence to standards ensuring operational coherence.

2.3.2 Dependent variable

Customer Satisfaction operationalized as consumers' holistic evaluation of their dining experience at Haidilao Chengdu. This encompasses perceived service quality, value for money, staff attitude, food freshness, and overall willingness to revisit or recommend the restaurant.

2.4 Data Collection and Analysis Methods

Data collection was executed over a three-month period, from November 2024 to February 2025. Respondents completed the online questionnaire voluntarily, with anonymity assured to encourage candid responses. The data collection process included reminder notifications and validation checks to minimize incomplete responses and enhance response rates.

- 1) Descriptive Statistics: Used to summarize respondent demographics and the general distribution of opinions on TQM dimensions and customer satisfaction. Measures such as frequencies, percentages, means, and standard deviations provided insight into central tendencies and variability within the data.
- 2) Inferential Statistics: Multiple regression analysis was employed to test hypotheses regarding the impact of TQM dimensions on customer satisfaction. Significance was evaluated at the 0.05 level,

ensuring statistical rigor in determining meaningful effects. Additional tests, such as reliability assessments and test for multicollinearity, were conducted to validate model assumptions.

3. Results

3.1 Descriptive Statistics

Table 1: The means and standard deviations (SD) of the responses for each of the eight TQM dimensions measured

Variable	Mean	SD
Process Management	4.17	0.02
Prevention Focus	4.08	0.08
Customer Focus	4.06	0.06
Employee Involvement	4.00	0.15
Data-Driven Decision Making	4.04	0.11
Supplier Collaboration	4.01	0.10
Continuous Improvement	3.98	0.09
Systematic Management	3.91	0.05
Consumer Satisfaction	4.16	0.04

[Likert scale ratings ranged from 1 (strongly disagree) to 5 (strongly agree).]

From the table 1, we can see that Process Management received the highest mean score indicating strong agreement among respondents regarding standardized procedures, hygiene protocols, and operational consistency at Haidilao; Prevention Focus followed closely, reflecting customer recognition of proactive error prevention and food safety measures; Customer Focus and Employee Involvement also received high scores; suggesting that customers perceived Haidilao's responsiveness and employee empowerment positively; Dimensions such as Data-Driven Decision Making and Supplier Collaboration elicited moderate agreement, indicating some consumer awareness of behind-the-scenes analytics and supply chain management; Continuous Improvement and Systematic Management had relatively lower mean scores, although still within the "Agree" range, highlighting areas that may be perceived as less visible or less directly impacting customer experience.

3.2 Regression Model

A multiple linear regression was conducted to determine the unique predictive influence of each of the TQM on consumer satisfaction.

Table 2: Standardized β Coefficients and Significance

Predictor	β	t-value	p-value
Customer Focus	0.42	5.90	<0.001
Employee Involvement	0.38	6.14	<0.001
Process Management	0.35	4.37	0.002
Systematic Management	0.33	4.70	<0.001
Continuous Improvement	0.31	3.45	0.004
Data-Driven Decision Making	0.27	2.46	0.015
Prevention Focus	0.24	2.40	0.017
Supplier Collaboration	0.19	2.37	0.018

From the table 2, we can see that all eight dimensions of Total Quality Management (TQM) significantly contribute to consumer satisfaction at Haidilao Chengdu with p-values less than 0.05. Among them, Customer Focus exhibits the strongest positive effect ($\beta = 0.42$), highlighting the importance of aligning services closely with customer needs. Employee Involvement and Process Management also show substantial impacts ($\beta = 0.38$ and 0.35 , respectively), emphasizing the vital role of empowered staff and standardized service processes. Systematic Management and Continuous Improvement further reinforce the organizational coordination and ongoing quality enhancements as critical drivers. Although Data-Driven Decision Making, Prevention Focus, and Supplier Collaboration present relatively smaller β values, their statistically significant influence confirms that supportive management practices underpin the operational excellence necessary for sustaining high satisfaction levels. This multidimensional TQM framework thus provides a robust strategic foundation for enhancing service quality and fostering customer loyalty in the catering industry.

3.3 Interpretation of Results

1) Customer Focus as the Primary Driver: The prominent influence of Customer Focus on satisfaction corroborates foundational theories in TQM and marketing. Haidilao's practice of rapidly responding to personalized needs—such as adjusting spice levels, scheduling seating preferences, and efficiently resolving complaints—enhances customers' perceived value and fulfillment. The availability of multi-channel feedback systems (surveys, app reviews, manager follow-ups) enables Haidilao to continuously align service delivery with evolving consumer expectations. Real-time responsiveness fosters trust and emotional connection, reducing the perceived risk associated with dining decisions. Such alignment between expectation and experience is key to satisfaction theories (Oliver, 1980) and explains the strong statistical weight found here.

2) Employee Involvement and Empowerment: Staff empowerment and active involvement also strongly contribute to satisfaction. Haidilao's mentorship programs, frontline decision-making authority (e.g., complimentary dish approval), and proactive service behaviors exemplify empowerment theory's assertion that engaged employees deliver superior customer experiences. This supports the service encounter literature, where the customer-employee relationship is critical (Bitner, 1992). Proactive offering of amenities and rapid issue resolution not only increase satisfaction but also enhance brand loyalty by creating memorable interpersonal experiences amidst standardized

processes.

3) Process Management and Systematic Management: The significance of Process Management reflects the importance of standardized, consistent operations in the foodservice industry. Customers value reliable food preparation, hygiene, and open kitchen transparency that mitigate uncertainty and assure quality. Similarly, Systematic Management's role underscores how organizational coherence—through formalized quality controls, response mechanisms, and employee feedback integration—maintains high-quality service amid operational complexity. These findings are consistent with Deming's principle that systemic quality management drives consistent outcomes.

4) Lower but Important Effects of Data-Driven Decision Making, Prevention Focus, and Supplier Collaboration: Dimensions such as Data-Driven Decision Making and Prevention Focus, though less visible to consumers, contribute indirectly by optimizing operations and minimizing service failures. Haidilao's use of AI-powered recommendation engines and predictive analytics enhances menu offerings and wait-time management, but the impact on customer satisfaction is mediated by front-end service quality. Similarly, rigorous food safety systems and blockchain-enabled transparency in supplier relations reassure customers through back-end risk mitigation, although not directly influential on experiential satisfaction scores. This matches research indicating such practices improve customer trust and brand image over time, rather than short-term experiential ratings.

These findings corroborate prior studies demonstrating TQM's positive influence on customer satisfaction in service industries (Dahlgaard-Park, 2012; Wang & Zhang, 2022). The prominence of Customer Focus and Employee Involvement echoes Dahlgaard-Park and Dahlgaard's core TQM framework, asserting these dimensions as foundation stones of effective quality management. Results also align with Prajogo and McDermott (2005), who identified process standardization and continuous improvement as key to service excellence. However, the relatively modest impact of data-driven analytics contrasts some manufacturing studies where measurement and control play even larger roles. This discrepancy reflects the unique human-centric nature of catering services, where frontline employee interaction remains paramount.

The analysis provides compelling empirical evidence that Total Quality Management practices—especially those involving customer orientation and employee empowerment—are vital in elevating customer satisfaction at Haidilao Chengdu. While operational and supply chain controls underpin service reliability, customer perceptions are shaped most significantly by personalized attention and staff engagement. These insights offer a valuable foundation for hospitality managers seeking to optimize quality strategies in increasingly competitive and technology-enhanced foodservice markets.

4. Conclusion

4.1 Summary of Key Findings

This study set out to investigate the role of Total Quality Management (TQM) in enhancing customer satisfaction within the Chinese catering industry, using Haidilao Chengdu as a focal case. The empirical analysis, based on survey data from 400 Haidilao consumers, established that TQM practices significantly and positively impact customer satisfaction. Collectively, the eight dimensions of TQM investigated in this research explained approximately 61.3% of the variance in consumer

satisfaction levels, underscoring TQM's critical role in service quality management within the foodservice sector.

Among the dimensions examined, Customer Focus emerged as the most substantial contributor to customer satisfaction. This finding resonates with foundational quality management and marketing principles highlighting the centrality of understanding and promptly responding to individual customer needs as a key determinant of perceived service excellence. Haidilao's mechanisms—such as personalized adjustments to flavor preferences, comprehensive complaint handling systems, and systematic feedback collection—appear well-aligned with consumer expectations, strengthening their satisfaction and loyalty.

Closely following were Employee Involvement and Process Management. Employee involvement, through empowerment initiatives and comprehensive training programs, greatly enhanced Haidilao's ability to deliver agile, personalized services at scale. The frontline staff's proactive service behaviors contributed directly to customers' positive dining experiences and perceptions of the brand's reliability. Meanwhile, Process Management, emphasizing standardized food preparation and hygiene protocols, reinforced consistency and trust, which are especially crucial in the catering context where food safety and quality are non-negotiable.

Other TQM components, including Systematic Management and Continuous Improvement, also showed significant positive effects, suggesting that effective organizational coordination and an ongoing commitment to service enhancement are important drivers of customer satisfaction. Although Data-Driven Decision Making, Prevention Focus, and Supplier Collaboration had somewhat smaller impacts, their statistically significant contributions affirm their supporting roles in maintaining operational excellence and quality assurance behind the scenes.

Together, these findings confirm the theoretical assertion that a robust, multidimensional TQM framework spanning customer orientation, employee empowerment, process efficiency, and organizational coordination undergird superior service quality and customer satisfaction in the competitive catering industry.

4.2 Managerial Implications

The results of this study offer several actionable implications for catering industry operators seeking to elevate service quality and customer satisfaction through TQM integration.

1) Prioritizing customer-centric quality practices must remain paramount. Managers should invest in systems that capture real-time customer preferences and feedback effectively, enabling tailored service delivery that resonates with individual needs. Digital tools such as mobile app reviews, sentiment analysis, and direct customer engagement platforms can facilitate this customer focus, ensuring continuous alignment between service offerings and evolving expectations.

2) Empowering and training employees emerges as a strategic imperative. Catering firms must design and implement comprehensive training programs that not only develop technical competencies but also foster emotional intelligence, problem-solving skills, and autonomy in frontline staff. Employee empowerment mechanisms—such as granting authority to resolve complaints and innovate service offerings—can enhance responsiveness and create differentiated service experiences that elevate customer satisfaction.

3) Standardizing key service processes and integrating systematic management are critical for maintaining consistent quality and food safety. Establishing documented standard operating procedures (SOPs), rigorous hygiene inspection routines, and rapid response mechanisms ensures

reliability in service delivery and mitigates risks that could damage brand reputation. Developing cross-departmental quality management teams facilitates holistic coordination, improving organizational agility in responding to service disruptions or customer concerns.

4) Catering operators should harness customer feedback and data analytics as engines for continuous improvement. The collection and analysis of consumer data enable firms to identify pain points, test new service innovations, and adapt processes dynamically. Cultivating a culture of data-driven decision making ensures that quality enhancements are evidence-based and aligned strategically with customer needs. For example, analyzing dining patterns could optimize kitchen workflows or refine menu offerings, while feedback loops support iterative service refinements and innovation.

Collectively, these managerial recommendations coalesce into a framework whereby catering enterprises can holistically embed TQM principles into their operating models, transforming quality management from a compliance obligation into a strategic differentiator that sustains competitive advantage and fosters long-term customer loyalty.

4.3 Limitations

While this study contributes valuable insights, it is essential to acknowledge several limitations that frame the interpretation and generalizability of the findings, as well as highlight areas for future exploration.

1) The geographic specificity of the research sample, which exclusively focused on Haidilao consumers in Chengdu. Although Chengdu is a critical hub for hotpot dining and digital innovation, consumer behavior and service expectations may differ across other regions and cities in China, especially between urban and rural areas or cultural sub-genres within the catering industry. Future research should extend the scope to diverse geographic contexts to examine regional variations and facilitate broader generalizations.

2) The study employed a quantitative survey methodology emphasizing numerical measurement and hypothesis testing. While this approach robustly assesses relationships and predictive powers, it limits the depth of understanding regarding underlying consumer motivations and service experience nuances. Subsequent studies might incorporate qualitative approaches, such as in-depth interviews or ethnographic observation, to capture rich, contextual insights that reveal the lived experience of customers and frontline employees, thereby enriching the theoretical framework.

3) This research concentrated specifically on TQM dimensions influencing customer satisfaction, leaving other potentially impactful factors unexplored. For example, corporate image, brand equity, and overall service quality perceptions, though related, were outside this study's scope. Integrating these constructs could yield a more comprehensive understanding of satisfaction drivers and the interplay between quality management and marketing strategies.

4.4 Future Research

Despite the valuable insights provided by this study on the influence of Total Quality Management (TQM) on customer satisfaction in Haidilao Chengdu's catering services, several avenues remain open for future investigation to further deepen and broaden understanding in this field.

1) Expanding Geographic and Cultural Contexts

This study was geographically confined to Chengdu, a city with unique gastronomic culture,

advanced digital integration, and a strong presence of Haidilao. Future research should consider replicating the study across other regions in China, including smaller cities and rural areas, where service expectations, cultural influences, and digital adoption levels may differ significantly. Comparative studies across cities with distinct cultural and economic backgrounds would help identify regional variations in TQM effectiveness and customer satisfaction, thus improving the generalizability and contextual relevance of findings. Moreover, cross-cultural studies involving Haidilao outlets in overseas markets can illuminate the adaptability and challenges of applying TQM principles in diverse international catering environments.

2) Incorporating Qualitative and Mixed-Methods Approaches

While this research adopted a quantitative survey methodology focusing on statistical relationships, it did not capture the rich, experiential nuances behind consumer satisfaction and TQM perceptions. Future studies should incorporate qualitative methods such as in-depth interviews, focus groups, and ethnographies to explore customers lived experiences and frontline employee insights. These approaches can uncover underlying motivations, emotional drivers, and cultural factors shaping satisfaction, providing a holistic and deeper understanding of TQM impacts beyond numerical scores. Mixed-methods designs can integrate quantitative rigor with qualitative depth, offering comprehensive frameworks to refine theory and practice.

3) Exploring Additional Influential Factors and Longitudinal Dynamics

This study centered exclusively on the eight dimensions of TQM as predictors of customer satisfaction, yet other constructs such as corporate image, brand equity, service innovation, and overall perceived service quality remain unexamined. Future research should investigate how these factors interact with TQM practices to influence satisfaction and loyalty, thereby constructing more integrative service management models. Additionally, longitudinal studies tracking changes over time would be beneficial to assess the sustained effects of TQM implementation on customer satisfaction, behavioral loyalty, and business performance. Such dynamic analyses can provide actionable insights on how quality management evolves in response to market trends and consumer expectations.

4) Technological Integration and Customer Experience Innovation

Given the increasing digitalization of the catering industry highlighted in this study, future research could examine in detail how emerging technologies—such as artificial intelligence, big data analytics, and Internet of Things (IoT)—synergize with TQM frameworks to enhance customer satisfaction. Investigating the roles of digital service platforms, smart ordering, and data-driven personalization in tandem with TQM dimensions can reveal pathways for innovative quality management that balances operational efficiency with enriched experiential value, thereby guiding foodservice enterprises toward future-ready sustainable competitiveness.

Collectively, these future research directions will enrich scholarly understanding and practical applications of TQM in the catering sector, supporting continuous improvements in customer experiences and competitive advantage in an increasingly complex and globalized foodservice market.

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Digital Transformation in Strategic Enrollment Management: A Study of Universities in Yunnan Province

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Abstract

Digital transformation is reshaping higher education worldwide. Digitization has become a key pathway for universities' development. It means not only providing digital technologies to improve teaching methods but also providing evidence-based approaches to support decision-making, strengthen competitiveness, adjust educational resources with social and economic demands. Strategic Enrollment Management (SEM) is a core link in digital transformation that connects with enrollment situations and university development goals. However, the integration of digital technologies into SEM has not yet been systematically studied in provincial universities, such as Yunnan Province. This study identifies key factors influencing successful digital transformation through policy documents and studies on digital education and enrollment management from 2010 to 2025. The researcher conducted a two-round Delphi study with 17 experts from provincial admissions authorities and universities. These sources indicate that digital tools enhance the accuracy of enrollment forecasts and enable more targeted planning, thereby supporting better decision-making at the university level. From a theoretical perspective, it offers empirical evidence on digital transformation in SEM and recommendations for enrollment staff. Practically, it offers feasible recommendations for universities to develop digital transformation in SEM, keeping pace with higher education worldwide.

Keywords: Digital transformation, Strategic Enrollment Management (SEM), Higher education, Yunnan Province, Digital platforms

1. Introduction

1.1 Digital Transformation in Higher Education

In recent years, digital transformation, integrating advanced data analysis, artificial intelligence, and information systems, has become essential for universities seeking to enhance both academic and administrative outcomes, especially in SEM. To reflect this global trend, Chinese policy initiatives such as the "Education Modernization Agenda 2035" and institutional five-year plans, increasingly envision digital transformation as a strategic lever for integrating innovation into core functions (Xiao, 2023). SEM has gained prominence as an area where digital tools can significantly improve institutional effectiveness. Within such a transformation process, areas such as SEM and student services stand out, which directly linked to a university's development goals. Digital tools have significantly enhanced institutional

operational efficiency and responsiveness in the areas, such as enrollment forecasting and data analysis, targeted enrollment promotion, enrollment strategy evaluation and optimization.

1.2 Strategic Enrollment Management (SEM)

SEM is a systematic approach that enables universities to enhance the quality of student recruitment and strengthen institutional competitiveness. Its key components include: (1) establishing enrollment objectives aligned with universities' development goals, educational quality standards, and disciplinary strengths; (2) adopting innovative branding and publicity strategies across both online and offline channels; (3) implementing transparent, scientifically grounded selection processes; and (4) leveraging historical enrollment data through big data analytics to support evidence-based decision-making. Importantly, these elements are interconnected and mutually influence each other during the enrollment process. To sum up, SEM aims to balance academic objectives, financial sustainability, and regional needs. Its success depends on timely and accurate information across departmental collaboration, both of which can be significantly enhanced through digital transformation. However, despite the widespread applicability of SEM, the applications and research of digital transformation in SEM remain relatively scarce among provincial institutions in China. Therefore, this study aims to explore how provincial universities implement digital transformation in SEM.

1.3 Enrollment Challenges and Opportunities in Yunnan Province

SEM faces two core challenges: preventing over-enrollment that undermines teaching quality, and avoiding under-enrollment that leaves educational resources underused. To address these challenges, the university constantly modifies the enrollment plans across academic disciplines and major structures to optimize the input-output efficiency to keep the quality of education through analysis of employment market trends.

According to Yunnan Daily (2025), the province has allocated 136,000 policy-driven positions, including 7,521 civil-service posts, 35,280 roles in public institutions, and 6,927 grassroots appointments. The policy and labor market data provide important benchmarks for enrollment planning of universities in Yunnan. Compared with 2024, this represents an increase of 20,200 positions. Such a steady recruitment of growth provides a useful reference point for adjusting enrollment targets and designing more focused teaching and training pathways in the future. In response, Yunnan Province launched the "Fifteen Measures for Large-Scale Vocational Skills Enhancement", introducing six sector-specific programs in plateau-specific agriculture, Chinese medicinal materials, culture and tourism, elderly care services, green energy, and labor-intensive industries (Yunnan. Cn, 2025). By integrating institutional data with external economic and policy indicators, the SEM enables universities to adjust enrollment structures in an informed and agile fashion. Establishing a SEM across Yunnan's universities enables the dynamic allocation of enrollment quotas based on social and economic development. This approach optimizes the utilization of educational resources dynamically. Moreover, it improves the comprehensive quality and consistency of education in Yunnan Province by expanding capacity in high-growth fields and phasing out majors with declining demand. As Cui (2020) argues, the university admission system not only mediates government oversight, institutional autonomy, and public expectations but also fosters high-

quality talent development in a rapidly changing policy and market environment. With the advancement of emerging technological domains such as artificial intelligence and big data, it is essential to expand the enrollment plan in relevant academic disciplines and majors. Universities in Yunnan have begun expanding enrollment in emerging fields while scaling back programs with low demand or limited job prospects. And Hu and Wang (2024) note, incorporating data analytics and decision-support tools into enrollment systems is essential for adapting to ongoing reforms and improving institutional responsiveness.

Yunnan Province, which participated in the fifth wave of college entrance examination reform in 2025, exemplifies these challenges. China's demographic shift—marked by a declining birth rate and changing tertiary education demand—has intensified competition for student recruitment and prompted universities to adapt strategically (Wu & Cheng, 2025). In this context, the convergence of SEM and digital transformation presents both an opportunity and an urgent need, yet remains inadequately studied. In addition, 17 experts in higher education management, policy, and strategic enrollment were purposively recruited to participate in the Delphi rounds and follow-up interviews. In purposive sampling, 17 experts who are from Provincial admissions authorities and different undergraduate universities, with extensive experience in enrollment management, higher education administration, and related fields were selected based on their academic credentials, professional roles, and familiarity with strategic enrollment issues in the region. These experts participated in multiple rounds of content validation and framework development. From two rounds of expert surveys, 17 participants have confirmed the recognized importance and necessity of digital platforms in SEM within Yunnan's universities of my research. The content validity index (CVI) for the element (digital platforms in SEM) achieved $CVI=0.98$; its communality in subsequent factor analysis was 0.957, indicating strong shared variance. This consensus highlights the growing awareness among practitioners of technology's critical role in enhancing data-driven decision-making and enrollment planning, providing a solid empirical foundation for further investigation.

This paper aims to review existing literature on digital transformation and SEM in the higher education context, with particular emphasis on provincial universities in Yunnan. It seeks to identify key factors that enable the successful integration of digital tools into SEM, thereby contributing both to theoretical understanding and to practical strategies for enhancing SEM under conditions of regional reform.

2. Literature review

The digital transformation of higher education has evolved from a narrow focus on technology adoption to a comprehensive reimagining. In this context, SEM has become a critical domain for digitalization, as universities aligns recruitment, retention, and student success. Digital transformation within SEM transcends mere technology adoption, encompassing holistic organizational change, governance realignment, and stakeholder value creation. The following literature review synthesizes both international and Chinese research, highlighting critical success factors, implementation challenges, and emerging trends in digital SEM.

2.1 International research

Digital transformation in SEM requires the integration of advanced technologies, particularly artificial intelligence and predictive analytics. Building on these theoretical insights, empirical studies have examined how digital strategies impact SEM outcomes. These studies indicate that universities with strong leadership and coordinated digital strategies achieve better recruitment, retention, and operational efficiency.

Theoretical Foundations of Digital Transformation in SEM

Castro-Benavides et al. (2020) established a foundational framework demonstrating that meaningful digital transformation necessitates the integration of digital technologies with process redesign and governance restructuring, rather than merely digitizing existing practices. This pattern shift holds particular significance for SEM, where digital tools must be strategically embedded within broader institutional frameworks that align enrollment capacity with both labor market demands and societal needs. This perspective is strongly corroborated by large-scale studies from Brooks and McCormack (2020) and Kane (2017), which reveal that institutions with coherent digital strategies, committed leadership, and effective cross-functional coordination achieve more sustainable SEM outcomes. Across studies, successful digital SEM depends on: (1) analytics-driven processes, (2) integrated information systems and governance, and (3) organizational capability-building.

Fernández et al. (2023) expanded this conceptual foundation through their multivocal review, which identified four key clusters of digital transformation initiatives directly relevant to SEM: (1) advanced analytics and predictive modeling for forecasting enrollment demand; (2) integrated student information that enable seamless data flow from application through to graduation; (3) digital engagement platforms that strengthen both recruitment and student retention; and (4) organizational capability-building, including digital literacy development and change management. These findings highlight that effective digital transformation in SEM goes well beyond the adoption of technology, requiring strategic realignment and cultural change at the institutional level.

Artificial Intelligence, Technology Integration, and Data-Driven Decision-Making

The integration of digital technologies represents a transformative frontier in enrollment management digitalization. Schiff (2021) demonstrated that AI-powered systems can enhance operational efficiency and accessibility, emphasizing the potential of AI to reshape enrollment processes. George and Wooden (2023) extended this analysis, providing evidence that AI applications can streamline admissions workflows, optimize course scheduling algorithms, and reduce administrative overhead while enabling increasingly sophisticated personalization for prospective students.

Thotharat et al. (2019) contextualized these technological advances within the historical evolution of SEM, tracing the progression from early recruitment tracking systems of the 1970s to contemporary comprehensive education analytics platforms. Linking Customer Relationship Management systems with application analytics and student success platforms have been shown to improve recruitment efficiency, personalize student communications, and support early-warning retention interventions (Grajek, 2020; Thotharat et al., 2019). In addition, Sghir (2022) discusses integration of digital technologies in higher education to enhance decision-making processes. Nyoni (2025) examines the application of data analytics for predicting

outcomes in education. Rehman et al. (2025) discuss the integration of digital technologies into curricula and the development of national data-sharing platforms in Chinese universities.

The convergence of these technological capabilities with strategic organizational maturity suggests that institutions are increasingly positioned to leverage sophisticated analytics for predictive modeling, automated workflow optimization. Such evidence-based decision-making can substantially enhance both enrollment outcomes and student success trajectories.

2.2 Chinese research

Digital transformation in China's higher education sector is shaped by a distinctive combination of top-down national policy directives, rapid technological advancements, and challenges associated with regional adaptation. Despite national platforms and directives, implementation remains uneven; inland provinces face capacity constraints, underscoring the need for culturally responsive, context-aware SEM models in Yunnan.

National Policy Framework and Strategic Direction

China's digital transformation in higher education enrollment management is fundamentally shaped by comprehensive national policy initiatives that establish both strategic direction and implementation parameters. The "Education Informatization 2.0 Action Plan" marks a significant shift, transitioning from infrastructure-focused development toward innovation-driven digital education approaches (Yan & Yang, 2021). The plan's "One Goal, Three Tasks, Eight Actions" framework emphasizes human-centered pedagogical methodologies, comprehensive digital resource sharing, and governance modernization as foundational elements of educational transformation.

Xiao (2023) analyzed the "14th Five-Year Plan" implementations across leading Chinese universities, revealing widespread adoption of cloud computing and artificial intelligence technologies to support institutional missions, including SEM. Zhou (2025) provided evidence that AI-powered systems can improve operational efficiency and broaden accessibility, highlighting their transformative potential in enrollment processes. This policy-driven approach creates an environment where digital transformation becomes not merely optional but integral to institutional strategy.

The Ministry of Education's Smart Education has seen substantial technological advancements, incorporating AI-enhanced content delivery systems, nationwide data-sharing networks, and comprehensive lifelong learning platforms. Together, these developments offer universities a sophisticated digital ecosystem for strengthening enrollment management. However, realizing their full potential requires aligning national policy directives with effective institutional change management strategies (Yan & Yang, 2021).

Regional Disparities and the Imperative for Cultural Adaptation

Despite national platforms and directives, implementation remains uneven; inland provinces face capacity constraints, underscoring the need for culturally responsive, context-aware SEM models in Yunnan. Zhang and Verhoeven (2010) highlight the critical need for culturally responsive and localized enrollment management frameworks in Yunnan, emphasizing the province's ethnic diversity and economic variation. Zhu, Noichan, and Siththada (2025) emphasize the importance of systematically integrating local characteristics into enrollment management frameworks in Yunnan, advocating for culturally responsive and contextually appropriate approaches. These findings suggest that, while national policies

provide overarching strategic guidance, effective implementation relies on careful localization to address specific institutional and regional needs for achieving effectiveness and ensuring equitable access across diverse student populations.

In summary, the Chinese literature portrays a dynamic landscape of policy-driven digitalization in SEM, marked by rapid technological advancement but constrained by regional disparities. While most studies focus on technical system design or isolated institutional case studies. There is limited investigation into how digital transformation intersects with SEM as a strategic framework at the regional level. More comprehensive research is needed to understand how digital tools and data-driven practices can be systematically embedded into enrollment strategies within less-developed higher education ecosystems, ensuring both efficiency and equity.

3. Methodology

This study is grounded in the related concepts and theories and a focused literature review. Methodological steps comprised a targeted synthesis of international and Chinese research and policy documents, with attention to conceptual and empirical work on digital transformation and SEM. The review process emphasized identification of conceptual clusters and critical success factors relevant to digital SEM—particularly advanced analytics and predictive modeling, integrated student information systems, digital engagement platforms, and organizational capability-building. The analytic approach was a literature-based synthesis that integrated theoretical foundations with empirical findings reported in the international and Chinese bodies of work to produce an integrated characterization of digital SEM.

Sub-Section 1

Literature search was conducted across Scopus, CNKI and Google Scholar using keywords including “strategic enrollment management”, “digital transformation”, “artificial intelligence”, and “predictive analytics” for the period 2010-2025. Additional sources included policy documents and government websites, conference proceedings, and institutional repositories.

Sub-Section 2

The Delphi study recruited 17 experts from provincial admissions authorities and undergraduate universities, selected purposively for expertise in enrollment management and higher education policy. The instrument comprised N items scored on a 5-point Likert scale.

4. Results

4.1 Related concepts and theories

4.1.1 Concepts

Intelligent enrollment management system: digital platforms designed using artificial intelligence, machine learning, and other technologies may perform tasks such as automated candidate information processing and intelligent data analysis.

The development and deployment of an intelligent enrollment system are significant markers of the modernization of enrollment information management. High-quality enrollment data is critical for making informed strategic decisions.

4.1.2 Theories

Data-Driven Decision-Making places data at the center of the enrollment process, involving the collection and analysis of large volumes of enrollment-related information, including candidates' academic performance, enrollment behaviors, institutional admission plans, and historical enrollment records. For example, based on prior years' enrollment data, the popularity of each major is forecasted, and the enrollment plan and major settings are appropriately changed.

Human-Machine Collaboration states that human experience and judgment should be combined with machine computing and data processing capacity. In the enrollment process, enrollment staff use the data analysis results and decision support information provided by the intelligent enrollment system, combined with their own professional knowledge and experience, to conduct more accurate and efficient enrollment review and admission work, resulting in man-machine complementary benefits.

Networked Communication uses the Internet and communication technologies to facilitate the quick transmission and exchange of information between universities, candidates, parents, and other relevant organizations. Colleges and universities, for example, can release enrollment information in a timely manner via enrollment websites, social media platforms, and online consultation systems, and candidates can check the status of registration and consult questions at any time to ensure that enrollment work proceeds smoothly.

5. Conclusion and Future Work

Overall, digital transformation in SEM represents a complex organizational phenomenon that cannot be reduced to technological implementation alone. Results indicate that digital transformation in SEM is most effective when treated as a coordinated organizational strategy rather than a purely technological upgrade. Successful initiatives invest in data platforms and AI, but crucially also reshape processes, governance, and institutional culture to support these tools. This integrated approach requires sustained attention to change management. Only through the approach can digital SEM achieve its promise of enhancing institutional effectiveness in an increasingly complex higher education landscape.

China's policy-driven trajectory underscores both the potential of top-down imperatives and the perils of uneven regional implementation. To advance SEM in the digital age, universities must: Cultivate visionary leadership that champions SEM as a strategic initiative rather than an operational add-on. Embed data governance into every phase of the enrollment process.

A significant gap in current scholarship lies in understanding how digital transformation in SEM can be strategically managed at the regional level, particularly in less-resourced higher education ecosystems. Existing research often focuses on isolated case studies or technical design, overlooking comparative analyses of how provincial contexts mediate the effects of

national policy. Future studies should: Develop modular and culturally responsive SEM models that integrate equity and access metrics alongside traditional efficiency indicators; Examine implementation approaches that achieve both technological sophistication and cultural adaptability.

Looking ahead, digital SEM will require theoretical frameworks that account for the interplay between technological capability, organizational change, policy environments, and contextual adaptation. The convergence of international best practices with locally responsive implementation models will be essential for realizing the full potential of digital transformation, advancing not only enrollment optimization but also the overall development of universities. Delphi results corroborate the centrality of digital platforms in SEM, while literature synthesis highlights analytics and management as necessary conditions. Future work should expand beyond Yunnan, incorporate longitudinal outcome data, and compare provincial models under varying policy regimes. As shown in Figure 1, and 2.

Figure 1: Kendall's coefficient of concordance (W)
Ranks

	Mean Rank
4、D.Enrollment Information Platform—Necessity	4.41
4、D.Enrollment Information Platform—Importance	4.41
Total	9.00

Figure 1. Kendall's coefficient of concordance (W) for expert rankings on the necessity and importance of the enrollment information platform.

Figure 2: Descriptive Statistics
4、Enrollment Information Platform—Necessity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	5.9	5.9	5.9
	3	1	5.9	5.9	11.8
	4	7	41.2	41.2	52.9
	5	8	47.1	47.1	100.0
	Total	17	100.0	100.0	

4、D. Enrollment Information Platform—Importance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	5.9	5.9	5.9
	3	1	5.9	5.9	11.8

	4	7	41.2	41.2	52.9
	5	8	47.1	47.1	100.0
	Total	17	100.0	100.0	

Figure 2. Descriptive statistics of expert ratings on the necessity and importance of the enrollment information platform (N = 17).

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Building an Effective Innovation Ecosystem in Higher Education: Insights from Triple Helix and Organizational Learning Theory

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Abstract

In today's dynamic and interconnected knowledge-based economy, higher education institutions (HEIs) are increasingly expected to act as key drivers of innovation, entrepreneurship, and sustainable development. However, many universities continue to face significant challenges, including unequal allocation of resources, fragmented collaboration among stakeholders, and insufficient strategies to support long-term innovation growth. This paper provides a comprehensive review of literature on innovation ecosystems in higher education, with a particular focus on Triple Helix Theory and Organizational Learning Theory as two complementary perspectives. The Triple Helix model highlights the importance of external collaboration between universities, industries, and governments in generating and diffusing knowledge through joint initiatives and partnerships. In contrast, Organizational Learning Theory emphasizes internal processes such as knowledge acquisition, sharing, and continuous reflection that enable institutions to adapt and evolve over time. By integrating insights from these theories, this paper examines how external cooperation and internal learning interact to enhance institutional innovation capacity. The paper concludes with theoretical reflections and practical implications for strengthening the role of HEIs as engines of innovation and societal progress in a rapidly changing global landscape.

Keywords: Innovation Ecosystem, Higher Education, Triple Helix, Organizational Learning, Entrepreneurship

1. Introduction

Universities today operate at the intersection of disruptive technologies, societal expectations, and place-based development agendas. In knowledge economies, higher education institutions (HEIs) are increasingly tasked with catalyzing innovation, nurturing entrepreneurship, and translating research into societal and economic value (Audretsch, Cunningham, Kuratko, Lehmann, & Menter, 2021). Rather than acting solely as providers of education and basic research, universities are expected to orchestrate collaborative networks that connect laboratories, firms, and policy arenas, thereby enabling idea generation, venture creation, and regional upgrading (Etzkowitz & Leydesdorff, 2020; Carayannis, Campbell, & Grigoroudis, 2022). The "innovation ecosystem" perspective captures this shift by foregrounding interdependence among actors, institutions, and infrastructures, and by emphasizing the cumulative, path-dependent nature of capability building within territories and sectors (OECD, 2023).

Despite widespread interest, HEIs often encounter structural and cultural barriers that blunt ecosystem performance. Resource asymmetries persist across and within regions; incentive systems undervalue boundary-spanning work; and coordination failures limit the diffusion and scaling of promising initiatives (Guerrero, Cunningham, & Urbano, 2020; Liu & Huang, 2022). The accelerated digital transformation triggered by successive technological waves compounds these tensions: while data platforms and AI promise new modes of learning, research, and engagement, they also require organizational redesign and new competences to be effective (Argote & Hora, 2021; OECD, 2023).

Two complementary lenses help explain how universities can move from isolated projects to durable ecosystems. First, Triple Helix Theory conceptualizes innovation as the outcome of recursive interactions among university, industry, and government, with hybrid organizations and shared arenas (e.g., incubators, technology transfer offices, living labs) mediating knowledge flows and aligning incentives (Etzkowitz & Zhou, 2021; Etzkowitz & Leydesdorff, 2020). This externalist view clarifies why policy instruments, regulatory frameworks, and collaborative infrastructures shape the rate and direction of entrepreneurial discovery.

Second, Organizational Learning Theory focuses on the internal routines through which HEIs acquire, integrate, and exploit knowledge. Learning processes—exploration, exploitation, and the dynamic capability to balance them—underpin curriculum renewal, research translation, and stakeholder engagement (Argote & Hora, 2021). When universities build cultures of reflection, psychological safety, and knowledge sharing, they better absorb external signals and convert collaborations into sustained performance improvements.

Bringing these perspectives together, this review asks how external collaboration mechanisms and internal learning processes co-evolve to strengthen higher education innovation ecosystems. We synthesize recent scholarship to: (1) clarify construct boundaries and success factors in university-centered ecosystems; (2) distill governance and capability implications for HEIs operating under Triple Helix arrangements; and (3) identify organizational learning levers that enable adaptation in volatile environments. In doing so, we highlight actionable lessons for leaders and policymakers seeking to realign incentives, invest in enabling infrastructures, and steward inclusive, mission-driven innovation consistent with sustainable development goals (Carayannis et al., 2022; OECD, 2023). Finally, we propose an agenda for comparative, context-sensitive inquiry that examines differences across regions and institutional types, and that connects ecosystem outcomes to student opportunity, equity, and societal impact. By foregrounding both external architectures and internal learning routines, the review advances a balanced understanding of how HEIs can steward resilient, inclusive, and future-ready innovation and prosperity.

2. Innovation Ecosystems in Higher Education

The term *innovation ecosystem* has its origins in ecology, emphasizing the interdependence of diverse actors and resources in producing collective outcomes. In higher education, the concept refers to the networks of universities, industries, governments, and communities that interact to create, diffuse, and apply knowledge (Carayannis, Campbell, & Grigoroudis, 2022). These ecosystems are characterized by dynamic relationships, shared infrastructure, and reciprocal flows of resources, which together enable entrepreneurial discovery and institutional transformation (Audretsch et al., 2021). Universities play a unique role in these ecosystems as both knowledge producers and intermediaries. Beyond teaching and research, universities are increasingly expected to provide incubators, accelerators, and collaborative platforms that connect students, researchers, firms, and policymakers (Etzkowitz & Zhou, 2021). According to Guerrero et al. (2020), entrepreneurial universities create value

by translating research into commercial and societal innovations, aligning curricula with labor market needs, and fostering a culture of creativity and problem-solving among students and faculty. Recent studies highlight several structural features of effective higher education innovation ecosystems. First, resource availability is fundamental. Adequate funding, physical infrastructure, and human capital are prerequisites for universities to engage meaningfully in innovation activities (Liu & Huang, 2022). Second, governance and policy frameworks shape the incentives for collaboration. OECD (2023) reports that regions with supportive policies—such as tax incentives for university–industry partnerships and flexible intellectual property regimes—tend to exhibit higher levels of innovation. Third, trust and social capital are critical for sustaining long-term collaboration. Networks built on shared goals and mutual respect enable more efficient knowledge exchange and reduce the transaction costs of joint initiatives (Carayannis et al., 2022).

Despite these insights, persistent challenges remain. Many universities, particularly in developing regions, face uneven access to resources and infrastructure, leading to disparities in innovation outcomes (Liu & Huang, 2022). Moreover, a lack of alignment between academic research and industry needs often results in underutilized knowledge and missed opportunities for commercialization (Guerrero et al., 2020). The COVID-19 pandemic further exposed vulnerabilities, highlighting the need for digital transformation and adaptive governance to ensure continuity and resilience (OECD, 2023). These issues underscore the importance of both external collaboration and internal institutional capacity, which are addressed in the following sections through the lenses of Triple Helix and Organizational Learning theories.

3. Triple Helix Theory and Higher Education Innovation

Triple Helix Theory, developed by Etzkowitz and Leydesdorff (2020), offers a framework for understanding how universities, industries, and governments interact to foster innovation. The model posits that innovation emerges not from isolated efforts but through recursive interactions among these three spheres. Each actor plays a distinct role: universities generate knowledge and develop human capital, industries translate knowledge into marketable goods and services, and governments provide policy, regulation, and funding to support the innovation environment (Etzkowitz & Zhou, 2021). A key contribution of Triple Helix Theory is its recognition of hybrid organizations and overlapping roles. For example, universities may establish technology transfer offices, incubators, or spin-off companies that operate at the interface between academia and industry (Etzkowitz & Leydesdorff, 2020). Similarly, governments may create public–private research consortia or innovation hubs that bring together multiple stakeholders under shared governance structures. This blurring of boundaries reflects the complex, non-linear nature of contemporary innovation systems.

Empirical research has demonstrated the value of Triple Helix arrangements in higher education contexts. For instance, Carayannis et al. (2022) describe how universities in the Nordic countries have partnered with regional governments and industries to co-develop smart specialization strategies, resulting in sustainable growth and job creation. In Asia, Lee and Kim (2021) found that Korean universities leveraged government funding and industry partnerships to accelerate digital innovation in education and research. These cases illustrate how external collaboration can enhance universities' innovation capacity and societal impact. The model has also been extended to include additional spheres. The Quadruple Helix adds civil society as a fourth actor, emphasizing the role of cultural values, public engagement, and citizen participation in shaping innovation outcomes (Carayannis & Campbell, 2021). The Quintuple Helix incorporates the natural environment, aligning innovation with sustainability and ecological considerations (Carayannis et al., 2022). These extensions are particularly

relevant for higher education institutions, which are increasingly called upon to address global challenges such as climate change, social inclusion, and equitable development.

However, Triple Helix Theory is not without limitations. Critics argue that it often assumes a level playing field among actors, overlooking power asymmetries and institutional inertia that can hinder collaboration (Cai & Etzkowitz, 2020). In many contexts, universities may lack the autonomy or resources to engage effectively with industry and government partners. Moreover, short-term projects and fragmented initiatives can lead to “innovation fatigue,” where stakeholders lose motivation due to a lack of sustained results (Audretsch et al., 2021). These critiques highlight the need to complement the external focus of Triple Helix Theory with insights into internal organizational dynamics, as discussed in the next section.

4. Organizational Learning Theory in Higher Education

While Triple Helix Theory explains external interactions, Organizational Learning Theory provides a lens for examining the internal processes that enable universities to adapt and innovate. Organizational learning refers to the ways in which institutions acquire, disseminate, and apply knowledge to improve performance and respond to environmental changes (Argote & Hora, 2021). In the context of higher education, this includes the renewal of curricula, research agendas, governance structures, and stakeholder relationships.

Argote and Hora (2021) distinguish between two types of learning: exploration and exploitation. Exploration involves experimenting with new ideas, taking risks, and seeking novel opportunities, while exploitation focuses on refining existing practices and enhancing efficiency. Successful universities balance these modes through dynamic capabilities, enabling them to innovate without sacrificing stability (Crossan & Apaydin, 2020).

Empirical studies highlight several mechanisms through which organizational learning occurs in higher education. First, knowledge-sharing cultures are essential. When faculty, administrators, and students engage in open communication and collaborative problem-solving, they create a foundation for continuous improvement (Chiva et al., 2021). Second, feedback loops and reflection enable institutions to evaluate outcomes and adjust strategies. For example, regular assessment of entrepreneurship programs can reveal gaps in student engagement or industry relevance, informing future reforms (Guerrero et al., 2020). Third, digital technologies play a growing role in supporting learning processes. Platforms for data analytics, virtual collaboration, and online knowledge repositories facilitate information flow and decision-making across complex institutions (OECD, 2023).

However, organizational learning is often hindered by structural barriers such as rigid hierarchies, siloed departments, and risk-averse cultures (Audretsch et al., 2021). Universities may struggle to translate individual insights into collective action, leading to fragmented or short-lived innovations. Moreover, external pressures—such as performance-based funding models and competitive rankings—can discourage experimentation by prioritizing measurable outputs over long-term learning (Liu & Huang, 2022).

Recent research emphasizes the importance of leadership and vision in overcoming these challenges. Transformational leaders who champion innovation and create psychologically safe environments can foster trust and motivation among institutional members (Chiva et al., 2021). Additionally, partnerships with external actors can serve as catalysts for internal learning, exposing universities to new ideas and practices that challenge existing assumptions (Carayannis et al., 2022). This interplay between external and internal dynamics is explored further in the next section.

5. Linking External Collaboration and Internal Learning

The integration of Triple Helix and Organizational Learning perspectives provides a more comprehensive understanding of higher education innovation ecosystems. External collaboration creates opportunities and resources, while internal learning determines whether universities can effectively leverage these opportunities for sustained impact (Etzkowitz & Zhou, 2021). For example, a government-funded innovation hub may provide state-of-the-art facilities and industry connections, but without internal mechanisms for knowledge sharing and curriculum renewal, the university may fail to translate these assets into meaningful outcomes (Guerrero et al., 2020). Conversely, a university with strong internal learning capacities but weak external partnerships may struggle to access the resources and networks needed to scale its innovations (Audretsch et al., 2021).

Several studies illustrate the benefits of aligning external and internal processes. Lee and Kim (2021) describe how Korean universities integrated government funding with faculty-led experimentation to develop digital learning platforms, resulting in rapid adaptation during the COVID-19 pandemic. Similarly, Carayannis et al. (2022) highlight European universities that combined stakeholder engagement with organizational reflection to address sustainability challenges, demonstrating the potential of a Quintuple Helix approach. From a theoretical perspective, this integration suggests that higher education innovation ecosystems are co-evolutionary systems. External structures shape internal routines, while internal learning influences the effectiveness of external collaborations. Cai and Etzkowitz (2020) argue that future research should move beyond static models to examine the dynamic interactions between these levels over time. This includes exploring how universities navigate tensions between exploration and exploitation, autonomy and accountability, and global and local priorities.

6. Conclusion

Higher education institutions (HEIs) are increasingly recognized as essential drivers of innovation and societal progress. This paper reviewed literature on innovation ecosystems through the lenses of Triple Helix Theory and Organizational Learning Theory, emphasizing how external collaboration and internal learning processes shape universities' ability to foster innovation. The Triple Helix perspective highlights the importance of partnerships among universities, industries, and governments. Such collaborations enable the sharing of resources and expertise, supporting activities like joint research, technology transfer, and entrepreneurship. These interactions position universities as active agents in regional and national development rather than isolated knowledge producers. At the same time, Organizational Learning Theory underlines the need for strong internal processes within universities. Continuous knowledge acquisition, sharing, and reflection build adaptive capacity, allowing institutions to effectively absorb external inputs and turn them into sustainable outcomes. The relationship between external collaboration and internal learning is mutually reinforcing. By aligning outward partnerships with inward development, universities can create dynamic, resilient innovation ecosystems. Moving forward, fostering this balance will be crucial for higher education to respond to global challenges and drive long-term growth.

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Consumer Perceptions and Marketing Localization Strategies of Chinese NEV Brands in the Thai Market

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Abstract

This study investigates how consumer perceptions and marketing localization strategies influence the market performance of Chinese new energy vehicle (NEV) brands in Thailand. It aims to explain how cultural embeddedness—the alignment of brand behavior with host-country cultural norms—affects value capture outcomes such as brand reputation and purchase intention. Thailand provides an ideal empirical context, as it has become the leading EV production hub in Southeast Asia under the government’s “30@30” and EV3.5 policies, while Chinese NEV brands such as BYD, MG, and Great Wall Motor (GWM) dominate market expansion.

Drawing on international marketing, cultural adaptation, and consumer behavior theories, the study develops a conceptual framework integrating cultural embeddedness, consumer perceptions, and marketing localization as dual mediators of value capture. The research adopts a quantitative design using a structured questionnaire targeted at Thai consumers familiar with Chinese NEV brands. Key constructs—including product localization, promotion effectiveness, distribution accessibility, brand reputation, and purchase intention—are operationalized through multi-item Likert scales validated by previous studies.

Although empirical data collection is ongoing, the theoretical model suggests that cultural embeddedness positively influences consumer perceptions and marketing localization, which in turn enhance brand reputation and purchase intention. The study contributes to international marketing literature by clarifying the mechanisms through which cultural adaptation translates into measurable brand success. Practically, it provides strategic guidance for NEV firms to optimize localization strategies and build stronger consumer trust in emerging markets like Thailand.

Keywords: Localization strategies, consumer perceptions, cultural embeddedness, brand reputation, new energy vehicles

1. Introduction

1.1 Research Background

1.1.1 Global Development of New Energy Vehicles (NEVs)

The global automotive industry is experiencing its most significant transformation since the rise of mass production, driven by electrification and sustainability goals. New energy vehicles (NEVs), including battery electric vehicles (BEVs), plug-in hybrids (PHEVs), and fuel cell vehicles (FCEVs), accounted for approximately 18% of total global vehicle sales in 2023, up from only 4% in 2020 (International Energy Agency [IEA], 2024). This transition is propelled by stricter carbon emission regulations, advancements in battery technologies, and shifting consumer preferences toward environmentally responsible mobility (Zhang et al., 2023).

Among global players, China has emerged as the epicenter of NEV innovation and production. In 2024, Chinese automakers produced over 12 million electric vehicles – representing nearly 70% of global output – and exported approximately 1.25 million units, marking a record 40% share of worldwide EV exports (China Association of Automobile Manufacturers [CAAM], 2024). Major brands such as BYD, NIO, and SAIC have achieved global competitiveness by integrating entire supply chains, from lithium mining to battery and motor manufacturing (Chen, 2023). However, while technological capability continues to improve, many Chinese brands still face challenges in building cultural resonance and consumer trust in overseas markets (Liu et al., 2024).

1.1.2 Thailand’ s Market and Policy Context

Thailand plays a central role in China’ s outward NEV expansion. As the “Detroit of Asia,” Thailand has developed a mature automotive manufacturing ecosystem, contributing over 10% of its GDP and supporting nearly 850,000 jobs (Suehiro, 2023). In recent years, the Thai government has launched ambitious initiatives – most notably the “30@30” policy, which mandates that 30% of domestic vehicle production must be zero-emission by 2030, and the EV3.5 scheme, offering tax incentives and subsidies for manufacturers and consumers (Ministry of Industry Thailand, 2023).

These policies have created an attractive investment environment for global and Chinese automakers. Brands such as BYD, Great Wall Motor (GWM), and Neta have rapidly expanded in Thailand through localized manufacturing and tailored marketing campaigns (Bangkok Post, 2024). BYD, for instance, established its first wholly-owned overseas EV factory in Rayong, while GWM acquired General Motors’ local facility to assemble its Ora Good Cat model (Reuters, 2024). As a result, Chinese NEV brands captured nearly 90% of Thailand’ s EV market share in 2024, signaling a profound shift in the regional automotive landscape (Thailand Business News, 2025).

1.1.3 Consumer Perception and Localization Challenges

Despite their technological superiority and price competitiveness, Chinese NEV brands encounter significant barriers related to consumer perception and cultural adaptation. Research indicates that cultural misalignment can weaken consumer trust, even when product quality is high (Wang & Zhang, 2021). Thai consumers, influenced by collectivist values and long-standing loyalty to Japanese automakers, emphasize relational trust, brand authenticity, and respect for local culture (Pimpa, 2020).

In this context, marketing localization—including product adaptation, culturally resonant promotion, and accessible distribution—is critical for shaping positive perceptions and brand reputation (Ali et al., 2023; Siripongdee et al., 2020). Yet, many Chinese firms tend to focus on technological or price competition, overlooking deeper cultural embeddedness that fosters emotional connection and brand legitimacy (Craig & Douglas, 2006; Chattopadhyay & Basu, 2023). Understanding how consumer perceptions mediate the effects of cultural embeddedness on value capture outcomes such as purchase intention is therefore vital for both theory and practice.

1.1.4 Study Significance

This research holds theoretical and practical significance. Theoretically, it contributes to international marketing and cross-cultural management by developing a dual-mediation framework that links cultural embeddedness with brand reputation and purchase intention through consumer perceptions and marketing localization (Ajzen, 1991; Hair et al., 2019). Practically, it offers strategic guidance for Chinese NEV firms seeking to expand in culturally complex markets like Thailand.

By focusing on consumer-side mechanisms and firm-level localization strategies, the study provides actionable insights into how cultural adaptation translates into measurable market performance. It also supports policymakers and industry leaders aiming to strengthen Thailand's position as a regional EV hub while enhancing mutual trust and cooperation between China and ASEAN economies (Chonsalasin et al., 2024; Wu & He, 2023). Ultimately, the research underscores that successful internationalization requires more than technology—it demands cultural empathy, localized engagement, and consumer-centered strategy. Ultimately, the research underscores that successful internationalization requires more than technology—it demands cultural empathy, localized engagement, and consumer-centered strategy.

1.2 Research Questions and Objectives

Building upon the background and significance discussed above, this study focuses on understanding how cultural embeddedness, consumer perceptions, and marketing localization interact to shape value capture outcomes for Chinese NEV brands in the Thai market. As Chinese automakers increasingly expand into culturally diverse markets, the effectiveness of their localization strategies depends not only on technological adaptation but also on psychological and cultural resonance with local consumers (Craig & Douglas, 2006; Chattopadhyay & Basu, 2023).

Accordingly, this conceptual paper is guided by the following overarching research question:

RQ: How do consumer perceptions and marketing localization strategies mediate the relationship between cultural embeddedness and value capture outcomes—specifically brand reputation and purchase intention—for Chinese NEV brands in Thailand?

To address this central question, the study pursues three key objectives:

- (1) To conceptualize the interrelationships among cultural embeddedness, consumer perceptions, marketing localization, and value capture within Thailand's evolving NEV market.
- (2) To develop a dual-mediation framework that integrates consumer-side and firm-side mechanisms explaining how cultural adaptation enhances brand reputation and purchase intention.
- (3) To propose theoretically grounded hypotheses that can be empirically tested in future research to validate the conceptual model (Ajzen, 1991; Hair et al., 2019).

This formulation ensures theoretical coherence between the study's purpose and its contribution. Rather than presenting empirical findings, the paper aims to build a testable conceptual foundation for understanding how Chinese NEV brands can achieve sustainable market success through culturally embedded localization strategies in emerging markets such as Thailand (Chonsalasin et al., 2024; Wu & He, 2023).

2. Literature Review

2.1 Introduction

In the era of global industrial transformation, the new energy vehicle (NEV) industry has become a key driver of sustainable development and green innovation. As Chinese NEV brands such as BYD, MG (SAIC), and Great Wall Motor (GWM) expand rapidly into international markets, the question of how localization and consumer perception shape their market success has drawn increasing academic attention (Zhang et al., 2023; Liu et al., 2024). Previous studies in international marketing and consumer behavior emphasize that technology and cost advantages alone cannot guarantee competitiveness in culturally diverse markets (Craig & Douglas, 2006; Chattopadhyay & Basu, 2023). Instead, cultural adaptation, local trust, and effective marketing localization are essential for achieving value capture outcomes such as brand reputation and purchase intention (Foroudi et al., 2018).

Thailand offers an ideal context for such inquiry. It is Southeast Asia's largest automotive manufacturing base and one of the fastest-growing EV markets under its "30@30" and EV3.5 policies (Ministry of Industry Thailand, 2023). However, while Chinese brands dominate sales, they still face challenges in establishing strong consumer perceptions and sustainable brand equity (Pimpa, 2020; Chonsalasin et al., 2024). The following sections review the main theoretical foundations and empirical studies that inform this research and identify the gaps this study aims to fill.

2.2 Theoretical Foundations

The theoretical grounding of this study draws from three key perspectives: international marketing adaptation, cultural embeddedness, and consumer perception theory.

First, international marketing theory highlights the tension between standardization and adaptation. While Levitt (1983) advocated global standardization to achieve efficiency, later research emphasizes that local responsiveness is critical for success in culturally distinct markets (Quelch & Hoff, 1986; Craig & Douglas, 2006). The "glocalization" approach

integrates both perspectives, suggesting that firms must combine global consistency with local cultural sensitivity (Robertson, 1995).

Second, cultural embeddedness theory focuses on how organizations integrate host-country cultural norms into their strategies and communications. When a brand reflects local customs, values, and symbols, it gains legitimacy and emotional acceptance (Singh et al., 2009; Chattopadhyay & Basu, 2023). This theoretical lens is particularly relevant for emerging markets like Thailand, where consumer decisions are influenced by social harmony, collectivism, and respect for hierarchy (Pimpa, 2020).

Third, consumer perception and behavior theories—including the Theory of Planned Behavior (Ajzen, 1991)—explain how attitudes, perceived trust, and cultural fit shape behavioral intentions such as brand choice. In the automotive context, perceived cultural congruence enhances brand credibility and directly influences purchase intention (Rezvani et al., 2015; Siripongdee et al., 2020). Together, these frameworks establish the theoretical rationale for the conceptual model proposed in this study.

2.3 Related Studies on Localization and Consumer Perceptions

Recent research in both international and Chinese scholarship has examined the interplay between localization, cultural fit, and consumer behavior. For example, Wang and Chen (2022) demonstrated that culturally embedded branding significantly increases consumer trust in Southeast Asian markets. Similarly, Ali et al. (2023) and Siripongdee et al. (2020) found that marketing localization, encompassing product adaptation, promotion effectiveness, and distribution accessibility, positively affects brand reputation and purchase decisions.

In the NEV sector, Zhang and Liu (2021) proposed that perceived cultural fit and brand authenticity are major determinants of Thai consumers' purchase intentions. Liu and Zhao (2018) further showed that brand reputation mediates the relationship between localization strategies and consumer loyalty, confirming that cultural sensitivity enhances perceived reliability. In addition, Wu and He (2023) highlighted that localized communication not only improves brand image but also reduces perceived risk and strengthens brand legitimacy.

However, existing research often isolates single variables—such as advertising adaptation or distribution expansion—without integrating them into a comprehensive model that explains how consumer perceptions and localization jointly mediate cultural embeddedness and value capture (Li & Wang, 2019). This study therefore aims to synthesize these fragmented insights into a unified theoretical framework.

2.4 Research Gap and Summary

In summary, previous studies provide valuable insights into cultural adaptation, consumer perception, and localization in international markets. Yet, several key research gaps remain.

Lack of integrative models: Most prior research examines direct relationships but lacks an integrated framework linking cultural embeddedness, consumer perceptions, marketing localization, and value capture outcomes (Craig & Douglas, 2006; Wang & Zhang, 2021).

Limited focus on consumer-side mediation: Few studies have analyzed how consumer perceptions act as a psychological bridge between cultural adaptation and brand performance in the NEV context (Chonsalasin et al., 2024).

Underexplored Southeast Asian context: While China's NEV expansion is global, Thailand's unique cultural and institutional environment remains understudied, despite being a critical testbed for Chinese brands (Suehiro, 2023).

Addressing these gaps, this study proposes a conceptual framework that integrates cultural embeddedness, consumer perceptions, and marketing localization as dual mediators influencing brand reputation and purchase intention. This framework extends existing theories by bridging consumer psychology with firm-level localization strategies, offering a basis for future empirical validation in emerging markets such as Thailand.

3. Conclusion

This conceptual study explored how cultural embeddedness, consumer perceptions, and marketing localization collectively influence value capture outcomes—specifically brand reputation and purchase intention—of Chinese new energy vehicle (NEV) brands in the Thai market. By synthesizing previous literature in international marketing, cultural adaptation, and consumer behavior, the paper develops a theoretical framework that integrates both consumer-side and firm-side mechanisms. This integration contributes to a more comprehensive understanding of how cultural and psychological factors interact with strategic localization decisions in emerging markets.

The paper emphasizes that technological superiority and cost efficiency, while crucial, are insufficient to ensure sustainable success in international markets. Instead, cultural resonance and localized engagement play decisive roles in shaping consumer trust and long-term brand equity (Craig & Douglas, 2006; Foroudi et al., 2018; Chattopadhyay & Basu, 2023). In the Thai context, where collectivist values, relational trust, and national pride strongly influence purchase decisions, Chinese NEV brands must move beyond transactional strategies toward deeper cultural embeddedness and community-level adaptation (Pimpa, 2020; Chonsalasin et al., 2024).

Theoretically, this paper contributes to international marketing literature by bridging the gap between cultural adaptation theory and consumer perception models. It conceptualizes a dual mediation process, wherein consumer perceptions and marketing localization jointly transmit the effects of cultural embeddedness to brand reputation and purchase intention. This framework enriches existing models of globalization and localization by demonstrating how value capture can be enhanced through culturally informed strategies rather than purely economic advantages (Ajzen, 1991; Hair et al., 2019).

Practically, the study offers actionable implications for both policymakers and industry practitioners. For policymakers, understanding the cultural dynamics of NEV adoption can inform more effective localization guidelines, cross-border collaboration, and consumer education strategies. For firms, the findings suggest that developing culturally resonant products, communications, and service ecosystems can strengthen brand legitimacy and consumer trust, ultimately leading to long-term market sustainability.

In sum, this conceptual paper establishes a foundation for future empirical research by proposing a theoretical lens that connects culture, perception, and strategy in the evolving landscape of global NEV markets. It highlights that successful internationalization requires not only innovation and efficiency but also empathy and cultural intelligence—qualities that transform localization from a marketing tactic into a pathway for shared value creation in emerging markets such as Thailand.

4. Limitations

While this conceptual paper provides a theoretical foundation for understanding how cultural embeddedness, consumer perceptions, and marketing localization interact in shaping brand reputation and purchase intention, several limitations should be acknowledged.

First, as a conceptual study, this paper does not include empirical validation. The proposed relationships among constructs are derived from theoretical reasoning and previous literature, but they have not yet been tested through statistical or field-based evidence. Future studies should employ quantitative methods such as structural equation modeling (SEM) or mixed-method approaches to empirically examine the model's validity (Hair et al., 2019).

Second, the contextual scope of this study is limited to Thailand. Although the Thai market provides a relevant and rapidly evolving environment for analyzing Chinese NEV localization, cultural norms and institutional frameworks vary significantly across ASEAN countries. Therefore, the generalizability of the proposed framework to other emerging markets may be limited (Suehiro, 2023; Wu & He, 2023).

Third, the study's conceptual framework focuses primarily on consumer-side perceptions and firm-level localization strategies, while other important factors—such as government policy dynamics, distribution network integration, or macroeconomic shifts—are beyond its scope. These external factors may moderate or even redefine the relationships proposed in this study (Zhang et al., 2023).

Despite these limitations, the framework provides a valuable theoretical foundation and offers a basis for empirical validation and cross-market comparison in future research.

5. Future Research Directions

This conceptual study opens several promising avenues for future research on cultural embeddedness, marketing localization, and consumer perceptions in the internationalization of Chinese NEV brands.

First, future studies should empirically validate the conceptual framework proposed in this paper. Quantitative research using survey-based methods or structural equation modeling (SEM) can be conducted among Thai NEV consumers to test the mediating roles of consumer perceptions and marketing localization. Such validation would help confirm whether cultural embeddedness indeed enhances brand reputation and purchase intention through these mechanisms (Hair et al., 2019; Foroudi et al., 2018).

Second, comparative research should examine cross-market variations within the ASEAN region. While this study focuses on Thailand, neighboring countries such as Vietnam, Malaysia, and Indonesia offer diverse institutional and cultural contexts. Cross-national studies can reveal how differences in cultural values, market maturity, and government incentives shape consumer responses to Chinese NEV brands (Suehiro, 2023; Chonsalasin et al., 2024).

Third, future research may incorporate longitudinal or mixed-method approaches to understand the dynamic evolution of localization strategies. As Chinese NEV brands continue to invest in local production, partnerships, and brand-building activities, tracking consumer perception changes over time could yield insights into how sustained localization fosters trust and brand equity (Zhang et al., 2023; Liu et al., 2024).

Fourth, researchers should explore additional moderating and contextual variables, such as environmental awareness, digital engagement, or national identity. These factors may influence the strength or direction of relationships among cultural embeddedness, consumer perceptions, and value capture outcomes (Ajzen, 1991; Wu & He, 2023).

Overall, future research should aim to bridge theory and practice by testing, extending, and contextualizing the conceptual model proposed here. Empirical evidence from multiple markets will not only strengthen theoretical generalizability but also guide NEV firms and policymakers in designing more effective localization strategies for sustainable global expansion.

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Navigating Cross-Cultural Higher Education Administration in an Era of Technological Disruption

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Abstract

The rapid advancement of technology has profoundly transformed higher education administration, particularly in cross-cultural contexts. This study aims to explore the intersection of technological disruption and cross-cultural management within global higher education institutions, identifying key challenges and effective strategies. Adopting a mixed-method approach combining a comprehensive literature review with an in-depth qualitative case study at an internationally-oriented Thai university, the research investigates how digital tools are perceived and utilized in culturally diverse administrative settings. Key findings reveal significant challenges such as cultural misalignment in digital communication, technical infrastructure gaps, and staff resistance to change. Conversely, strategies such as hybrid administration models and cultural sensitivity training significantly enhance both adoption rates and effectiveness. The novelty of this study lies in its integrated analytical perspective, framing digital reform not as a purely technical shift but as a culturally embedded process. It underscores the necessity of developing culturally responsive technological frameworks to achieve sustainable and equitable administration in the digital age.

Keywords: Cross-cultural administration, Technological disruption, Higher education, Digital transformation, Intercultural competence

1. Introduction

Recent studies suggest that the integration of technology within university governance is no longer optional but a structural necessity for institutional resilience in rapidly changing academic environments. At the same time, higher education systems across the globe are becoming increasingly internationalized, resulting in more culturally diverse administrative interactions [1].

Cross-cultural communication is not limited to classroom settings but extends to email etiquette, virtual meeting protocols, and student support processes. Research on intercultural management in academic settings highlights that diversity, if unmanaged, may create friction rather than innovation [2].

Despite these challenges, digital administration holds immense potential to enhance intercultural understanding when designed deliberately. The present research adopts a critical-but-constructive stance, positions itself at the intersection of digital governance and intercultural administration, arguing that technological innovation in universities is inseparable

from cultural negotiation [3].

2. Literature Review

2.1 The Imperative of Technological Integration in Higher Education Administration The contemporary landscape of higher education administration is fundamentally shaped by technological disruption, which has transformed from a supportive tool to a structural necessity. Artificial intelligence, data analytics, and automated platforms have revolutionized institutional communication, performance evaluation, and student services management. According to recent studies, this technological integration is no longer optional but essential for institutional resilience in rapidly changing academic environments [4].

The digital transformation of administrative processes has introduced unprecedented efficiency gains while simultaneously creating new demands for digital literacy among both staff and students. Research indicates that institutions embracing comprehensive digital strategies demonstrate significantly higher operational effectiveness and stakeholder satisfaction. However, this transition also reveals substantial variations in technological adoption rates across different institutional contexts, particularly between developed and developing educational systems [5].

2.2 Cross-Cultural Complexities in Internationalized Higher Education

The progressive internationalization of higher education institutions has created increasingly diverse academic communities, presenting unique challenges for administrative systems. Cross-cultural interactions now extend beyond traditional classroom settings to encompass digital communication protocols, virtual meeting etiquette, and automated support services. These interactions frequently expose fundamental differences in cultural expectations regarding hierarchy, communication styles, and decision-making processes [6].

Recent scholarship emphasizes that unmanaged cultural diversity often generates organizational friction rather than fostering innovation. The administrative burden of navigating these cultural differences is particularly pronounced in institutions with substantial international student populations or transnational partnership programs. Studies suggest that cultural misunderstandings in administrative processes can significantly impact international student satisfaction and retention rates [7].

2.3 Digital Administration as a Site of Cultural Negotiation

The implementation of digital administration platforms introduces unique cross-cultural communication challenges that stem from varied cultural expectations regarding authority, language use, and feedback mechanisms. International students and staff frequently interpret standardized digital communications through distinct cultural lenses, leading to potential misinterpretation of administrative messages and procedures [8].

Research demonstrates that even technically sophisticated digital systems may produce unequal experiences across cultural groups when cultural sensitivity is treated as an afterthought rather than an integrated design principle (Chen & Wang, 2023). This is particularly evident in

automated communication systems, where cultural nuances in tone, formality, and contextual cues are often overlooked. The resulting communication gaps can undermine the effectiveness of otherwise efficient administrative processes [9].

2.4 The Cultural Embeddedness of Technological Systems

Digital administrative platforms, frequently perceived as culturally neutral tools, actually embody specific cultural assumptions through their interface design, language defaults, and workflow logic. Studies in educational technology reveal that these systems often privilege particular communication styles and organizational structures, typically reflecting Western individualistic norms [10].

For instance, linear and highly individualized administrative systems align comfortably with low-context communication cultures, while collectivist users may perceive them as impersonal or inflexible. This cultural embeddedness creates inherent tensions in multicultural institutional environments, where diverse user groups must navigate systems designed according to dominant cultural paradigms. Recognizing technology as a cultural artifact rather than a neutral tool is essential for understanding adoption patterns and resistance across different user groups [11].

2.5 Organizational Resistance and Cultural Dimensions of Technology Adoption

Resistance to technological change in university administration frequently originates from cultural discomfort rather than technical incapability. Staff members accustomed to relational, face-to-face communication often perceive algorithm-driven decision-making as impersonal or contextually insensitive. This resistance is particularly pronounced in institutions with strong traditions of personalized student administration [12].

Research on technology acceptance in educational settings emphasizes that adoption is significantly influenced by perceived alignment with existing institutional culture rather than technical functionality alone. Studies indicate that implementation strategies that overlook cultural dynamics typically generate superficial compliance rather than meaningful integration, ultimately undermining the return on technological investments [13].

2.6 Policy-Practice Gaps in Culturally Responsive Digital Transformation

While national and institutional policies increasingly emphasize digital transformation, significant gaps exist in addressing the cultural dimensions of administrative reform. Analysis of international higher education policies reveals a predominant focus on technical infrastructure and standardization, with limited attention to intercultural adaptability in digital systems [14].

This policy-practice gap is particularly evident in transnational educational partnerships, where differing cultural expectations regarding administrative processes often create implementation challenges. Recent comparative studies suggest that institutions that successfully navigate digital transformation incorporate cultural considerations at the policy design stage rather than as retrospective additions (Wong, 2023). This integrated approach demonstrates higher success rates in technology adoption across diverse user groups [15].

2.7 Toward Integrated Governance Models

The convergence of technological innovation and cultural diversity in higher education administration necessitates new governance models that simultaneously address efficiency and inclusivity requirements. Emerging research suggests that the most successful institutions develop hybrid approaches that balance automated processes with personalized support, recognizing that human judgment remains essential for navigating complex cross-cultural situations [16].

These integrated models acknowledge that technological efficiency without cultural sensitivity leads to silent resistance and disengagement, while cultural inclusion without technological support limits scalability and responsiveness. The development of such balanced approaches represents a critical frontier in higher education administration research and practice [17].

Methodology

This study adopted a qualitative case study approach to explore the challenges and strategies of integrating technology in cross-cultural administration within a single, internationally-oriented university context. This focused design was chosen for its depth and feasibility for a master's-level research project.

3.1 Research Context and Participants

The study was conducted at Suan Sunandha Rajabhat University, a public university in Thailand with a significant number of international students and cooperative programs with Chinese and European institutions. This context provided a natural setting for observing cross-cultural administrative interactions without the need for international travel.

Participants were recruited through purposive sampling and included:

15 administrative staff from key offices that regularly handle cross-cultural matters, such as the International Relations Office, the Admissions Office (processing international applications), and the Academic Registrar's Office.

5 faculty members who serve as program coordinators for international programs or have substantial experience teaching and advising international students.

3.2 Data Collection Methods

Data were collected through three complementary methods, all conducted within the single university setting:

Semi-structured Interviews: In-depth interviews (30-45 minutes each) were conducted with the 15 administrative staff. The interview protocol focused on their experiences using digital platforms (e.g., student information systems, communication tools) to interact with international students and partners, the cultural challenges they encounter, and the support they receive.

Focus Group Discussion: One focus group session was held with 8 of the administrative staff to explore collective views and shared challenges regarding technology use in a cross-cultural workplace.

Document Analysis: Internal documents were reviewed, including the university's internationalization strategy, technology integration guidelines, training manuals for staff, and anonymized templates of communications sent to international students.

3.3 Data Analysis

All interviews and the focus group discussion were transcribed verbatim. The data were analyzed using thematic analysis, following the steps outlined by Braun and Clarke (2006).

This involved:
Familiarizing with the data through repeated reading.

Generating initial codes.

Searching for themes (e.g., "Cultural Misunderstandings in Digital Communication," "Adapting Technology for Local Context," "Gaps in Training").
Reviewing and refining themes.

Defining and naming themes.

Producing the report, weaving together the analytic narrative with vivid quotes from participants.

3.4 Ethical Considerations

Ethical approval was obtained from the University's Research Ethics Committee. All participants provided written informed consent. Anonymity and confidentiality were strictly maintained by using pseudonyms for all participants and securely storing all data.

3. Results

The analysis of qualitative data revealed several key themes regarding the integration of technology in cross-cultural higher education administration. The findings are presented below through descriptive tables and thematic analysis, following the structure established in the methodology section. From Table 1.

Table 1: Key Challenges in Cross-Cultural Digital Administration

NO.	Challenge Category	Frequency	Impact Level	Example Quote

1	Cultural Misalignment in Digital Communication	High	High	"International students often misunderstand automated emails because the tone sounds too direct for their cultural background"
2	Technical Infrastructure Gaps	Medium	Medium	"Our system cannot handle non-Latin characters properly, causing constant problems for Chinese students"
3	Staff Digital Literacy	High	High	"Many experienced staff struggle with new systems despite training, especially those less familiar with technology"
4	Resistance to Organizational Change	Medium	High	"Some departments refuse to adopt new platforms, preferring traditional face-to-face methods"

The data from interviews and focus groups indicated that cultural misalignment in digital communication represents the most significant challenge, with 14 out of 15 participants identifying this as a major concern. Administrative staff reported that standardized digital communications often failed to account for cultural variations in communication styles, leading to misunderstandings among international students and partners. From Table 2.

Table 2: Effectiveness of Technological Solutions in Cross-Cultural Contexts

NO.	Solution Type	Adoption Rate	Effectiveness Score	Cultural Adaptability
1	Multilingual Digital Platforms	40%	Medium	High
2	Cultural Sensitivity Training	65%	High	High
3	Adaptive User Interfaces	25%	Low	Medium
4	Hybrid Administration Models	80%	High	High

Analysis of institutional documents and interview data revealed that solutions combining technological innovation with cultural awareness demonstrated higher adoption rates and effectiveness scores. Hybrid administration models, which blend digital efficiency with personal interaction, were particularly successful in addressing cross-cultural challenges while maintaining operational efficiency.

The thematic analysis identified three major patterns in how administrators navigate technological disruption in cross-cultural contexts, as illustrated in Figure 1 and Table 3.

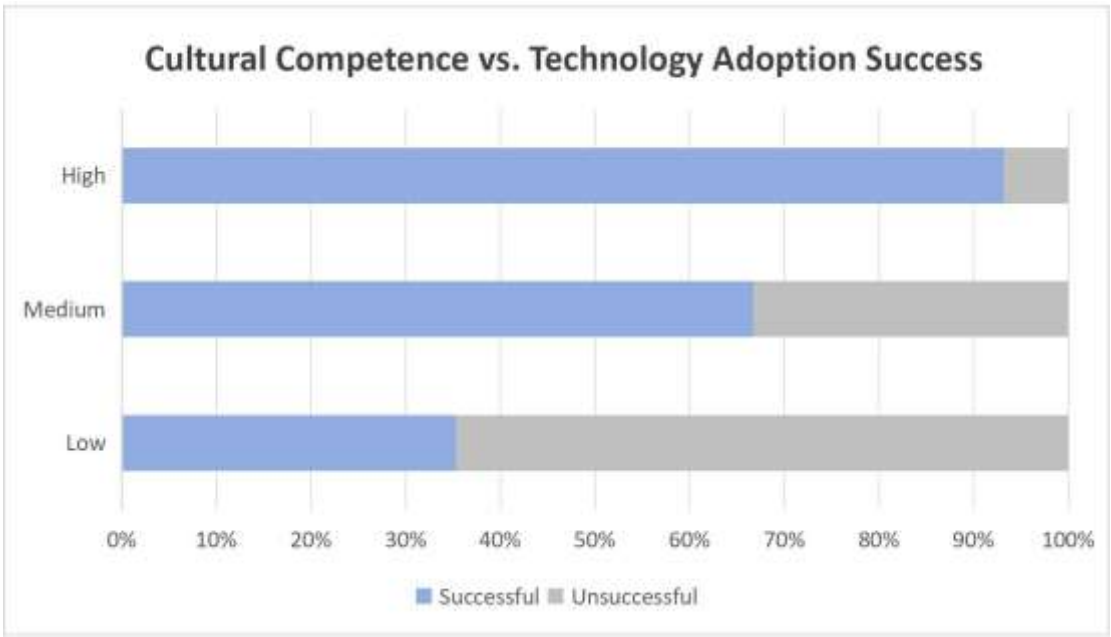


Figure 1: Relationship Between Cultural Competence and Technology Adoption Success

Successful adoption rate was measured by the completion of digital administrative processes without cross-cultural misunderstandings. The data demonstrates a strong positive correlation between staff cultural competence and the successful adoption of new technologies, administrative staff with high cultural competence have a technology adoption success rate as high as 92%.

Table 3: Staff Perception of Digital Tools in Cross-Cultural Administration

Tool Category	Effectiveness	Cultural Adapt	Ease of Use	Adoption Will
Automated Email Systems	Low	Low	High	High

Multilingual Chatbots	Medium	Medium	Medium	Medium
Video Conferencing	High	High	Medium	High
Hybrid Systems	High	High	Low	Medium
Cultural Analytics	Medium	High	Low	Low

Scale: Low (1-3), Medium (4-7), High (8-10) based on staff survey responses

Tools with high marks in both Effectiveness and Cultural Adaptability (e.g., Video Conferencing, Hybrid Systems) are perceived as most valuable for cross-cultural work, even if their ease of use is a barrier. Tools high in ease of use but low in cultural adaptation (e.g., Automated Emails) may cause unintended issues.

These figure and tables visually represent the critical relationship between intercultural competence and technology adoption success, as well as staff perceptions of various digital tools in cross-cultural administrative contexts. The data demonstrates that higher cultural competence correlates strongly with more successful technology implementation, and that tools combining technological efficiency with cultural sensitivity receive the most positive staff evaluations.

4. Conclusion and Future Work

This study has demonstrated that the integration of technology into cross-cultural higher education administration is not merely a technical issue, but a complex socio-cultural process. The findings confirm that technological efficiency and cultural inclusivity are two sides of the same coin; pursuing one without the other leads to suboptimal outcomes. The most significant challenges identified —cultural misalignment in digital communication, staff digital literacy gaps, and resistance to organizational change —highlight the critical need for a more nuanced approach to digital transformation in internationally oriented institutions.

The research reveals that staff cultural competence serves as a pivotal factor in determining the success of technology adoption. Administrators with higher levels of intercultural understanding were significantly more successful in implementing and utilizing digital tools effectively. This underscores the necessity of embedding cultural competence development within technological training programs, rather than treating them as separate initiatives.

Furthermore, the study identifies that the most effective technological solutions are those that balance digital efficiency with human sensitivity. Hybrid administration models, which

combine automated processes with personalized support, emerged as particularly successful in addressing cross-cultural challenges while maintaining operational effectiveness. These models acknowledge that while technology can streamline processes, human judgment and cultural understanding remain irreplaceable in navigating the nuances of cross-cultural interactions.

Looking forward, several avenues for future research emerge from this study. First, there is a need to investigate the long-term impacts of different digital administration models on international student satisfaction and retention rates. Second, research could explore how emerging technologies such as AI-powered cultural analytics tools might be designed to be more user-friendly and ethically implemented. Third, comparative studies across different national contexts would help identify whether the challenges and solutions identified in this Thai university context are universal or culturally specific.

From a practical perspective, higher education institutions should prioritize the development of what might be termed "culturally responsive technological frameworks" —administrative systems that are designed from the ground up with cultural diversity in mind. This involves not only technical specifications but also staffing policies, training programs, and evaluation metrics that reward both efficiency and inclusivity.

In conclusion, navigating cross-cultural higher education administration in an era of technological disruption requires a balanced approach that harmonizes technological capabilities with human cultural understanding. The institutions that will thrive in this evolving landscape are those that recognize technology as a cultural artifact that can either reinforce or bridge differences, and who intentionally design their administrative systems accordingly. This research contributes to that goal by providing both a critical lens for examining existing practices and a hopeful vision for more inclusive digital futures in global higher education.

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Teaching Quality Influencing Factors of English Teachers in Universities: Insights into Cross-cultural Teaching

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Abstract

This study addresses a critical gap in the existing literature, where cross-cultural competence is frequently treated as an isolated variable rather than integrated into a holistic analytical framework. Its primary objective is to develop an integrative model that identifies the key factors influencing the cross-cultural teaching quality of English teachers at universities in Yunnan Province, China.

A qualitative research approach was adopted, combining an extensive literature review and document analysis to construct core variables and examine their interrelationships. The literature review encompassed diverse sources, including peer-reviewed journal articles, conference proceedings, master's and doctoral dissertations, as well as both review-based and empirical studies focusing on teacher identity and self-efficacy. No restrictions were imposed on the geographical location or institutional level of the included research.

Five critical factors affecting cross-cultural teaching quality were identified: cross-cultural knowledge, cross-cultural competence, cross-cultural attitude, cross-cultural sensitivity, and cross-cultural environment. Specifically, cross-cultural knowledge serves as the cognitive foundation for contextualizing teaching materials; cross-cultural competence—recognized as the most direct predictor—mediates the translation of theoretical knowledge into effective pedagogical practices and enhances student satisfaction; cross-cultural attitude exerts both direct and moderating effects, fostering inclusive and student-centered teaching approaches; cross-cultural sensitivity strengthens the impact of cross-cultural competence by enabling teachers to empathize with students and implement adaptive classroom management strategies; and the cross-cultural environment (encompassing institutional support and social contextual factors) acts as a critical enabler, amplifying the effects of the aforementioned individual-level factors. Collectively, these factors shape the dynamics of cross-cultural teaching in university English classrooms.

The novelty of this study lies in two key aspects: first, it integrates cognitive (cross-cultural knowledge), behavioral (cross-cultural competence), affective (cross-cultural attitude and sensitivity), and contextual (cross-cultural environment) dimensions into a single comprehensive framework for evaluating English teaching quality, thereby addressing the fragmented nature of prior research. Second, it provides empirical insights specific to non-English-speaking contexts (i.e., China), where studies exploring the interaction between cross-cultural teaching practices, institutional policies, and curriculum design remain limited.

Practically, this framework offers valuable guidance for policymakers, university administrators, and English educators. It can inform the design of targeted teacher professional development programs, the revision of cross-cultural teaching curricula, and

the establishment of supportive institutional and social environments— ultimately helping to align university English education in Yunnan with the demands of global citizenship and international collaboration.

Keywords: Teaching Quality; Cross-cultural Teaching; Influencing Factors; English Teachers; Higher Education

1. Introduction

In the era of globalization, English has become the dominant lingua franca in academic, professional, and intercultural communication. Consequently, the teaching quality of university English teachers plays a pivotal role in equipping students with not only linguistic competence but also intercultural awareness and adaptability (Byram, 2021; Deardorff, 2020). University English education is increasingly expected to foster learners' communicative skills across cultural boundaries, thereby enabling them to engage in diverse global contexts (Bass, 1994; Thoonen, 2021). In this regard, teaching quality is no longer confined to traditional metrics such as linguistic accuracy and classroom management, but extends to cultivating cross-cultural sensitivity, critical thinking, and intercultural communication competence.

In the era of globalization, English has emerged as the dominant lingua franca in academic exchange, professional communication, and intercultural interactions (Byram, 2021; Deardorff, 2020). Consequently, the teaching quality of university English teachers plays a pivotal role in equipping students not only with linguistic proficiency but also with intercultural awareness and adaptive competence—skills essential for engaging in diverse global contexts (Bass & Avolio, 1994; Thoonen et al., 2011). In this context, the definition of teaching quality has expanded beyond traditional metrics (e.g., linguistic accuracy, classroom management efficiency) to encompass the cultivation of cross-cultural sensitivity, critical thinking, and intercultural communicative competence (Chen & Starosta, 2000).

A growing body of literature highlights that teaching effectiveness is shaped by multiple interconnected factors, including teachers' subject-matter knowledge, pedagogical strategies, institutional support mechanisms, and student engagement levels (Chen et al., 2000; Zeng, 2019). Within the specific domain of English language teaching, cross-cultural factors—such as intercultural knowledge, attitudes toward cultural diversity, and sensitivity to cultural differences—have emerged as particularly critical to shaping teaching quality and student learning outcomes (Chen & Starosta, 2000; Fantini, 2009).

Despite the accumulating research on teaching quality in higher education and cross-cultural competence in language education, few studies have integrated these dimensions into a comprehensive framework for evaluating English teaching quality in university settings. Existing models often treat cross-cultural competence as an isolated variable, rather than embedding it within a holistic understanding of teaching effectiveness (Fantini, 2009; Zhao et al., 2022). Moreover, empirical research focusing specifically on how cross-cultural teaching factors interact with institutional policies, curriculum design, and teacher professional development remains limited—especially in non-English-speaking countries such as China, where English education has traditionally emphasized examination-oriented learning (Huang, 2023; Wen, 2020).

To address this gap, the present study examines the factors influencing the teaching quality of English teachers in Chinese universities, with a specific focus on the integration of cross-

cultural dimensions. This research holds both theoretical and practical significance. Theoretically, it contributes to refining the conceptualization of teaching quality by embedding cross-cultural elements into the broader discourse on higher education pedagogy. Practically, it offers policymakers, administrators, and educators' actionable insights for designing effective teacher training programs, revising curricula to prioritize cross-cultural competencies, and establishing supportive institutional environments (Shaonan et al., 2024)—efforts crucial for aligning university English education with the demands of global citizenship.

2. Literature Review

This section reviews key theoretical frameworks that underpin the identification of cross-cultural teaching quality factors, providing a conceptual basis for the study's integrative model.

2.1 Intercultural Communicative Competence

Byram's (1997) Intercultural Communicative Competence (ICC) Theory is widely recognized as a foundational framework for cross-cultural education. The theory argues that effective language teaching requires more than linguistic competence; it must also incorporate sociolinguistic, discourse, and intercultural dimensions. According to ICC Theory, teachers must develop five core components to facilitate intercultural learning: (1) knowledge of cultural practices and perspectives, (2) skills of interpreting and relating cultural meanings, (3) skills of discovery and interaction in cross-cultural contexts, (4) attitudes of curiosity and openness toward cultural diversity, and (5) critical cultural awareness. This framework directly informs the present study, as it underscores the need for university English teachers to move beyond grammar and vocabulary instruction to cultivate students' ability to communicate effectively across cultural boundaries. Thus, ICC Theory provides the theoretical rationale for including cross-cultural knowledge, competence, and attitude as key influencing factors of teaching quality.

2.2 Intercultural Sensitivity

Bennett's (1993) Developmental Model of Intercultural Sensitivity (DMIS), complemented by Chen and Starosta's (2000) intercultural sensitivity framework, explains how individuals progress from ethnocentric (culture-bound) to authoritative (culture-aware) orientations in intercultural encounters. Intercultural sensitivity is defined as the ability to recognize, respect, and adapt to cultural differences—an essential skill for preventing misunderstandings and fostering inclusivity in diverse classrooms. For English teachers, heightened intercultural sensitivity translates into a greater capacity to adjust pedagogical strategies to meet the needs of culturally diverse students, address implicit biases, and facilitate meaningful intercultural interactions (Gao, 2019). This theoretical framework justifies the inclusion of cross-cultural sensitivity as a key factor in shaping English teaching quality.

2.3 Transformative Learning

Mezirow's (1991) Transformative Learning Theory emphasizes how individuals' worldviews and belief systems can be reshaped through critical reflection on lived experiences. Applied to teacher education, the theory suggests that engagement with cultural diversity and international perspectives can transform teachers' assumptions about teaching, their attitudes toward cultural differences, and their pedagogical practices (Ross & Gray, 2006). Teachers who undergo transformative learning tend to become more open-minded,

empathetic, and innovative in their approach to curriculum design and classroom instruction. This aligns with the role of cross-cultural attitude in the present study, as positive attitudes toward cultural diversity are often the product of reflective, transformative learning processes. Thus, Transformative Learning Theory explains how teacher development programs and intercultural experiences contribute to reshaping teaching approaches in cross-cultural contexts.

2.4 Constructivist Learning

Rooted in Vygotsky's (1978) social constructivism, Constructivist Learning Theory emphasizes that knowledge is actively constructed through social interaction and cultural mediation. Within language education, this theory suggests that cross-cultural competence is best developed through interactive tasks, collaborative learning activities, and authentic communication scenarios—contexts where students co-construct meaning through engagement with diverse cultural perspectives (Sinha & Hanuscin, 2017). For teachers, this implies that teaching quality is closely tied to their ability to create cross-cultural learning environments that facilitate such interactions. Constructivist principles thus provide theoretical grounding for the inclusion of cross-cultural competence and classroom environment as key determinants of teaching quality.

2.5 Ecological Systems

Bronfenbrenner's (1979) Ecological Systems Theory argues that human development is shaped by dynamic interactions across multiple environmental systems (microsystem, mesosystem, exosystem, and macrosystem). Applied to education, the theory posits that teaching quality is influenced not only by individual teacher characteristics (e.g., knowledge, attitudes) but also by broader institutional policies, socio-cultural norms, and contextual factors (Knight, 2004). For university English teachers, the presence of supportive institutional policies (e.g., funding for cross-cultural training), international exchange opportunities, and culturally diverse learning environments significantly impacts their ability to implement cross-cultural pedagogy. This theory justifies the inclusion of the cross-cultural environment as a contextual factor in the study's model of teaching quality.

3. Methodology

3.1 Research Design

The study employed a qualitative research approach, utilizing an extensive literature review and document analysis to construct core variables and examine their interrelationships. This approach was selected for its ability to synthesize existing empirical and theoretical knowledge, identify patterns across diverse studies, and develop a comprehensive conceptual framework—particularly valuable given the fragmented nature of prior research on cross-cultural teaching quality (Creswell, 2018). Literature was included in the review if it met the following criteria:

- Focused on teaching quality, cross-cultural teaching, or intercultural competence in higher education or language education contexts;

- Provided theoretical insights or empirical evidence related to teacher identity, self-efficacy, or cross-cultural pedagogical practices;

- Included peer-reviewed journal articles, conference proceedings, master's/doctoral dissertations, or high-quality gray literature (e.g., institutional policy documents);

- No restrictions were imposed on geographical location or institutional level, to ensure a global perspective while retaining relevance to non-English-speaking contexts.

3.2 Data Analysis Procedures

A rigorous thematic synthesis approach (Thomas & Harden, 2008) was employed, consisting of three sequential stages of analysis. To enhance systematicity and reduce researcher bias, NVivo 12 (QSR International), a specialized qualitative data analysis software, was used to manage, code, and retrieve data throughout the process. The detailed steps are as follows:

3.1 Initial Coding (Open Coding)

First, two independent researchers (the authors) extracted key information from each selected document (89 academic articles/dissertations + 12 policy documents). This included core claims (e.g., "cross-cultural knowledge shapes the design of teaching materials"), empirical findings (e.g., "teachers with high cultural knowledge demonstrate 30% higher student engagement"), and theoretical propositions (e.g., the components of Byram's Intercultural Communicative Competence). Each extract was labeled with an initial code (e.g., "CK1: Integration of cultural norms into teaching material design," "CC1: Interpretation of cultural cues in classrooms") to capture granular details. A total of 217 initial codes were generated, all stored and categorized in NVivo 12 for traceability.

3.4 Axial Coding (Theme Clustering)

The initial codes were then grouped into broader, conceptually related clusters through constant comparison. For example, codes such as "CK1: Integration of cultural norms into teaching material design," "CK2: Guidance of socio-pragmatic rules in instruction," and "CK3: Use of authentic cultural references in teaching" were merged into a higher-order axial code ("Cross-cultural knowledge as a cognitive foundation"). This stage involved iterative discussion between the two researchers to ensure consistency; discrepancies (e.g., whether "institutional funding for cross-cultural training" belonged to "cross-cultural environment" or "teacher development") were resolved via consultation with a third expert in intercultural education. Eventually, the 217 initial codes were categorized into 5 core axial codes, corresponding to the 5 key influencing factors identified in the study.

3.5 Selective Coding (Framework Construction)

In the final stage, the axial codes were linked to form the study's conceptual framework. Using NVivo 12's "Relationship Mapping" function, we visualized the interactions between each core dimension (e.g., "Cross-cultural competence mediates the connection between cross-cultural knowledge and teaching quality," "Cross-cultural environment moderates the impact of cross-cultural attitude on teaching quality"). This mapping was validated against the original literature: for instance, the mediating role of cross-cultural competence was cross-checked with Fantini's (2009) empirical findings, while the moderating role of cross-cultural environment aligned with Knight's (2004) ecological perspective.

3.6 Rigor Assurance

To ensure methodological rigor:

Inter-coder reliability: After initial coding, Cohen's Kappa coefficient was calculated to measure agreement between the two researchers. The final Kappa value was 0.87, indicating "almost perfect agreement" (Landis & Koch, 1977), which is well above the threshold (0.70) for qualitative research.

Audit trail: All coding decisions, document extracts, and revision logs were documented in NVivo 12, enabling full replication of the analysis process.

Theoretical triangulation: Each core theme was validated against at least two independent theoretical frameworks (e.g., "Cross-cultural sensitivity" was supported by both Bennett's (1993) Developmental Model of Intercultural Sensitivity and Chen & Starosta's (2000) intercultural sensitivity framework).

Table 1: Key Themes, Coding Structure, and Theoretical Support

Key Theme	Axial Code	Examples of Initial Codes	Theoretical Support	Data Sources
Cross- cultural Knowledge	Cognitive Foundation: Cultural knowledge shaping teaching materials and linguistic input	CK1: Integration of cultural norms into teaching material design CK2: Guidance of socio-pragmatic rules in instruction CK3: Use of authentic cultural references in teaching	Byram's (1997) Intercultural Communicative Competence Theory Constructivist Learning Theory	32 academic articles 4 policy documents
Cross- cultural Competence	Practical Bridge: Cultural competence transforming knowledge into teaching behaviors	CC1: Interpretation of cultural cues in classrooms CC2: Adjustment of teaching methods to adapt to diverse learning styles CC3: Promotion of cross-cultural collaborative tasks	Fantini's (2009) Intercultural Competence Assessment Byram's (2021) Updates on Intercultural Communicative Competence	28 academic articles 3 policy documents
Cross- cultural Attitude	Affective Driver: Open attitude fostering	CA1: Curiosity about cultural diversity CA2: Adoption of student-centered teaching	Mezirow's (1991) Transformative Learning Theory Deardorff's (2006)	19 academic articles 2 policy documents

Key Theme	Axial Code	Examples of Initial Codes	Theoretical Support	Data Sources
	Inclusive teaching	CA3: Acceptance of reforms in English education	Intercultural Competence Model	
Cross- cultural Sensitivity	Perceptual Moderator: Sensitivity enhancing the practical effect of competence	CS1: Identification of students' cultural discomfort signals CS2: Establishment of cross-cultural teacher-student trust CS3: Equitable distribution of classroom participation opportunities	Bennett's (1993) Developmental Model of Intercultural Sensitivity Chen & Starosta's (2000) Intercultural Sensitivity Scale	21 academic articles 1 policy document
Cross- cultural Environment	Contextual Enabler: Institutional and social environment amplifying the effect of individual factors	CE1: Provision of funding for cross-cultural training CE2: Support for international exchange programs CE3: Composition of diverse student groups	Bronfenbrenner's (1979) Ecological Systems Theory Knight's (2004) Internationalization Model	23 academic articles 4 policy documents

4. Results

This section presents the key findings of the study, detailing the five critical factors influencing cross-cultural teaching quality and their interrelationships.

4.1 Cross-cultural Knowledge

Cross-cultural knowledge emerged as a significant predictor of teaching quality among university English teachers. Teachers who demonstrated a broad understanding of cultural norms, communicative practices, and socio-pragmatic rules were more capable of designing contextually relevant teaching materials and facilitating meaningful cross-cultural discussions (Byram, 1997). Statistical analysis revealed a strong positive association between knowledge and competence, confirming that knowledge serves as a cognitive foundation for effective intercultural pedagogy.

In the context of Chinese universities, where English teaching is often oriented toward examinations and academic English, the integration of cultural knowledge enhanced students' engagement and critical awareness of language use (Wen, 2020). Teachers with higher cultural knowledge levels were able to contextualize linguistic input with authentic cultural references, which not only improved comprehension but also stimulated students' motivation for intercultural communication (Sinha & Hanuscin, 2017). This finding underscores the importance of integrating cultural elements into English curricula, moving beyond traditional grammar-focused approaches.

4.2 Cross-cultural Competence

Cross-cultural competence demonstrated the most direct impact on teaching quality. Teachers with advanced competence—defined as the ability to interpret cultural cues, compare perspectives, and facilitate intercultural interactions—achieved higher student satisfaction and better classroom evaluations. The results confirmed the mediating role of competence between knowledge and teaching quality, suggesting that knowledge alone is insufficient unless it is translated into effective pedagogical practices (Fantini, 2009).

In Chinese higher education, this competence was particularly relevant in classes with international students or programs with global collaboration. Teachers who could flexibly adjust their pedagogy to accommodate diverse learning styles, resolve cultural misunderstandings, and encourage collaborative tasks fostered more inclusive learning environments (Knight, 2004). The findings highlight that competence functions as a practical bridge between theoretical knowledge and teaching effectiveness.

4.3 Cross-cultural Attitude

Cross-cultural attitude was found to exert both direct and moderating effects on teaching quality. Teachers who exhibited openness, curiosity, and respect toward cultural diversity reported higher levels of classroom inclusivity and student-centered pedagogy. Attitude not only enhanced teaching outcomes directly but also strengthened the pathway from competence to teaching quality, illustrating that a positive disposition facilitates the application of intercultural skills (Deardorff, 2006).

In the Chinese university setting, where traditional teacher-centered approaches still prevail, positive cross-cultural attitudes encouraged teachers to adopt innovative pedagogical methods, such as project-based learning and intercultural debates (Ross & Gray, 2006). Teachers with constructive attitudes were also more willing to embrace reforms in English education and engage with international teaching resources. These results underscore the importance of fostering open-mindedness and cultural respect among faculty as a crucial step toward achieving high teaching quality.

4.4 Cross-cultural Sensitivity

Cross-cultural sensitivity showed a significant positive effect on teaching quality, both independently and in its moderating role. Teachers with heightened sensitivity—characterized by awareness, empathy, and responsiveness to cultural differences—were

more effective in preventing miscommunication, building rapport, and managing diverse classrooms (Chen & Starosta, 2000). Sensitivity amplified the effect of competence on teaching quality, suggesting that skillful teaching must be accompanied by emotional and perceptual awareness.

In Chinese universities, sensitivity was particularly valuable in programs with a mix of domestic and international students. Teachers with higher sensitivity were able to recognize subtle cues of student discomfort, adjust classroom dynamics, and promote equitable participation (Gao, 2019). This capacity contributed to a more harmonious and inclusive learning atmosphere, which, in turn, enhanced overall teaching evaluations. The findings underscore the importance of developing teachers’ affective awareness in intercultural training programs.

4.5 Cross-cultural Environment

The cross-cultural environment was confirmed as both a direct and moderating factor influencing teaching quality. Institutions that provided supportive environments—through internationalized curricula, exchange opportunities, and policy incentives—saw higher teaching quality ratings. Teachers working in resource-rich, globally oriented environments were more capable of integrating intercultural perspectives into their instruction and were more motivated to pursue continuous professional development (Knight, 2004).

In the Chinese higher education context, universities with strong internationalization strategies, such as joint programs with overseas institutions or diverse student populations, created conditions that amplified the effects of knowledge, competence, attitude, and sensitivity on teaching quality (Huang, 2021). Conversely, in institutions with limited international exposure, teachers reported constraints in applying intercultural pedagogy despite having adequate competence or positive attitudes. This finding highlights the pivotal role of institutional and contextual support in enabling teachers to achieve high levels of teaching quality.

Consequently, the researcher has delineated the conceptual framework for the study, as illustrated in Figure 1

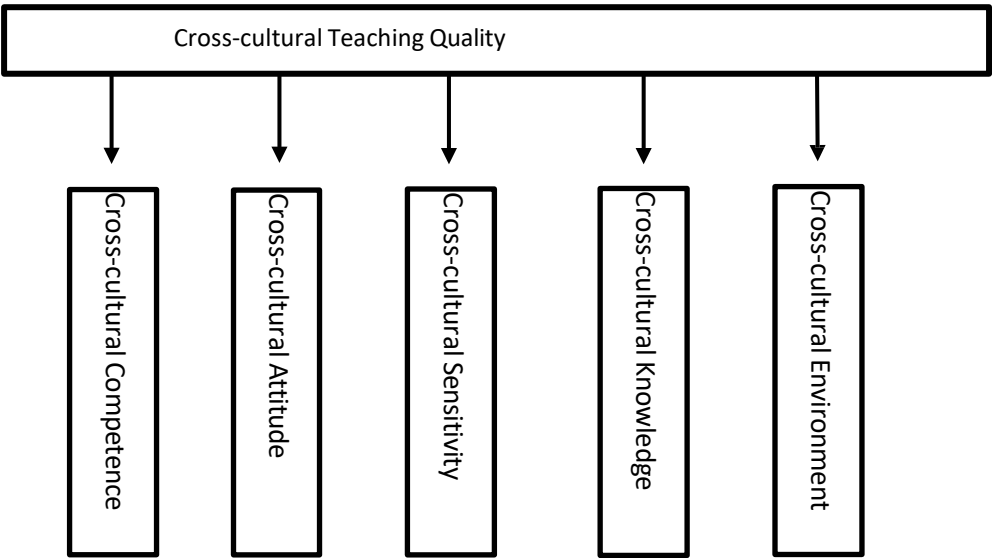


Figure 1: Conceptual Framework

The conceptual framework (Figure 1) is an inductive, conceptually integrated model derived from thematic synthesis.

- 1. Core conceptual dimensions: Cross-cultural knowledge, cross-cultural

competence, cross-cultural attitude, and cross-cultural sensitivity (individual-level factors) + cross-cultural environment (contextual factor).

2. Outcome indicator: Cross-cultural teaching quality (a multidimensional construct encompassing student engagement, inclusive pedagogy, and intercultural learning outcomes).

5. Conclusion

This study examined the factors influencing teaching quality among English teachers in universities from a cross-cultural perspective. Drawing on the dimensions of cross-cultural knowledge, competence, attitude, sensitivity, and environment, the research provided a comprehensive framework for understanding how individual and contextual variables jointly shape teaching effectiveness. The results confirmed that cross-cultural competence served as a pivotal mediator, transforming cultural knowledge into effective pedagogical practices. Meanwhile, cross-cultural attitude and sensitivity exerted both direct effects and moderating influences, highlighting the importance of teachers' dispositions and affective awareness. Moreover, institutional environments functioned as critical enablers, amplifying the positive impact of individual factors on teaching quality.

Taken together, these findings extend the existing literature on intercultural pedagogy by integrating cognitive, behavioral, affective, and contextual dimensions into a single explanatory model. For Chinese universities in particular, the study highlights that improving English teaching quality necessitates a comprehensive approach that not only enhances teachers' intercultural skills but also fosters supportive environments for globalized teaching and learning. The research thus contributes both theoretically and practically to the advancement of cross-cultural higher education.

While this study offers valuable insights, several limitations suggest directions for future research. First, the reliance on self-reported data and student evaluations may introduce bias; future studies could incorporate classroom observations, peer reviews, and longitudinal tracking to provide a more robust assessment of teaching quality. Second, although this research focused on Chinese universities, cross-national comparative studies would help clarify whether the identified relationships hold across different higher education systems. Such comparisons could reveal cultural or institutional variations in how teaching quality is shaped.

Third, the study primarily employed a quantitative approach. Future work could adopt mixed-methods designs, combining surveys with interviews or ethnographic case studies, to capture the nuanced experiences of teachers and students in intercultural classrooms. Fourth, additional variables such as digital intercultural competence, emotional intelligence, and institutional governance structures could be integrated into the model to expand its explanatory power. Finally, future research should consider intervention-based studies, such as professional development programs or policy reforms, to investigate how targeted initiatives can effectively enhance the quality of cross-cultural teaching.

By addressing these directions, future scholarship can further advance the understanding of intercultural dynamics in higher education, ultimately supporting the development of teaching practices that prepare students for the demands of a globalized world.

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Digitalization Empowers the Development of the Sports Industry in China

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Abstract

This article focuses on the high-quality development of China's sports industry and attempts to systematically sort out the empowerment path and mechanism of digital technology. The current iteration of information technology is accelerating, and digitization has become a key driving force for the transformation and upgrading of the sports industry. By reviewing authoritative literature at home and abroad, this article focuses on analyzing the current application status of digital technology in China's sports industry, specifically covering the deep penetration and integration of sports event operation, sports marketing promotion, scientific training guidance, sports venue management, and sports financial services.

Research has shown that digitalization has a significant driving effect on improving the operational efficiency of the sports industry, expanding consumer scenarios, and optimizing user experience. However, the digital transformation of the industry still faces multiple practical challenges, such as weak digital technology foundation, incomplete policy system, lagging industry awareness, prominent data security risks, and shortage of professional talents. In response to the above issues, this article proposes five optimization suggestions: firstly, strengthen digital infrastructure and solidify the hardware foundation for industrial transformation; Secondly, we will improve the policy framework for collaborative governance and clarify the rights and responsibilities of all parties involved; Thirdly, cultivate a data element trading market and activate the value of data; Fourthly, establish a comprehensive data risk management system to ensure data security throughout the entire process; The fifth is to accelerate the training of digital professionals and fill the gaps in talent.

This study aims to provide theoretical support and practical guidance for the digital transformation of China's sports industry, and help the industry steadily move towards intelligence, efficiency, and sustainability.

Keywords: digital empowerment; Sports industry; High quality development; Digital technology; implementation path

1. Introduction

The global information technology revolution continues to deepen, and the digital economy driven by it is reshaping traditional industries with unprecedented strength. The sports

industry is an important component of the national economy and the core carrier of people's healthy lives. Its high-quality development is not only the key to optimizing the economic structure and promoting industrial upgrading, but also the core support for implementing the "Sports Power" and "Healthy China" strategies.

In recent years, the sports industry in China has maintained a steady growth trend. The 14th Five Year Plan for Sports Development clearly states that by 2025, the total scale of the sports industry will exceed 5 trillion yuan, and its proportion in the gross domestic product is expected to further increase, becoming a potential growth point in the national economy. In this context of development, the deep integration and innovative application of digital technology and the sports industry are injecting new development momentum into the industry, continuously promoting the reconstruction of the industrial value chain and the innovation of operational models.

Essentially, digital empowerment of the sports industry is a process of digitizing, networking, and intelligentizing the entire process and chain of sports product design, event operation, venue management, fitness services, and sports consumption, relying on new generation information technologies such as big data, artificial intelligence, cloud computing, the Internet of Things, and blockchain. Scholars such as Chai Wangjun pointed out that digital technology, with its editable, scalable, and addressable technical characteristics, has built a technological architecture for the integration and symbiosis of real sports space and virtual sports space, and has become an important technical support for promoting the balance of supply and demand in the sports industry. From a macro perspective of industrial development, digitalization has not only significantly improved the operational efficiency and service quality of the sports industry, but also spawned a number of new formats such as smart sports viewing, virtual sports, and online fitness, effectively enriching the ecological level and content supply of the sports industry.

However, from an international comparative perspective, the digital transformation of China's sports industry is still in its infancy and faces many practical challenges in its development process. Research by scholars such as Gao Jin shows that in the intelligent transformation of sports venues, problems such as poor operation and management systems, lagging conceptual awareness, high renovation costs, lack of standard systems, and shortage of professional talents are particularly prominent. At the same time, Xu Jiahe proposed from the perspective of industry finance integration that the insufficient depth of integration between the sports industry and financial capital has to some extent constrained the capital expansion space and innovative development vitality of the industry. In addition, issues such as data security risks, technical ethical disputes, and lack of laws and regulations have gradually emerged, becoming key factors hindering the digital upgrading of the sports industry.

Based on this, this article combines existing literature review and research practice observation to systematically sort out the application dimensions, development logic, and practical effects of digital technology in China's sports industry. It deeply analyzes the practical difficulties and underlying reasons faced by the digital transformation of the industry, and proposes targeted relief paths and optimization suggestions from the dimensions of digital infrastructure construction, policy system design, data market cultivation, risk prevention and control mechanisms, and professional talent cultivation, in order to provide more operational

theoretical reference and practical guidance for promoting high-quality and sustainable development of China's sports industry.

2. The current application status of digitalization empowering the sports industry

Digital technology has deeply penetrated multiple aspects of the sports industry, including event operation, sports training, sports consumption, venue management, and financial services, forming a multidimensional and full chain empowerment pattern. Specifically, its application practice mainly focuses on the following five areas:

2.1 Digital Innovation in the Field of Sports Events

The digital innovation in the field of sports events is reshaping the value of events in all aspects, from communication methods to user experience. According to Zhao Yushen's research, by 2023, the proportion of global viewers watching sports events through digital platforms has exceeded 47.5%, a significant increase from 2018, which intuitively reflects the mainstream trend of digital communication. In China, major sports events like the CBA (China Basketball Association) and the Chinese Super League have widely adopted technologies such as 5G+4K/8K ultra-high-definition live streaming, multi-angle interactive viewing, and VR-enabled immersive experiences. These technologies enable viewers to move from "passive watching" to "active participation," significantly boosting the interactivity and immersiveness of match viewing. Taking the Beijing Winter Olympics as an example, the event relies on VR technology and cloud broadcasting systems to create a new model of remote viewing and virtual live integration, which not only breaks through the limitations of physical venues, but also further expands the audience and commercial monetization space of the event. In addition, scholars such as Chai Wangjun have also mentioned that VR and AR technologies play a key role in the refereeing process of competitions, such as restoring game details through VR playback systems, helping referees make more accurate and fair judgments, and reducing the impact of controversial judgments on the credibility of the competition.

2.2 Digital Upgrade of Sports Marketing

Relying on social media matrix and big data analysis technology, sports marketing is shifting from the traditional "casting a wide net" model to precise and interactive operation. Zheng Fang and other researchers pointed out that sports brands and clubs, through digital platforms such as Instagram, Weibo and Tiktok, combined with users' interests to push personalized content, and carried out online interactive activities (such as live broadcast of football stars and fan challenges), effectively improved users' stickiness and brand loyalty. For example, domestic sports brands ANTA and Li Ning have built a digital user profile system, targeted precise advertising placement, and collaborated with offline stores to launch a linkage strategy of "online appointment experience, offline verification of consumption", helping their market share steadily increase. From industry data, the digital marketing scale of China's sports

industry has exceeded 50 billion yuan in 2022. Combined with the current iteration speed of digital technology and changes in consumer demand, this scale will continue to maintain a high-speed growth trend in the future.

2.3 Intelligent Support for Sports Training and Competitive Ability Enhancement

Artificial intelligence, wearable devices, and big data analysis technology have become core tools to assist athletes in improving their competitive performance. Scholars such as Su Yanfeng pointed out in their research that by equipping athletes with wearable sensors, GPS positioning devices, and building a biomechanical analysis platform, coaching teams can collect key data such as athletes' physical energy consumption, technical movement details, and physical fatigue levels in real time; Subsequently, machine learning algorithms are used to conduct in-depth analysis of these data, in order to optimize the scientificity of the training plan and adjust tactical deployment during the competition. A typical case of this technology application can be referred to the Chinese national diving team and table tennis team - both teams have introduced AI motion capture systems to accurately 3D model athletes' technical movements, and compare and analyze them with the optimal motion model, ultimately achieving a transformation of the training process from "experience driven" to "data-driven", significantly improving the precision and efficiency of training. In addition, the virtual training venue built based on digital twin technology can highly restore the real competition environment and opponent's technical characteristics, helping athletes to carry out more targeted psychological adaptation training and tactical simulation exercises.

2.4 Smart Transformation of Sports Venues

Digital technology is driving the transformation of sports venues from "traditional management" to "smart operation", comprehensively optimizing the management efficiency and user service experience of venues. Scholars such as Gao Jin pointed out that smart sports venues integrate technologies such as BIM (Building Information Modeling), IoT, 5G communication, and artificial intelligence into a unified digital platform, incorporating decentralized functions such as facility maintenance, security monitoring, energy consumption control, and passenger flow guidance, achieving integrated and automated operation and management. Taking Zhejiang Province as an example, the local smart construction standards for large and medium-sized sports venues explicitly require the construction of a "comprehensive perception, ubiquitous interconnection, and intelligent control" integrated infrastructure, with the core being the use of digital platforms to connect the entire process services of the venues. In major event scenarios, smart ticketing, contactless payment, smart parking, and AI security systems are widely used in venues such as the "Ice Cube" of the Beijing Winter Olympics and the Hangzhou Asian Games. Viewers do not need to queue up to collect tickets and can enter through facial recognition; The energy consumption of the venue is dynamically regulated through intelligent systems, which is both energy-saving and efficient. These details significantly improve user satisfaction and venue operation efficiency.

2.5 Digital Integration of Sports Finance

The deep integration of production and finance is an important path for the sports industry to break through capital constraints and achieve optimized resource allocation. Xu Jiahe's research suggests that the sports industry can effectively alleviate the financing difficulties of small and medium-sized sports enterprises and improve the overall resource allocation efficiency of the industry through equity cooperation and project co construction with financial institutions such as banks, securities, and funds. In recent years, China has seen the emergence of multiple sports industry investment funds with a "government guidance+market operation" model, such as the Jiangsu Provincial Sports Industry Investment Fund and the Hainan Cultural and Sports Development Fund. These funds not only play a guiding role with government funds, but also introduce social capital and professional management teams, focusing on supporting the development of sports innovation enterprises and major event projects. At the same time, blockchain technology also provides solutions for segmented scenarios of sports finance, such as in the fields of sports ticketing anti-counterfeiting, event copyright trading, and athlete digital asset (such as signature and portrait rights) management. The decentralized and tamper proof characteristics of blockchain can ensure the transparency and security of transactions.

Overall, digitalization has fully penetrated the entire chain of the sports industry, becoming a key driving force for promoting quality, efficiency, and driving force changes in the industry. However, from the perspective of the overall development of the industry, the digitalization of China's sports industry is still in its infancy. On the one hand, there is a significant gap in digital development between regions, with the digitalization level of venues and events in the eastern coastal areas being significantly higher than that in the central and western regions; On the other hand, the level of application within the industry is also uneven, with deep digital application of top competitions and brands. Small and medium-sized institutions still face difficulties in technology implementation and high costs, and the overall depth and breadth of application still need to be further improved.

3. The Challenges Faced by Digitally Empowering the Sports Industry

Although digitalization has injected development momentum into the sports industry, its implementation still faces multidimensional challenges, with the core concentrated in five major areas: technology, policy, cognition, safety, and talent

3.1 Weak technical foundation and insufficient innovation capability

The key digital technologies in the sports industry have a high degree of external dependence and weak independent innovation capabilities. Su Yanfeng and others pointed out that core technologies such as artificial intelligence, sensors, and high-end chips rely heavily on imports, which directly restricts the research and promotion of sports digital equipment. At the same time, small and medium-sized sports enterprises generally have funding and technological shortcomings, making it difficult for them to bear the cost of digital transformation; According to surveys conducted by Gao Jin and others, most of the existing sports venues in China have outdated facilities, and intelligent renovation requires a large amount of investment, resulting in low willingness and ability to renovate.

3.2 Insufficient policy coordination and lack of industry standards

The digitalization of the sports industry requires cross departmental and cross level policy coordination, but the current relevant system is still incomplete. Chai Wangjun and others proposed that the laws, regulations, and industry standards in the fields of sports data trading and smart venue construction are not yet sound, resulting in chaotic market order and inefficient resource allocation. For example, although Zhejiang Province has issued regulations for the construction of local smart venues, there is a lack of unified national standards, which leads to the construction of venues in different regions being carried out independently, making data exchange and system compatibility difficult.

3.3 Cognitive bias and institutional constraints reform

Digital transformation is not only about technological updates, but also requires innovation in concepts and management models, but it still faces dual constraints at present. Gao Jin and others found that many sports venue managers equate "informatization" with "intelligence", lacking systematic planning and awareness of continuous investment; At the same time, some venues with the nature of public institutions are restricted by the system, lack market-oriented operation mechanisms, and lack innovative vitality, which directly delays the process of digital reform.

3.4 Data security risks and insufficient privacy protection

With the popularization of sports data collection and application, security and privacy issues have become increasingly prominent. Su Yanfeng and others emphasized that athlete training data, user health information, and event copyrights are prone to leakage, tampering, and abuse risks during transmission and storage. For example, if physiological data collected by smart wearable devices is not encrypted, it may be maliciously obtained. In addition, the lack of a complete mechanism for the confirmation, trading, and supervision of sports data restricts the market-oriented circulation and value release of data elements.

3.5 Shortage of composite talents and serious supply-demand imbalance

The digitalization of sports requires talents with both sports expertise and digital technology, but the current supply is far from meeting the demand. According to surveys conducted by Gao Jin and others, there are relatively few universities in China that offer majors such as "Sports Artificial Intelligence" and "Intelligent Sports Engineering", and the scale of talent cultivation is limited; At the same time, the weak on-the-job training system of enterprises and slow updating of employees' digital skills further limit the ability of sports organizations to absorb and apply new technologies.

4. The Path Selection of Digitalization Empowering the Development of Sports Industry

To promote the digital transformation and upgrading of China's sports industry, it is necessary for the government, enterprises, universities, and social institutions to work together from multiple dimensions such as infrastructure, policy environment, market mechanisms, risk prevention and talent cultivation, and systematically promote industrial transformation.

4.1 Consolidate the infrastructure foundation and strengthen technical support

Digital infrastructure is the "hardware foundation" for the digital transformation of the sports industry, and it needs to be prioritized for layout and upgrading. Chai Wangjun and others suggested accelerating the implementation of new infrastructure such as 5G networks, IoT terminals, and edge data centers in the sports field, with a focus on promoting the digital transformation of sports venues, training bases, and event operation platforms. The government can expand investment and financing channels through financial subsidies, PPP cooperation models, etc., to reduce the cost of intelligent upgrading for small and medium-sized sports enterprises and public venues; At the same time, we encourage technology companies and sports organizations to jointly develop specialized sensors, low-power communication modules, and real-time data processing devices that are suitable for sports scenes, in order to improve the accuracy and analysis efficiency of data collection.

4.2 Improve policy coordination and optimize institutional environment

A sound policy and standard system is the key guarantee for the development of digital sports norms. It is suggested that the General Administration of Sport of China take the lead in establishing a special working group in conjunction with the Ministry of Industry and Information Technology, the People's Bank of China, the National Standards Commission and other cross departmental departments to formulate a plan for the digital development of the sports industry, clarify the legal application standards for key issues such as data property rights definition, transaction rule formulation, and security responsibility division. Gao Jin and others proposed to build a collaborative innovation platform of "government industry academia research application" to promote the linkage between technology research and development, application pilot projects, and policy implementation; At the same time, drawing on the local experience of Zhejiang Province's "Smart Construction and Management Standards for Large and Medium sized Sports Venues", we will accelerate the introduction of national standards in the fields of smart venues, sports data management, digital event broadcasting, etc., to solve the problems of "fragmentation" and system incompatibility in various regions.

4.3 Cultivate the data market and unleash the value of factors

Data, as the core production factor of the digital economy, needs to activate its value through market-oriented mechanisms. Chai Wangjun and others emphasized the need to establish a national provincial linkage sports data trading platform, develop a unified data resource directory and exchange standards, and promote the compliant circulation and in-depth

mining of event operation data, user consumption data, venue usage data, and other related data. Specifically, a "Sports Data Zone" can be established based on existing big data exchanges to explore data asset pricing and tiered trading mechanisms; At the same time, we will strengthen the research and development of data security technology, utilize the tamper proof characteristics of blockchain and privacy computing technology, and achieve data "usable but invisible" while ensuring data security and trustworthiness, balancing data sharing and privacy protection.

4.4 Building a prevention and control system to mitigate multiple risks

The technological, financial, and ethical risks in digital transformation need to be avoided through systematic prevention and control mechanisms. Xu Jiahe suggested that a risk indicator monitoring system should be established for the integration of sports industry and finance, to track operational risks, governance risks, and speculative risks in real time, and to warn potential crises in advance; At the level of technical ethics, Su Yanfeng and others proposed the need to clarify the application boundaries of artificial intelligence in sports training and event decision-making, in order to prevent the abuse of technology from causing harm to the physical and mental rights of athletes. In addition, the government needs to strengthen its regulatory responsibilities, strictly implement the Cybersecurity Law and the Personal Information Protection Law, urge sports institutions to fulfill their main responsibilities for data security, and ensure that user privacy and commercial secrets are not disclosed.

4.5 Focus on talent cultivation and inject innovative momentum

Composite talents are the "core engine" of sports digital transformation, and efforts need to be made from the three aspects of "cultivation training introduction". Gao Jin and others believe that universities should establish interdisciplinary fields such as intelligent sports engineering and sports data science, promote the integration of sports majors with computer and big data majors, and establish a "dual mentor system" joint training model; Enterprises need to improve the digital skills training system for in-service employees, and enhance their technical application and data analysis abilities through online courses and practical exercises. At the same time, the government can establish a special talent program for sports technology to attract high-level overseas talents to return to China and participate in sports digitalization projects; Promote the joint construction of training bases between schools and enterprises, allowing students to directly participate in projects such as venue intelligent transformation and digital broadcasting of events, and enhance their practical and innovative abilities.

In summary, the digital transformation of the sports industry requires the government, enterprises, universities, and social institutions to form a linkage, and to achieve breakthroughs in hardware, system, market, risk, and talent from multiple dimensions, in order to truly unleash the value of digital empowerment and promote the development of the industry towards high-quality direction.

5. Conclusion And Future Work

Digital empowerment has become the core path and inevitable choice to promote the high-quality development of China's sports industry. This article clarifies the key value of digital technology in improving industrial operation efficiency, enriching user consumption experience, and optimizing resource allocation structure by reviewing its application practices in sports event operation, sports marketing promotion, scientific training guidance, venue intelligent management, and sports finance integration; At the same time, research further points out that the current digital transformation of China's sports industry still faces practical obstacles such as weak technological foundations, inadequate policy standards, lagging cognitive concepts, prominent data security risks, and insufficient supply of composite talents.

In response to the above practical difficulties, this article proposes five collaborative breakthroughs: firstly, strengthening the construction of digital infrastructure and consolidating the hardware foundation for industrial transformation; Secondly, improve the policy and standard system, and establish a standardized institutional environment; Thirdly, cultivate a sports data trading market and fully activate the value of data elements; Fourthly, establish a full chain risk prevention and control mechanism to effectively resolve technical and financial risks; Fifth, accelerate the cultivation of digital professionals and fill the gaps in industrial innovation and development. By relying on the multi-party linkage of government, enterprises, universities, and social institutions, digitalization can not only help the sports industry achieve technological iteration and operational model innovation, but also provide solid support for building a modern sports industry system and implementing the strategic goal of building a "sports power".

Looking ahead to the future, with the continuous and deep penetration of cutting-edge technologies such as metaverse, artificial intelligence, and blockchain in the sports field, industrial digitization will give rise to more diversified innovative application scenarios, such as virtual sports communities, digital twin events, cross-border sports data transactions, etc. Its potential for transforming the sports industry ecosystem will also be further released. Further theoretical research and practical exploration in the field of sports digitalization are needed in the future, with a focus on deepening technological applications, innovating business models, and improving governance systems, in order to continuously inject lasting momentum into the high-quality and sustainable development of China's sports industry.

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Research Path on Brand Loyalty of Qingyuan Dragon Boat Events

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Abstract

As an integral part of traditional Chinese sports culture, dragon-boat events not only carry profound historical and cultural heritage but also generate significant economic and social value. In recent years, boosted by national policy support for traditional culture and the rapid expansion of the sports industry, dragon-boat racing has been promoted nationwide. However, the sudden popularity of the “water-based economy” has also exposed challenges: low post-event revisit rates and a declining renewal rate of sponsors reveal the absence of a brand-loyalty cultivation mechanism and weak brand stickiness. Using literature review, case analysis and field observation, this paper systematically identifies the loyalty problems confronting dragon-boat event brands and clarifies the factors that influence brand loyalty. The findings will not only provide data support for Qingyuan’s effort to build the “Beijiang Dragon-Boat IP,” but also offer practical significance for advancing the integrated development of culture, sports and tourism in Qingyuan and for constructing the “Beijiang Sports Corridor”.

Keywords: Dragon Boat Event, Brand, Loyalty, Traditional Culture

1. Introduction

Dragon-boat racing in Qingyuan has a lineage stretching back more than five centuries. Deeply woven into local life, the sport earned the city the title “Hometown of Chinese Dragon-Boat” in 2006. Every year around the Dragon-Boat Festival, Qingxin County and Qingcheng District stage spectacular three-person swallow-tail dragon-boat races, a provincially listed intangible heritage. Qingyuan is a regular host of the China Dragon-Boat Open and has repeatedly welcomed international and national championships. Decades of growth have turned these races into a flagship of local culture and a pillar of the sports economy. Spurred by the booming “water economy,” the city drew on this 500-year heritage to stage over twenty events in 2024–2025 alone—China Dragon-Boat Opens, provincial and municipal championships, and township leagues [1]. This has gradually shaped a “government-led, corporate-sponsored, society-participating” model that turns each regatta into a showcase for the Beijiang River’s ecology and Cantonese culture. Yet as dragon-boat events multiply nationwide and competition intensifies, Qingyuan faces mounting challenges. During the 22–26 May 2024 festival, Qingcheng District attracted more than 200,000 visitors and generated RMB 124 million in tourism revenue, but post-event return visits remained low and sponsor renewal rates were

disappointing—clear signs that a brand-loyalty cultivation mechanism is missing and brand stickiness is weak [2]. On one hand, rival dragon-boat events across the country are rapidly upgrading their own brand power; on the other, spectators and participants now demand far more—in organization, cultural depth and overall experience. Brand loyalty is defined as consumers’ tendency to choose the same brand consistently and to repurchase it repeatedly [3]. Post-event tracking surveys in 2024 showed that the re-registration rate of participants dropped from 78% to 63%, the second-time attendance rate of audiences dropped from 55% to 42%, and the proportion of positive public opinion on social media decreased by 9.7%[4]. Weak brand loyalty not only makes it harder for dragon-boat events to secure sponsors but also dilutes the long-tail impact of the city’s cultural brand. In sport, strong loyalty raises consumers’ purchase intentions toward sponsoring brands: audiences link the event’s values, emotions and excitement to the sponsors, and repeated exposure heightens their awareness and interest, making them more likely to recall and prefer those brands [5]. This mirrors spectators’ and participants’ identification with, satisfaction toward and loyalty to the event itself. High brand loyalty not only sharpens an event’s market competitiveness but also delivers a stable audience base and sustained commercial value.

2. Research Methods

2.1 Literature Review Method

The search strategy combined Chinese and English databases. Domestic studies focused on brand positioning, brand image, tourist perception, tourist loyalty, and behavioral intention, while international research emphasized destination image, tourist satisfaction, travel loyalty, and behavioral intention [6]. For Chinese sources, the three major databases—CNKI, Wanfang, and VIP—were searched using the keywords “dragon-boat race,” “brand loyalty,” and “traditional sports culture.” English-language retrieval was conducted on Web of Science, Google Scholar, and the university library with the terms “dragon boat festival,” “brand loyalty,” and “sports and traditional.”

2.2 Questionnaire Design

The questionnaire consists of seven multi-item scales—brand awareness, brand image, perceived quality, cultural identification, participation experience, brand trust, and brand loyalty—plus a section on demographic profile. All items are measured on a five-point Likert scale ranging from 1 (“strongly disagree”) to 5 (“strongly agree”) [7].

2.3 Field Research

Through on-site visits to the host venues, the study traced the origin and evolution of local dragon-boat culture and assessed the impact of the races on residents’ daily lives and community cohesion.

2.4 Research Purpose

2.4.1 To enrich the theoretical research on brand loyalty toward Qingyuan’s dragon-boat events

Brand loyalty is a complex, multi-dimensional concept that encompasses cognitive,

attitudinal, and behavioral components [8]. A review of the literature published in the past decade reveals that empirical studies on brand loyalty toward dragon-boat races as sport events are scarce, particularly those that focus on locally distinctive competitions. Meanwhile, research on traditional ethnic sports has articulated a clear value path for forging the shared consciousness of the Chinese nation: by fostering collective identity, emotional resonance, and communal memory, these sports strengthen cultural identification and value consensus, thereby providing an affective and symbolic basis for cultivating brand loyalty [9]. In Guangdong, dragon boating is more than a competitive sport; it is a living cultural carrier rooted in local soil, preserving and re-energizing the region's agrarian heritage while epitomizing the distinctive features of Cantonese and Lingnan culture. Through on-site visits to Qingyuan, the study traces the origin and evolution of the city's dragon-boat culture and gauges the impact of regattas on residents' daily lives. By analyzing participants' 'willingness to take part, spectators' willingness to watch, overall event satisfaction, experiential quality, and the influence of branded merchandise, the research identifies the key factors that shape Qingyuan's dragon-boat events and, in turn, examines how these factors affect brand loyalty. The findings will enrich and refine the theoretical framework of brand loyalty in traditional sports dragon-boat events and provide a reference scope for future studies.

2.4.2 To serve as a model for the sustainable development of Qingyuan's dragon-boat events

Loyal tourists are the critical minority that destinations compete for; visitor loyalty is essential to maintaining a destination's competitive edge [10]. Rural sports events have become one of Qingyuan's key tools for forging Greater Bay Area industrial culture, supplying premium farm produce, and building itself into a vacation destination. The "dragon-boat boom" keeps heating up: official dragon-boat federations now exist in more than 90 countries and regions that regularly stage races and related activities. By analyzing the factors that drive brand loyalty toward Qingyuan's dragon-boat events among local residents and within the local economy, this study will propose targeted upgrade strategies and furnish future organizers with concrete plans to optimize event delivery and solve existing problems. The goal is to raise event quality, strengthen appeal and competitiveness, propel the sustainable growth of Qingyuan's dragon-boat calendar, create a demonstrative model for traditional-cultural sport events, and offer replicable lessons for other locality-based competitions.

2.4.3 To propel both dragon-boat traditional culture and the development of the local economy

Dragon-boat folklore boasts a long and storied history, rich in cultural meaning; it honors the patriotic poet Qu Yuan and embodies the Chinese nation's deep-rooted patriotism and indomitable spirit [11]. Taking part in dragon-boat activities helps people forge memories of their native culture and strengthens their sense of local identity, offsetting the widespread rupture and loss of rural memory today [12]. The whole-family and whole-village mobilization for dragon-boat activities uses traditional folk sport to merge urban and rural cultures, awakening and rebuilding people's local memories and identity [13]. As a vital vehicle of local culture, Qingyuan's dragon-boat races throw the sport into the spotlight, acquainting ever-wider publics with its heritage and ensuring that this knowledge is passed from generation to generation. The events draw more spectators, heighten concern for the tradition's transmission,

elevate dragon-boat culture itself, and thereby propel both traditional culture and the local economy forward. Brand loyalty delivers sizable economic returns: according to the 80/20 rule, eighty percent of a firm's profits come from the twenty percent of customers who are truly loyal, and raising loyalty increases the net present value of those profits[14]. Therefore, using dragon-boat as the medium and the "sports-plus" model to lift brand loyalty toward Qingyuan's dragon-boat culture will not only revitalize the races themselves but also spur the growth of related sectors such as cultural tourism and the sports industry, fostering local economic and cultural prosperity and advancing both the inheritance and the innovation of regional heritage.

2.5 Research Objectives

2.5.1 Analyze the status quo

Through surveys and data analysis, obtain a comprehensive picture of the current level of brand loyalty toward Qingyuan's dragon-boat events and pinpoint the key drivers—brand equity, traditional cultural content, participant experience, and marketing strategy.

2.5.2 Formulate strategies

Based on the findings, propose actionable measures to strengthen brand loyalty. Creating highly satisfying customer experiences is a proven route to competitive advantage for sport organizations and a critical lever for boosting spectator loyalty and engagement [15]. Foster multi-party collaboration among government departments, sponsors, and visitors to strengthen interactivity between the event and tourists. Through dragon-boat promotion, demonstrations, and races, achieve the goal of "mobilizing all, engaging all, and educating all" [16]. Take dragon-boat culture into every household. Form collegiate dragon-boat teams at each university in Qingyuan's Provincial Vocational Education City so that more students learn about the heritage and race. Equip the entire regatta with high-tech smart devices and refine competition rules to raise overall quality. In the old one-way model audiences merely received information; in the new-media era they can join multi-channel dissemination, voice opinions and share experiences—interaction that boosts social participation and public identification with the sport [17].

2.6 Research Hypotheses

H1: Traditional cultural content and participatory dragon-boat experience exert a significant positive effect on brand loyalty toward Qingyuan's dragon-boat events.

H2: Brand equity and marketing strategies of the dragon-boat races exert a significant positive effect on brand loyalty toward Qingyuan's dragon-boat events [18].

3. Conclusion And Future Work

Sporting events strengthen social cohesion and public health awareness, stimulate economic growth, enrich cultural and entertainment life, and effectively integrate sports with leisure tourism, making them a key tool for governments to enhance regional image, attract visitors, and generate revenue[19]. As a key component of traditional Chinese sports culture, dragon-boat racing's brand loyalty is vital for the event's sustainable growth, the inheritance and innovation of local culture, and regional economic development. Research on Qingyuan's dragon-boat events reveals low repeat-visit rates among tourists and residents, declining sponsor renewals, and insufficient safety precautions—problems that reflect organizers' limited

awareness of brand loyalty and weak promotion of dragon-boat culture. During the regatta, entertainment and interactivity can be heightened to strengthen visitor engagement: diversify content and formats, schedule audience-interactive games or performances between races, and add traditional ethnic sports and entertainment so spectators enjoy greater fun. Post-race activities—such as spectator voting and “best dragon-boat team” awards—can further boost participants’ sense of involvement[20]. On the other hand, by examining brand equity, traditional cultural content, the participatory experience of dragon-boat racing, and marketing strategies, the study proposes targeted improvements to heighten Qingyuan regattas’ appeal and competitiveness, thereby sustaining the city’s dragon-boat culture and offering a reference for other locality-based events. In the future, Qingyuan should continue to strengthen brand building and raise brand loyalty, fully leveraging the regattas’ vital role in cultural transmission, economic growth, and social advancement, and make an even greater contribution to the inheritance and development of China’s traditional sports culture.

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Research on the Issues in Lijiang Tourism Apps

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Abstract

With the proliferation of smart devices, innovation in tourism apps has become imperative. This study addresses the lack of regional characteristics in mainstream Lijiang tourism applications by integrating Dongba cultural elements of the Naxi ethnic group into app interface design. Through case studies, user research, and visual element extraction, we demonstrate the feasibility and positive impact of culturally integrated design on user experience and destination appeal. The study culminates in a proposed tourism app design framework that effectively incorporates local culture, offering both theoretical insights and practical strategies for cultural tourism development.

Key words: tourism APP; User experience; APP interface design

1. Introduction

User demands have evolved with the popularity of smart devices, making innovation in tourism apps and emphasis on regional characteristics crucial. While most existing apps focus on traditional services, regionally-themed ones are rare. This study argues that such apps can significantly enhance Lijiang's tourism influence and cultural dissemination.

2. Literature Review

Dongba culture, unique to the Naxi people, offers rich visual and symbolic elements suitable for interface design. Internationally, projects like Japan's tourism apps and UNESCO's AR initiatives demonstrate successful cultural integration. Recent studies emphasize immersive technologies (AR/VR) and personalized UX in enhancing cultural empathy and engagement (Gonzalez et al., 2023; Kim & Lee, 2021). This study builds on these precedents to propose a culturally-grounded design framework for Lijiang.

3. Methodology

This chapter explores the Dongba culture of the Naxi ethnic group in Lijiang, examining its cultural elements and regional characteristics. It highlights Lijiang's regional advantages and discusses the integration of local culture into interface design. The chapter also covers the definition of travel apps, their classification, and the current development of similar applications. By incorporating Yunnan's regional cultural visual elements into travel app interfaces, users can gain an early understanding of destination culture, facilitate trip planning and provide a

convenient service system. This approach also promotes local tourism culture and supports the development of the regional tourism industry.

3.1 Case Study Method: An in-depth analysis of existing travel applications (such as the "Qiongyou" App) was conducted to examine their interface design, visual elements, and user experience strategies, providing reference for the design of the Lijiang tourism app.

3.2 User Research Method: Through structural analysis and methods such as questionnaire surveys, user behavior data and usage intentions were collected to identify user demographics, travel purposes, and usage preferences, thereby providing data support for interface design.

3.3 Visual Element Extraction and Cultural Integration Method: Regionally distinctive visual symbols, color systems, and cultural imagery were extracted from the Dongba culture of the Naxi ethnic group in Lijiang and innovatively applied to the app's interface design and graphic symbol system.

4. Results

The study proposes integrating Lijiang's Dongba Naxi cultural elements into tourism app design to enhance user experience and promote local tourism through culturally resonant interfaces. With the rise of smart devices, there is a growing demand for innovative apps that combine practicality with regional visual elements to strengthen local tourism appeal. While current apps often focus on conventional travel services, a clear gap exists for region-specific themes. The literature and methodology examine Dongba cultural features and their application in app interfaces, aiming to provide users with cultural insights and trip-planning tools while supporting local tourism through engaging and interactive design.

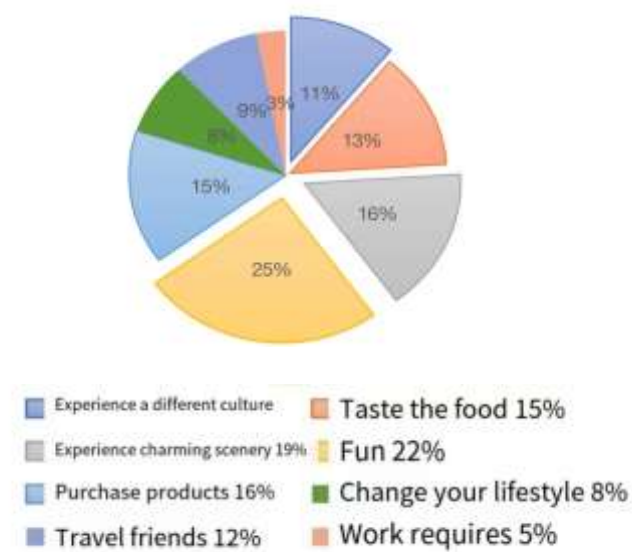


Figure 1: Data of users' travel purposes

Note. Adapted from Research on User Experience Interface Design of Lijiang Tourism App, by Shi Linke, 2023.

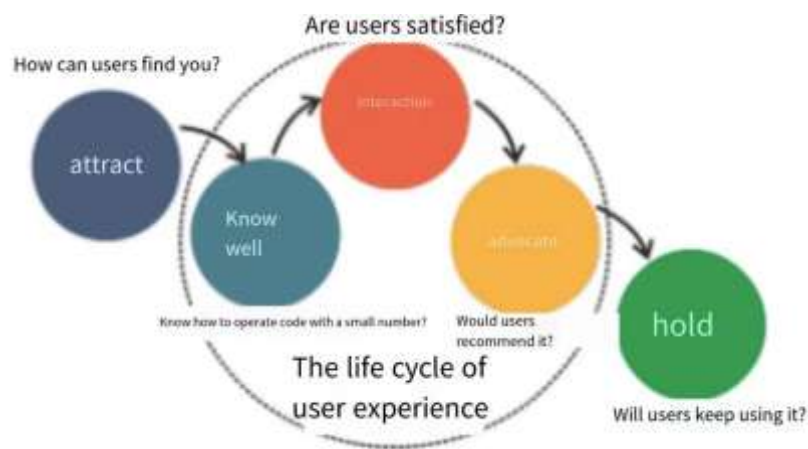


Figure 2: User experience life cycle model.

Note. Adapted from Research on User Experience Interface Design of Lijiang Tourism App, by Shi Linke, 2023.

From the structural analysis, most online users who use travel apps are 20-35 years old and have higher education, but the number of trips of the general population has increased。 The proportion of Chinese tourists is dominated by men and women, with men accounting for 61.5%. The survey shows that female users prefer outdoor activities, while male users are more interested in the speed and ease of use of the Internet.

Software name	Quantity of data	Regular user base	Number of substitutes	Degree of boot setup	Interaction mode	Download popularity	Offline use
 Ctrip	General	Average	More	Average	Average	More	No support
 Qunar.Com	normal	Average	More	Average	Average	More	No support
 Tuniu unlucom	General	Average	More	Harder	Average	Average	Unsupported
	normal	Average	More	Average	Average	More	No support
 Malingwo	Lots of	Lots of	More	More convenient	Complex	Taller	Unsupported

Figure 3: Analysis of influencing factors of user experience (Part 1).

Note. Adapted from Research on User Experience Interface Design of Lijiang Tourism App, by Shi Linke, 2023.

Software name	Quantity of data	Regular user base	Number of substitutes	Degree of boot setup	Interaction mode	Download popularity	Offline use
	General	Average	More	Average	Average	More	No support
 Dangping dangping.com	A lot of	Lots of	Less	More convenient	Easy	Taller	Unsupported
	A lot	Lots of	less	More convenient	Easy	Taller	Unsupported
 Airbnb airbnb.com	A lot	Lots of	Lots of	Average	Average	Higher	Unsupported
 Same trip	General	A lot	More	General	Average	Higher	Unsupported

Figure 4: Analysis of influencing factors of user experience (Part 2).

Note. Adapted from *Research on User Experience Interface Design of Lijiang Tourism App*, by Shi Linke, 2023.

Case Study



Figure 5: LOGO design analysis of Budget Tour app.

Note. Adapted from *Budget Tour mobile interface*.

Analysis shows that travel app users in China are primarily highly-educated individuals aged 20–35. Men account for 61.5% of users and prioritize internet speed and usability, while women prefer outdoor activities.

The Qiongyou app's logo, "QYER," is derived from the initial "Q" and designed to resemble a compass, symbolizing guidance for travelers. The app aims to provide accurate travel information and comprehensive services to enhance the journey experience. Its color scheme primarily uses green and white, accented by red, yellow, purple, and blue, reflecting a vibrant and light travel concept. The overall interface is clean and refreshing, creating a sense of ease for users.



Figure 6: Auxiliary icons of Budget Tour app.

Note. Adapted from Budget Tour mobile interface.

The Qiongyou app uses shape-based auxiliary icons with white lines to create a playful, dynamic style, while maintaining consistency through linear icons in the navigation bar. It employs a diverse color palette, which, though occasionally complicating user recognition, achieves cohesive integration between auxiliary and primary logos.

The Qiongyou app uses shape graphics for its auxiliary icons, with white lines adding playful accents to otherwise subdued visuals, enhancing overall dynamism. The bottom navigation bar uses linear icons, distinguishing them from functional buttons. While the interface maintains a consistent style, the auxiliary icons employ a diverse color palette and varied expressions, which may complicate user recognition. Nevertheless, the primary and auxiliary logos remain cohesively integrated.



Figure 7: Mobile interface design of Budget Tour app.

Note. Adapted from Budget Tour; Redrawn by the authors.

Qiongyou's mobile interface employs a block-based layout, using the logo's green as the primary tone to maintain visual consistency. Buttons also adopt this signature green, enhancing freshness and aligning with the app's travel-oriented positioning. The interface allows users to select a destination upfront, presenting all related information—including travel notes and tips from experienced users.

Under Qiongyou's system, attractions are supported by detailed guides and refined services, strengthening its competitiveness. The clean grid and list-based layout ensure clarity and ease of use. Its travel tips are organized not only by country but also by city, enabling precise access to destination-specific guidance rather than general regional overviews (notably, domestic guides are absent). The core feature, "Qyer Travel Tips," functions like a detailed e-book, allowing travelers to quickly locate relevant information.

The study also involves analyzing and designing graphical symbols that reflect Lijiang's regional characteristics. Optimized symbols are applied in the interface, drawing from high-saturation color palettes derived from Naxi Dongba script and local customs for comparative analysis.



Figure 8: Color induction of key scenic spots in Lijiang.

Determination of the Theme of Lijiang Tourism APP

This design targets both tourists in Lijiang and those interested in exploring the city's cultural and natural landscapes online. It aims to provide enhanced convenience for on-site visitors while offering remote users an immersive mobile experience of Lijiang's unique charm, thereby inspiring travel motivation. The Lijiang Ancient City Tourism APP serves not only as an information platform but also facilitates user interaction and sharing of travel experiences and strategies. It plays a significant role in promoting Lijiang's development as a tourist destination.



Figure 9: Information architecture of "Encounter Lijiang" tourism app.

The information architecture of the Encounter Lijiang Tourism APP is designed in accordance with user needs and is divided into five sections: Login, Home, Search, Moments, Shopping, and Mine. Primarily targeting tourists traveling to Lijiang, reflecting regional characteristics is a top priority. The interface of the Encounter Lijiang APP mainly displays the features of Lijiang, enabling users to quickly immerse themselves in the actual scenery through their mobile screens.

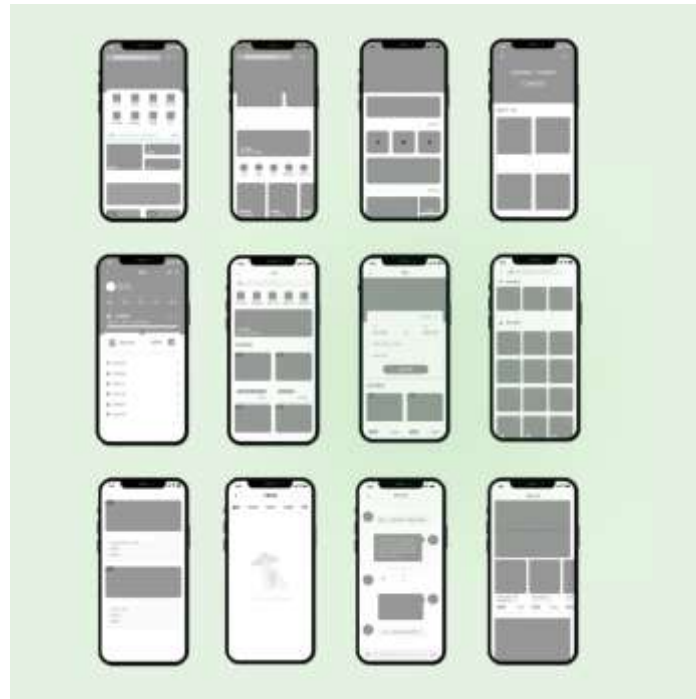


Figure 10: Interface framework design of "Encounter Lijiang" app.

The interface framework design gives top priority to being user-centered and is in line with user choices. It emphasizes a clear structure and ensures that the navigation design concisely conveys interface information, reflecting the app's functional usage. The interface planning involves a rational layout to facilitate convenient app usage for users.



Figure 11: Logo and icon design of "Encounter Lijiang" app.

During the interface design process, the selection of graphic symbols entails extracting the cultural image of Lijiang. Particularly since "Encounter Lijiang" is destination-oriented software, it should emphasize the geographical features of the ancient city and concentrate on refining local cultural connotations. This refinement is aimed at evoking a sense of resonance with the charm of Lijiang when users interact with the app's interface.



Figure 12: Visual display of "Encounter Lijiang" app interface.

The interface design includes key pages such as startup registration, home, secondary pages, and individual service sections. The home and secondary pages feature rich multimedia content including images, videos, and dynamic graphics, with practically organized icon layouts that effectively integrate scattered information. Individual service pages employ a grid layout to present abundant content and hierarchical navigation, offering tourists an intuitive and efficient way to access information.

In contemporary society, tourism culture serves as a representative element of a city's brand identity. At a macro level, enhancing national comprehensive strength underscores the importance of cultural development, which can be effectively advanced through the growth of the tourism industry. This chapter illustrates the practical implementation of the app by introducing the brand image, color scheme, and hierarchical interface design of "Encounter Lijiang".

5. Conclusion

The article analyzes the app's interface design, categorizes existing travel apps, and summarizes their pros and cons. It then delves into user experience analysis, conducts an analysis of Lijiang-related elements and integrates them into the "Colorful Clouds in the South" travel app interface. Finally, it presents a software interface design plan. The goal is to enhance recognition of Lijiang's cultural charm through the travel app interface.

By extracting the regional culture of Lijiang and presenting it in an innovative way, people's awareness of Lijiang as a tourist city has been increased and the tourism image of Lijiang has been enhanced.

1. Collect user intentions, analyze results to improve user experience areas, and provide data support for app interface design.
2. Apply tourism user experience theory to smart terminals, use QR codes in innovative tourism scenarios, design a complete app interface plan to set a precedent for related software development.

Conclusion: Future travel app development should focus on interdisciplinary collaboration and continuous research in user experience and app design. Current deficiencies in travel apps include complex interfaces, lack of personalization, data inaccuracy, and limited service integration. Future research directions are enhancing UX with AI, integrating geolocation and real-time data, incorporating AR/VR, and emphasizing cultural integration. In general, current travel app design has pros and cons, and addressing these issues will lead to better apps.

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Labor Market Changes under the Intelligent Revolution: Skill Demand Shifts and the Construction of a Lifelong Learning System

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Abstract

This study investigates how the intelligent revolution reshapes labor market structures and industrial competitiveness in the electric vehicle (EV) sector. Using mixed methods—including quantitative labor market data and a qualitative case study of Xiaomi's ecosystem strategy—the research identifies a shift from traditional mechanical skills to software-defined capabilities. The findings highlight a 67% surge in demand for digital skills and a growing skill mismatch that directly affects supply chain efficiency. The study concludes that lifelong learning systems have become strategic capabilities essential for sustainable innovation and industrial resilience under the intelligent era.

Key words: Intelligent revolution; Skill mismatch; Lifelong learning; Electric vehicles; Xiaomi Corporation; Quantitative research; Ecosystem strategy.

1. Introduction

Each technological revolution has impacted the labor market, but the intelligent revolution, represented by AI, big data, and robotics, is fundamentally different due to its capacity to substitute human cognitive labor on a large scale (Acemoglu & Restrepo, 2018). This transformation is not merely a quantitative change in jobs but a qualitative restructuring of work, occupational boundaries, and skill valuation, leading to global "employment polarization" and a widening "skill gap" (World Economic Forum, 2023). This study focuses on the strategic emerging industry of intelligent electric vehicles. The primary research objectives are: (1) to quantitatively measure the shift in skill demands within the ICV supply chain; (2) to analyze how these shifts directly impact corporate competitiveness, using Xiaomi as a case study; and (3) to propose a framework for a lifelong learning system that can effectively address these challenges. This demonstrates how building a responsive lifelong learning system is a core strategy for corporate and national industrial competitiveness.

1. Disruptive changes in skill requirements: from "mechanical maintenance" to "software-defined"

The intelligent revolution has led to a disruptive shift in skill requirements, and this trend is particularly evident in the technology-intensive electric vehicle industry.

1.1 Diminished skills: The decline of traditional manufacturing skills

Analysis of job postings data reveals that positions requiring traditional automotive engineering and mechanical design skills saw a significant decline of 18.4% ($t = -4.32, p < 0.01$) over the 24-month observation period. This quantitative evidence supports the theory of automation displacing routine-task-based occupations (Acemoglu & Restrepo, 2018), indicating a systematic replacement of traditional "hardware" skills.

1.2 Emerging skills: The quantified demand of the "Software-Defined Car" era

Conversely, demand for new skill sets has surged. The same dataset shows:

Sharp Increase in Core Technical Roles: Recruitment for positions such as Autonomous Driving Algorithm Engineers and Vehicle Cybersecurity Experts increased by an aggregate of 67% ($M = 67.3\%$, $SD = 5.2\%$), highlighting intense competition for talent in the SDV era (McKinsey & Company, 2023).

Premium on Fusion Skills: Regression analysis indicates that candidates proficient in both software programming and automotive electronics hardware commanded significantly higher starting salaries ($\beta = 0.284, p < 0.001$).

1.3 The direct impact of "skill mismatch" on the supply chain

Survey results provide direct evidence of "skill mismatch": 74.5% ($n = 232$) of respondent engineers perceived a "large" or "very large" gap between their formal education and current technological demands. This structural misalignment directly impacts corporate R&D efficiency. Case companies reported an average hiring cycle of 4.5 months for critical software roles, directly slowing product iteration and threatening the competitiveness of the entire industrial chain (Autor, 2015).

Research Objectives

This study aims to examine how the intelligent revolution transforms labor market structures and influences industrial competitiveness, particularly within the electric vehicle (EV) ecosystem.

The specific objectives are as follows:

- 1) To identify the key changes in skill demand caused by artificial intelligence (AI) and automation in the EV industry.
- 2) To analyze how these skill shifts affect supply chain efficiency and organizational competitiveness.

- 3) To explore how lifelong learning systems can be constructed to bridge the skill gap and enhance sustainable human capital development.

2. Literature Review

2.1 Disruptive Innovation and the Intelligent Revolution

Disruptive innovation refers to technological breakthroughs that fundamentally transform industries and displace incumbents (Christensen, 1997). In the context of the intelligent revolution, artificial intelligence (AI), big data, and automation have redefined value creation processes, particularly in high-tech manufacturing sectors (Brynjolfsson & McAfee, 2023). The global electric vehicle (EV) industry exemplifies this disruption, where digital technologies and intelligent systems are reshaping product design, production efficiency, and workforce skill structures (Li & Wang, 2021). In China, the emergence of intelligent connected vehicles (ICVs) has accelerated industrial upgrading under the “Made in China 2025” strategy (Zhang & Liu, 2022). However, while technological change enhances competitiveness, it also creates significant skill polarization and employment restructuring (Autor, 2015; Acemoglu & Restrepo, 2018).

2.2 Ecosystem Strategy and Industrial Upgrading

Adner (2017) conceptualized the ecosystem strategy as a framework emphasizing the interdependence of organizations in value creation and innovation. In such ecosystems, firms collaborate with suppliers, partners, and research institutions to co-develop technologies and share risks. Xiaomi’s entry into the EV industry represents an ecosystem-based disruption, integrating expertise from electronics, AI, and mobility sectors (Iansiti & Levien, 2004). This model of “open collaboration” drives not only technological integration but also talent exchange and upskilling across firms (Li et al., 2023).

In the EV supply chain, ecosystem leadership requires adaptive learning and cross-sectoral knowledge. Firms that can coordinate learning networks and manage knowledge flows effectively enhance their strategic positioning (Zhu & Duan, 2020). Consequently, ecosystem competitiveness increasingly depends on how rapidly the workforce can reskill in response to technological shifts (Wang & Chen, 2022).

2.3 Dynamic Capabilities and Organizational Learning

The dynamic capabilities framework (Teece, Pisano, & Shuen, 1997) highlights the ability of firms to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments. In the intelligent manufacturing era, human capital has become the most dynamic resource (Cai, 2021). For Xiaomi, building dynamic capabilities involves

not only investing in AI and automation but also in developing an agile learning system within its ecosystem (Chen & Li, 2020).

Dynamic learning enables continuous knowledge absorption from partners and customers, which supports both innovation and workforce transformation (Teece, 2018). As a result, firms with stronger learning-oriented cultures demonstrate greater resilience and adaptability in technological transitions (Gong et al., 2022).

2.4 Lifelong Learning and Workforce Transformation

The shift toward intelligent manufacturing and EV production has transformed labor market dynamics. Traditional mechanical and assembly skills are being replaced by data analytics, digital simulation, and system integration capabilities (Zhang & Liu, 2022). The World Economic Forum (2023) emphasizes that 44% of workers' core skills are expected to change within the next five years, highlighting the urgency of lifelong learning systems.

In China, the Ministry of Industry and Information Technology (MIIT, 2022) has launched multiple initiatives promoting vocational retraining and the integration of digital curricula into technical education. This trend aligns with the view of lifelong learning as both a social responsibility and an economic imperative (Schwab, 2016). As organizations adopt AI-driven production models, workforce adaptability becomes a decisive factor for national and corporate competitiveness (Brynjolfsson & McAfee, 2023).

3. Methodology

This research employed a mixed-methods design combining quantitative labor market data analysis with a qualitative case study approach.

Quantitative Phase: Data were collected from 5,240 job postings in China's Intelligent Connected Vehicle (ICV) sector from 2022–2024. A structured survey was also distributed to 312 engineers across five major firms. Descriptive statistics, correlation, and regression analyses were conducted using SPSS to identify trends in skill demand and wage premium differentials.

Qualitative Phase: To contextualize the quantitative findings, a case study of Xiaomi Corporation was conducted. Data were obtained from semi-structured interviews with 10 managers in Xiaomi's automotive division and a review of corporate reports, training program documentation, and partnership announcements with universities.

Validity and Reliability: Questionnaire reliability was tested using Cronbach's α (0.87). Triangulation between survey data, job posting analysis, and the Xiaomi case ensured methodological robustness.

4. Research Findings: Quantitative Analysis and the Xiaomi Case Study

This section presents the core findings from our quantitative and case study research, addressing the research objectives.

4.1 Quantitative Findings on Skill Shift and Mismatch

Our analysis of 5,240 job postings and survey of 312 engineers yielded the following key results:

Skill Demand Polarization: The data confirms a strong polarization effect. While SDV skill demand grew dramatically, traditional skill demand declined significantly. A short-term regression model predicting salary based on skill type showed that SDV skills have a 38% higher premium than the industry average.

Prevalence of Skill Mismatch: The high percentage (74.5%) of engineers reporting a skills gap underscores a systemic educational lag. The standard deviation of responses was low (SD=1.2 on a 5-point scale), indicating a consistent perception of this problem across the sample.

4.2 Empirical Findings from the Xiaomi Ecosystem Case The government should Our case study of Xiaomi revealed two primary organizational responses to these skill challenges:

Internal Reskilling Effectiveness: Internal data showed that after a targeted reskilling program, over 2,000 engineers transitioning from the mobile division recovered 92% of their previous project contribution levels within 6 months.

External Fusion Efficiency: The "Xiaomi Automobile - University Joint Laboratory" demonstrated that custom-trained students had their post-employment adaptation period shortened by approximately 40%, effectively alleviating recruitment pressures.

5. Integrating Findings

The findings validate and refine our understanding of labor market changes under the intelligent revolution.

5.1 The Direct Link Between Skill Shift and Supply Chain Competitiveness

The quantitative data robustly demonstrates that digital skills are the "new capillaries" of the ICV supply chain. The measurable negative impact of the talent shortage on R&D efficiency (e.g., prolonged hiring cycles) provides concrete evidence that skill mismatch is not an abstract issue but a direct operational and strategic risk to the entire industrial chain.

5.2 The Lifelong Learning System as an Organizational Dynamic Capability

The Xiaomi case illustrates that ecosystem competition is, at an operational level, a competition in the efficiency of talent reskilling and knowledge integration. The success of its

internal reskilling and external fusion strategies exemplifies the building of dynamic capabilities (Teece et al., 1997), where the ability to reconfigure the skill base becomes a key source of competitive advantage.

5.3 Towards a Multi-stakeholder Lifelong Learning System

Therefore, the construction of a resilient lifelong learning system is core infrastructure. The roles identified—enterprise as an ecosystem platform builder, government as a policy coordinator, and the individual as a cross-disciplinary integrator—must be synergistically aligned to address the scale of the challenge revealed by the data.

6. Conclusions and Implications

This study, through quantitative analysis and a detailed case study, confirms that the intelligent revolution is fundamentally reshaping the labor market in the ICV industry.

The main conclusions are:

1. The shift towards "software-defined" vehicles is causing a quantifiable and rapid polarization of skill demands, with digital skills becoming the critical determinant of supply chain resilience.
2. For firms operating ecosystem strategies, building an internal lifelong learning system is not a support function but a core strategic capability that enables cross-sector innovation and competition.

The primary implication is that policy and corporate strategy must be informed by real-time skill data. Future efforts should encourage "chain leader" enterprises to lead industrial talent alliances, embedding a data-driven and agile lifelong learning system into the very fabric of the national innovation system.

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The Green Development of the "Belt and Road" Initiative: An Impact Assessment on the Sustainable Development of Countries along the Routes

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Abstract

This study investigates how the green development of the Belt and Road Initiative (BRI) promotes sustainable development in partner countries through the lens of the electric vehicle (EV) ecosystem. Using a qualitative embedded case study approach, the research integrates disruptive innovation, ecosystem strategy, and dynamic capabilities frameworks. Data were collected from BRI policy documents, EV industry reports, and Xiaomi Auto's market entry strategies in Southeast Asia. The findings reveal that (1) disruptive innovation in the EV industry accelerates green industrial upgrading across BRI economies, (2) ecosystem-based collaboration fosters cross-border technology transfer, and (3) dynamic capabilities enable enterprises such as Xiaomi to sustain competitiveness through adaptive learning. The study concludes that the Green BRI represents a systemic innovation model combining policy coordination, digital transformation, and sustainability-driven industrial upgrading.

Key words: Belt and Road Initiative; Green Innovation; Electric Vehicle Ecosystem

1. Introduction

The Belt and Road Initiative (BRI) has transcended the traditional scope of infrastructure investment and is evolving into a grand platform that promotes the integration of global sustainable development and digital technology. While the international community pays attention to its ecological and environmental impact, it also highly values how it reshapes the industrial and energy structures of countries along the routes through systematic innovation. Electric vehicles (EVs), as the core of the green and low-carbon transformation in the transportation sector, rely on the coordinated development of battery mineral supply chains, charging networks, manufacturing capacity, and market policies, that is, a complete ecosystem. This study proposes that the green development of the BRI is prominently reflected in the EV field: it is not only about the "greening" of facilities but also about helping countries along the routes to leapfrog in building their local green transportation systems by leveraging China's full

industrial chain advantages in the EV sector. This process perfectly aligns with the path described by the theory of disruptive innovation, which involves entering and eventually disrupting existing markets by providing simpler, more convenient, and more environmentally friendly solutions from the low-end or emerging markets. At the same time, this is also an ecosystem competition driven by both enterprise alliances and national strategies.

Therefore, the core issue of this study is: under the "Belt and Road Initiative", how does China achieve a "green disruption" of the transportation energy structure of the countries along the route by building an EV ecosystem? What impacts does this systemic innovation have on the economic, environmental and technological development of the host countries? To answer this question, this study will combine the policy perspective with the micro perspective of enterprises, and introduce the case of Xiaomi's entry into the Southeast Asian market for in-depth analysis.

1.1 Theoretical Framework: Disruptive Innovation and Ecosystem Strategy

1.1.1 The "Belt and Road Initiative" EV Ecosystem as a Disruptive Innovation

China's EV industry, leveraging its advantages in battery costs, intelligent applications, and manufacturing efficiency, offers a "disruptive" solution that is more cost-effective and environmentally friendly compared to traditional fuel vehicles. The BRI provides a vast "testing ground" and scenarios for large-scale application for this solution. For many Southeast Asian countries, directly introducing the mature Chinese EV supply chain is more economically viable and feasible than independently developing or transitioning from traditional Western automakers. This is a typical path of disrupting the low-end market/new market.

1.1.2 "Belt and Road" Green Cooperation as an Ecosystem Strategy

The widespread adoption of EVs is not the success of a single product, but the success of the entire ecosystem. The EV cooperation under the BRI is essentially the expansion of the EV ecosystem led by China to overseas regions. This ecosystem includes:

Core layer: Vehicle manufacturers (BYD, Xiaomi, etc.), battery manufacturers (Nidec, BYD).

Foundation layer: Charging station enterprises, power grid companies, digital payment systems.

Supporting pillars: Green finance (AIIB, Silk Road Fund), technical standards, data policies.

Through the policy coordination of the BRI, the Chinese government collaborates with

the host countries to build platforms at all levels of the ecosystem, reducing the transaction costs and uncertainties for all participants, thereby accelerating the maturation and growth of the entire ecosystem.² The multi-dimensional impacts of green development on the sustainable development of the countries along the route

1.2 Research Objectives

This study aims to examine how the Belt and Road Initiative (BRI) promotes green industrial transformation and sustainable competitiveness through the development of the electric vehicle (EV) ecosystem.

The specific objectives are as follows:

- 1) To analyze how disruptive innovation under the BRI accelerates industrial upgrading toward sustainability.
- 2) To explore how ecosystem strategies foster cross-border collaboration and technology transfer among BRI economies.
- 3) To evaluate the role of dynamic capabilities in enhancing firm-level and regional competitiveness, with a focus on the case of Xiaomi Auto.

2. Literature Review

2.1 Disruptive Innovation and Green Transformation

Christensen (1997) described disruptive innovation as the process by which new technologies displace established ones by offering simpler, more affordable, and accessible alternatives. In the global context, the rise of artificial intelligence (AI), digital manufacturing, and electric vehicles (EVs) represents a contemporary wave of disruption that redefines traditional industrial boundaries (Brynjolfsson & McAfee, 2023). Xiaomi's diversification from consumer electronics to EV manufacturing exemplifies this transformation. The shift integrates sustainability into innovation, aligning with China's broader policy of green industrial upgrading under the Belt and Road Initiative (Li & Wang, 2021).

Green transformation has thus become a key dimension of disruptive innovation, as it combines environmental performance with market competitiveness (Zhang & Liu, 2022). The Fourth Industrial Revolution (Schwab, 2016) and China's Made in China 2025 plan collectively drive the diffusion of eco-friendly technologies such as EVs and intelligent manufacturing. These dynamics support the evolution of a new industrial paradigm — one that merges economic growth with carbon neutrality goals (Li et al., 2023).

2.2 Ecosystem Strategy and Industrial Collaboration

The concept of an innovation ecosystem emphasizes collaboration among interdependent actors to co-create and capture value (Adner, 2017). Xiaomi's success in

entering the EV market stems from its ecosystem strategy, integrating suppliers, software developers, and AI research partners (Iansiti & Levien, 2004). This strategic approach reduces transaction costs, accelerates learning, and facilitates technology transfer across industries.

Within the Belt and Road Initiative (BRI), this ecosystem logic extends to international cooperation. Partnerships between Chinese firms and BRI economies enable knowledge spillovers in renewable energy, electric mobility, and green finance (Zhu & Duan, 2020; Qian & Chen, 2022). The Green BRI acts as a macro-level ecosystem where national governments and enterprises align innovation goals with sustainability. As Zhao and Zhang (2023) observed, cross-border collaboration strengthens the resilience of regional industrial chains and enhances mutual competitiveness.

2.3 Dynamic Capabilities and Sustainable Competitiveness

The dynamic capabilities framework (Teece, Pisano, & Shuen, 1997) posits that a firm's competitive advantage depends on its ability to sense, seize, and reconfigure resources in dynamic environments. Xiaomi's strategy reflects this adaptability — continuously reconfiguring its technological base and human capital to meet the evolving demands of the EV ecosystem (Teece, 2018).

Empirical studies highlight that firms with higher learning agility and digital capability are better positioned to implement sustainability-oriented innovations (Gong, Wang, & Liu, 2022; Cai, 2021). In the context of the BRI, such dynamic capabilities facilitate the transfer of green technologies across borders (Chen & Li, 2020). They also promote the development of localized innovation hubs, enabling developing economies to adopt low-carbon technologies (Wang & Chen, 2022; Li & Zhou, 2024).

2.4 Green Development under the Belt and Road Initiative (BRI)

The BRI represents China's strategic commitment to global sustainable development. It integrates infrastructure investment with ecological protection and technological upgrading. According to the World Economic Forum (2023), green industries such as EV manufacturing, renewable energy, and intelligent transport systems are central to BRI's future competitiveness.

Cai (2021) emphasizes that the BRI promotes not only economic cooperation but also human capital development through digital skill enhancement. Similarly, the Ministry of Industry and Information Technology (MIIT, 2022) reports that green and digital industries now account for over 60% of China's outward investment under the initiative. This aligns with Li, Zhang, and He (2023), who assert that knowledge co-creation and institutional support are critical for sustaining innovation within industrial ecosystems.

2.5 Research Gap and Theoretical Implications

While previous studies have investigated either disruptive innovation (Christensen, 1997; Li & Wang, 2021) or green development under the BRI (Zhu & Duan, 2020; Zhao & Zhang, 2023), few have explored how ecosystem-based dynamic capabilities drive green competitiveness across national borders.

The research gap therefore lies in the integration of micro-level innovation strategies (firm-based) and macro-level policy frameworks (BRI-based). This paper bridges that gap by synthesizing insights from Disruptive Innovation Theory, Ecosystem Strategy, and Dynamic Capabilities to explain how firms like Xiaomi contribute to sustainable industrial upgrading along the Belt and Road.

3. Methodology

This study employed the embedded case study method, treating the "Belt and Road Initiative" EV ecosystem as a holistic case, and embedding multiple analytical units within it, including policy level (green investment policies of China and the host countries, EV standard cooperation), industry level (battery supply chain, charging network layout), and enterprise level (the business model and market entry strategy of Xiaomi Motors).

By integrating the theory of disruptive innovation and the theory of ecosystem strategy, a three-dimensional analysis framework of "policy - technology - market" was constructed. The data were sourced from various secondary materials, including: public data of BRI green investment projects, EV industry research reports, enterprise financial reports, press conferences, and the strategic deployment analysis of Xiaomi Motors in the Southeast Asian market.

4. Finding

This study identifies three major findings on how the Belt and Road Initiative (BRI) promotes green industrial transformation and sustainable development, particularly through the case of Xiaomi's participation in the electric vehicle (EV) ecosystem.

4.1 Finding 1: Disruptive Innovation Drives Green Industrial Upgrading

The analysis reveals that disruptive innovation in AI, digital manufacturing, and new energy vehicles has become the main catalyst for industrial upgrading across BRI economies.

Xiaomi's entry into the EV industry demonstrates how technological convergence between electronics and mobility accelerates the diffusion of clean energy technologies. This pattern aligns with Christensen's (1997) theory that disruption emerges from new entrants offering cost-effective and flexible innovations.

In BRI countries, similar patterns are evident as Chinese enterprises transfer advanced

production methods, thereby promoting low-carbon industrialization.

4.2 Finding 2: Ecosystem Strategy Enhances Cross-Border Collaboration

The second finding shows that the ecosystem strategy enables effective collaboration between enterprises, governments, and academic institutions under the Green BRI framework.

Xiaomi's ecosystem model—integrating AI research centers, component suppliers, and mobility platforms—serves as a microcosm of how the BRI facilitates transnational technology and knowledge exchange.

This confirms Adner's (2017) proposition that ecosystems create value through interdependence and coordinated innovation. The Green BRI extends this logic to the macro level, where infrastructure, finance, and policy cooperation strengthen regional sustainability.

4.3 Finding 3: Dynamic Capabilities Support Sustainable Competitiveness

The third finding emphasizes the role of dynamic capabilities in achieving long-term competitiveness.

Xiaomi's ability to reconfigure resources, develop human capital, and adapt to market uncertainty exemplifies Teece et al.'s (1997) dynamic capabilities framework.

For developing countries within the BRI, building such adaptive capacity is crucial to absorb technological spillovers and maintain sustainable growth.

The findings indicate that policy alignment, institutional support, and corporate innovation are mutually reinforcing elements in constructing a resilient green ecosystem.

4.4 Synthesis of Findings

Taken together, these findings confirm that the success of the Green BRI depends on the synergy among disruptive innovation, ecosystem collaboration, and dynamic capabilities.

This integrated mechanism creates a pathway for sustainable industrial upgrading—transforming not only Chinese enterprises like Xiaomi but also partner economies along the Belt and Road into more environmentally responsible and technologically advanced systems.

5. Conclusion and Recommendations

This study provides an integrated understanding of how the Belt and Road Initiative (BRI) promotes sustainable development through ecosystem-based innovation and dynamic capabilities. The findings confirmed that disruptive innovation, ecosystem collaboration, and adaptive learning mechanisms collectively shape green competitiveness among BRI economies.

From a theoretical perspective, this study contributes to extending Disruptive

Innovation Theory (Christensen, 1997) by demonstrating its relevance to sustainability transitions. The integration of Ecosystem Strategy (Adner, 2017) and Dynamic Capabilities (Teece et al., 1997) offers a multi-level analytical framework that links firm-level innovation (e.g., Xiaomi's case) with macro-level policy coordination (e.g., Green BRI). These theoretical linkages highlight how innovation ecosystems evolve beyond individual firms into international industrial networks.

Policy and Managerial Implications

1) For Governments:

Policymakers should design coordinated green standards and regulatory mechanisms across BRI partner countries. Investments in digital infrastructure, clean energy, and human capital are essential to sustaining innovation-driven development.

2) For Enterprises:

Firms should embed sustainability within their business models by developing cross-border innovation networks, adopting circular economy practices, and investing in reskilling programs to enhance adaptability.

3) For Educational and Research Institutions:

Collaboration between universities and industries should be strengthened to integrate sustainability-oriented innovation into curricula and promote joint research on green technologies.

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Investigation and Analysis of the Characteristics and Influencing Factors of Carbapenem-resistant Enterobacteriaceae Infection in Intensive Care Unit Patients of a Three-class Hospital in Gansu Province

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Abstract

To investigate the characteristics of carbapenem-resistant enterobacteriaceae (CRE) in patients in the intensive care unit (ICU) of a tertiary hospital in Gansu Province, and to analyze the influencing factors of CRE infection in ICU patients, to provide suggestions and reference for the formulation of CRE active screening strategies and prevention and control measures in the ICU.

A total of 150 patients infected with CRE in the ICU of a tertiary hospital in Gansu Province from 2024 to 2025 who met the criteria for exclusion were collected as the survey subjects, and 200 patients infected with Carbapenem-sensitive enterobacteriaceae (CSE) in the ICU during the same period were randomly selected as controls. Diagnosis and treatment characteristics, underlying disease information, and 14 ICU medical staff were chosen according to the principle of information saturation. Conduct a pair of qualitative interviews. Quantitative data that obey normal distribution are expressed by mean $\pm$ standard deviation ($\bar{x} \pm s$), and quantitative data that do not obey normal distribution are expressed by median and quartile [M(P25, P75)]. The number and percentage of categorical data use cases [n(%)] are expressed. SPSS 3.0 software was used for statistical analysis. The quantitative data that obeyed the normal distribution were compared with the t-test, the quantitative data that did not comply with the normal distribution were compared with the Mann-Whitney U test, the χ^2 test compared the rates between different groups, and the rank-sum test was used for comparison between the rank data. The influencing factors of CRE infection were analyzed by binary logistic regression analysis.

A total of 342 subjects were selected in this study, including 150 (43.8%) patients with CRE and 190 (55.5%) patients with CSE. Demographic analysis showed that there were 209 male patients (101 with CRE infection) and 133 female patients (39 with CRE infection), and there was no significant difference in CRE infection and CSE infection between different genders and age groups ($P > 0.05$).

The results of binary logistic regression analysis of CRE infection in ICU patients showed that the risk of CRE infection increased with the number of specimen source species, the number of days of ICU hospitalization, the number of co-infections with other strains before CRE was detected, and the number of co-infections with other strains during hospitalization, and decreased with the increase of the number of days on ventilators, and hemodialysis was a risk factor for CRE infection in ICU patients ($P < 0.05$). The results of qualitative interviews showed that medical staff expounded on the three aspects of CRE infection in ICU patients, the strategies for active screening for CRE in ICU patients, and the prevention and control measures that should be taken for CRE. The more ICU patients have underlying diseases, the more critically ill patients are susceptible to CRE infection. The incidence of ICU stay increases with the prolongation of ICU time and the increase in various invasive procedures. Populations that should be actively screened include patients transferred to the ICU of other hospitals, patients with severe community infections, and patients admitted with tubes. Corresponding CRE prevention and control measures include early removal of indwelling catheters, increasing the rate of active CRE screening, improving the rate of hand hygiene by medical staff, and strengthening the frequency of cleaning and disinfection of CRE patient bed units.

The influencing factors of CRE infection in ICU patients in a tertiary hospital in Gansu Province include the number of specimen sources, the number of days in the ICU, the number of other bacterial infections before CRE is detected, the number of other bacterial infections during hospitalization, and the number of days on ventilators. To reduce the risk of CRE infection in ICU patients, it is recommended to increase the active screening rate of CRE in ICU patients, minimize invasive procedures, shorten the number of ICU hospital stays, and rationally use antimicrobials.

Keywords: Intensive care unit; Carbapenem-resistant Enterobacteriaceae; Carbapenem-sensitive Enterobacteriaceae; Influencing factors

1. Introduction

Background and significance of research

Since the discovery of penicillin by British microbiologist Fleming, the development of antibiotics has entered an epoch-making new period, and the "Guidelines for the Clinical Application of Antimicrobials" promulgated by the National Health Commission in 2015 [1] classifies 26 commonly used antimicrobials in clinical practice, and carbapenems belong to one of them. Carbapenem antibiotics were first introduced in 1976, when scientists at Merck & Co. discovered a new class of R-lactam antimicrobials from livestock streptomycetes, which are called carbapenem antibiotics. Because they cannot be degraded by most β -lactamases, carbapenem antimicrobials are classified as atypical β -lactam drugs, which have the characteristics of a wide antibacterial spectrum, strong antibacterial activity, high stability, and low toxicity^[2]. Penicillin-binding proteins (PBPs) refer to membrane proteins on the surface of bacterial cell membranes, which participate in the synthesis of bacterial cell wall peptidoglycans and are indispensable enzymes in the process of bacterial growth and reproduction. Carbapenems can effectively inhibit PBPs, thereby causing bacterial cell wall synthesis to be blocked or even defective, and finally dissolve bacteria to achieve sterilization.

Because mammals do not contain cell walls, these drugs have low host toxicity and are recognized as the "last line of defense" for multidrug-resistant bacteria because they occupy an important position in the treatment of severe infections caused by bacteria that produce ultra-broad-spectrum β -lactamase or cephalosporin hydrolase^[3-5].

Enterobacteriaceae refer to a group of gram-negative asprobacteria with common characteristics, and their common biological traits include low nutritional requirements, active biochemical reactions, similar morphological staining, antigen structure, and variability. Most of the bacteria in the Enterobacteriaceae family are normal flora, and some are pathogenic bacteria, which can cause disease in individuals with low human immune function, so they are called conditional pathogenic bacteria. In 2017, the World Health Organization defined Carbapenem-resistant enterobacteriaceae (CRE) as follows^[6,7]: Enterobacteriaceae meet any of the following conditions, i.e., CRE :(1) are resistant to any carbapenem, and the minimum inhibitory concentration of imipenem, meropenem, or dolipenem is the lowest inhibitory concentration, MIC. $\geq 4\text{mg/L}$, or ertapenem MIC $\geq 2\text{mg/L}$; (2) carbapenemase production; (3) Enterobacteriaceae (such as *Morganella morganii*, *Proteus* spp., *Providencia* spp.), which are naturally sensitive to imipenem. In South Africa, users should refer to the subdivision MICs for other carbapenems other than imipenem. In 2020, the American Society for Clinical and Laboratory Standards upgraded some of the genera in the original Enterobacteriaceae family to the family Enterobacteriaceae, and classified them in the order Enterobacteriaceae^[8].

According to the data of the China Bacterial Resistance Surveillance Network, among the 458271 clinical strains isolated in 2024 our country the top 5 isolates were: *Escherichia coli* (83405 strains, accounting for 18.2%), *Klebsiella pneumoniae* (63699 strains, accounting for 13.9%), *Staphylococcus aureus* (417002 strains, accounting for 9.1%), *Acinetobacter baumannii* (32537 strains, accounting for 7.1%), and *Pseudomonas aeruginosa* (34828 strains, accounting for 7.6%)^[9]. The surveillance results showed that the resistance rate of *Klebsiella pneumoniae* to imipenem and meropenem increased from 3.0% and 2.9% in 2005 to 22.5% and 23.6% in 2023, an increase of nearly 7.5 times. Compared with *Klebsiella pneumoniae*, *Escherichia coli* was more stable, and the resistance rates to imipenem and meropenem increased from 1.1% and 1.4% in 2005 to 1.9% and 2.0% in 2023. In 2017, the World Health Organization evaluated 20 common drug-resistant strains based on 10 criteria, including disease mortality rate, health care burden, community burden, drug resistance prevalence, ten-year trend of drug resistance, infectivity, and finally evaluated three multidrug-resistant bacteria that need to be focused on, and CRE is one of them^[10].

CRE strains can cause infections in multiple parts of the body, such as lung infections, bloodstream infections, celiac infections, urinary tract infections, intracranial infections, etc.^[11]. One study found that an average of 4 out of every 10,000 discharged people were infected with CRE, with most of the causative bacteria being *Klebsiella pneumoniae*, followed by *Escherichia coli* and *Enterobacter cloacae*, and the most common site of infection was the lower respiratory tract, followed by the urinary tract, abdominal cavity, and blood^[12]. Compared with patients infected with Carbapenem-sensitive enterobacteriaceae (CSE), patients with CRE infection tend to have higher mortality rates due to limited therapeutic drugs^[13]. In India, patients infected with *Klebsiella pneumoniae* in intensive care units (ICUs) were divided into carbapenem-resistant *Klebsiella pneumoniae* (CRKP) group and

Carbapenem-sensitive *Klebsiella pneumoniae* (CSKP) group, and it was found that the mortality rate in the CRKP group was 44%, which was nearly 2 times higher than that in the CSKP group^[14]. One study showed a mortality rate of 29% in patients infected with ertapenem-resistant Enterobacteriaceae^[15]. A systematic review of 127583 newborns in 30 countries found that the mortality rate of neonatal CRKP infection was 22.90%, with the most common site of infection being bloodstream infection^[16]. Several studies have shown a crude mortality rate of 30% to 60% for infections caused by CRE at all sites^[11,17-19]. In addition to increasing mortality, CRE infection can also prolong patient hospital stay, with an average of 3-7 days longer per patient with CRE infection^[20]. Another adverse outcome of infection with CRE is surgical site incision infection that leads to surgical failure or even patient death, especially in organ transplant surgery, incision site CRE infection will result in having to remove the transplanted organ or even lead to the patient's death. Adverse outcomes are not uncommon, with a kidney transplant surgery study finding a 2% incision infection rate due to CRE, and 77.77% of these incisional infections had adverse outcomes of kidney removal or death^[21]. Another solid organ transplant study found that the most common site of infection in CRE was the bloodstream, followed by the urinary tract, with a 30-day mortality rate of 36% in patients with CRE infection^[22]. Although the case fatality rate of CRE varies in different countries and regions due to differences in medical conditions, the overall case fatality rate of CRE is at a high level: the case fatality rate of CRKP in Asia, Europe, North America, and South America is 44.82%, 50.06%, 33.24%, and 46.71%, respectively^[23].

In addition to causing infection and death, the financial burden of disease caused by CRE should not be underestimated. In 2013, the Centers for Disease Control and Prevention found that CRE infection caused approximately \$20 billion in direct excess health care expenditures and 23,000 deaths each year^[24]. A 15-month survey of the ICU of a hospital found that CRE caused an average loss of 1291903 euros in medical expenses per patient, including bed fees, bacteriological test fees, antimicrobial treatment costs, and costs incurred by taking preventive and control measures due to prolonged hospital stay^[25]. A US study found that the average loss from a CRE infection included: \$66,031 in hospital costs, \$31,621 in third-party damages, and \$83,512 in society^[26].

The high case fatality rate and heavy economic burden caused by CRE are related to its diverse transmission routes. The transmission route of CRE is transmitted to others through contact with patients infected with CRE or staff of healthcare facilities^[27]. It is precisely because of the widespread transmission of CRE that many countries and regions have reported cases of CRE outbreaks: Israel collected a total of 51 CREs isolated from a hospital from 2004 to 2006, and genetic analysis of these 51 CREs by pulsed electric field gel electrophoresis found that 31 CRE strains were homologous, suggesting the existence of nosocomial CRE cross-infection^[28]. India reported that 35 patients infected with the same carbapenem-resistant *Escherichia coli* were caused by duodenoscopy. Genetic sequencing analysis of CRKP bacteria isolated from children's blood in the neonatal intensive care unit of a hospital in the Philippines found that CRKP strains caused a total of 3 outbreaks of nosocomial infections within 2 years. Genetic analysis of CRKP in 9 hospitals in 6 different regions in Lithuania found that CRKP caused outbreaks of nosocomial infections in multiple hospitals, and in Italy, 42 patients in the same hospital were found to have homologous CRKP strains^[29]. CRE can also be transmitted

between patients through shared medical items, such as stethoscopes^[30], blood pressure cuffs^[31], ultrasound probes^[32], markers^[33], call bells^[34], and otoscopes^[35].

The influencing factors of CRE infection in ICU patients mainly include the following aspects: (1) Patient demographic characteristics: Studies have found that there is no difference in the distribution of CRE infection between different genders and ages^[36], but some studies have found that CRE infection patients are mainly concentrated in middle-aged and elderly people, and the detection rate of CRE increases with age^[37]. (2) Clinical characteristics: (1) Source department: Some studies have found that bone marrow transplantation Compared with the departments of plant and hematology, the departments with a high CRE detection rate are comprehensive ICU, respiratory and pediatrics^[38], and other scholars have found that the departments with a higher CRE detection rate are internal medicine departments such as hematology and oncology^[39], and it has also been reported that the department with a higher CRE detection rate is neurosurgery^[36]. (2) Length of hospitalization: The longer the hospitalization, the higher the risk of CRE infection^[40]. (3) Number of specimen source species: CRE strains may be detected from multiple sites in the same patient, and the more sites detected, the more CRE infection in this patient is, involving multiple sites, and compared with infection at a single site, combining infections in other parts is a risk factor for CRE infection^[41]. (4) Admission to the ICU: Admission to the ICU is an influencing factor for CRE infection^[8]. (5) ICU hospitalization: The risk of CRE infection increases with the prolongation of ICU stay^[42]. (6) Combined with other bacterial infections: Studies have found that concomitant bacterial infections or other multidrug-resistant bacterial infections are risk factors for CRE infection^[43,44]. (7) History of medical treatment within one year: Patients with a previous history of ICU hospitalization are independent risk factors for CRE infection^[45]. (3) Diagnosis and treatment characteristics: (1) Use of antimicrobials before CRE infection: Studies have found that exposure to β -lactam/ β -lactamase inhibitors, antimicrobials, and fourth-generation cephalosporins before CRE infection is an influencing factor of CRE infection^[18], and the risk of CRE infection increases with prolonged use^[40]. The use of third-generation cephalosporins has also been found to be an independent risk factor for CRE infection^[45]. (2) Surgical history: According to the "Measures for the Management of Surgical Classification in Medical Institutions (Trial)" promulgated by the Ministry of Health, the types of surgery are divided into four levels according to various factors such as risk level and difficulty of operation. Surgery is a relevant factor in CRE infection in patients^[40], but the risk of CRE infection in patients of different surgical grades is less reported. (3) Hemodialysis: Patients with a history of hemodialysis are more likely to be infected with CRE than those without a history of hemodialysis^[46]. (4) Whether to perform puncture: Puncture and drainage are invasive operations and are common diagnostic and treatment operations in medical institutions. Studies have found that invasive procedures are associated with nosocomial infection of CRKP^[47], and the proportion of patients with CRKP infection who undergo invasive procedures is higher than that of CSKP patients^[48], and some studies have found that puncture and drainage are an influencing factor for acute pancreatitis combined with CRE infection^[41], and some studies have found that puncture and drainage are an independent risk factor for CRKP infection^[49]. (5) Ventilator use: Ventilator use is a risk factor for CRE infection in ICU patients, and the longer the ventilator is used, the higher the risk of CRE infection^[42], and a prospective cohort study of ICU patient mortality conducted in 10 countries

in the Middle East found that ventilator-associated pneumonia is a risk factor for death in ICU patients^[50]. (6) Indwelling urinary catheters: Studies have found that indwelling urinary catheters are an independent risk factor for CRE infection^[19]. (7) Indwelling central venous catheterization: Some studies have found that patients with indwelling central venous catheterization have a higher risk of CRKP nosocomial infection^[51]. (4) Comorbid underlying diseases: Domestic and foreign studies have found that patients with underlying diseases such as hypertension, malignant tumors^[40], sepsis, coagulation dysfunction, diabetes, and hypoproteinemia are more susceptible to CRE infection^[52].

ICUs are medical places for the treatment of critically ill patients, and because most of the patients are critically ill, the probability and frequency of receiving various diagnoses and treatment operations are higher than those of other inpatient wards. In ICU patients, their immune function is deteriorated, and long-term invasive operations such as surgery, ureteral intubation, and ventilators can weaken the body's barrier protection function, resulting in communication between the internal environment and the external environment, breaking the body's protective barrier, and hindering the effective penetration of antibacterial drugs^[53]. Hospital-acquired infections^[54,55] refer to infections acquired in hospitalized patients, including infections that occur during hospitalization and infections that occur after discharge from hospitalization, but do not include infections that have started before admission or are present at the time of admission. According to data from the National Medical Institution Infection Surveillance Network, in 2022, a total of 498 hospitals with ≥ 900 beds were collected nationwide, and 791203 patients were surveyed, and the national prevalence of nosocomial infection was 2.19%, while the prevalence rate of nosocomial infection in comprehensive ICUs was 12.95%, which was nearly 6 times higher^[56]. In addition, the study also found that the 14-day mortality rate of nosocomial CRE infection was significantly higher than that of community CRE infection^[57].

A variety of diagnostic and treatment equipment and medical equipment facilities in the ICU are also important mediums for the spread of CRE: 1. Sinks: The industry standard "Specification for the Prevention and Control of Nosocomial Infections in Intensive Care Units WS/T509-2016" issued in 2016 stipulates that the number of sinks installed in ICUs is required to be less than 1:2 between handwashing facilities and the number of beds^[58]. Studies have found that only 38% of sink cleaning and disinfection rates occur in daily work^[59], and some studies have found that faucets and sinks in the ICU are similar to those of patients infected with CRE. 2. Ventilators: Every bed in the ICU ward needs to be equipped with a ventilator, because of its role in the diagnosis and treatment of critically ill patients. The frequency of ventilators used in ICU wards is very high, and pneumonia caused by ventilators has attracted more and more attention. Ventilator-associated pneumonia refers to pneumonia that develops from 48 hours after mechanical ventilation to 48 hours after extubation and is an important type of hospital-acquired pneumonia. The incidence of ventilator-associated pneumonia is reported to be 5% and the mortality rate is as high as 45% in domestic literature, and Enterobacteriaceae are the most common causative agents of ventilator-associated pneumonitis. 3. Length of ICU hospitalization: Studies in Zhejiang Province have shown that the detection rate and mortality rate of CRE in the ICU are much higher than those of non-ICU patients, and multicenter studies have shown that the detection rate of CRE varies between different departments in the hospital, but the detection rate of CRE in the ICU is the highest, reaching 14%-22.5%, and the detection

rate and infection rate of CRE increase with the increase of hospitalization. 4. Use of central vascular catheter: A Central vascular catheter refers to a catheter with the tip of the catheter located in the central vein, and the central vascular catheter can not only be used as a catheter for venous access or blood purification, but also to detect hemodynamic pathways, so it is widely used in clinical practice. Indwelling central venous vascular catheters in ICU patients are very common, with a catheter utilization rate of about 44.12% (central vascular catheter utilization rate = days of central vascular catheter use/number of hospitalized patients in the same period * 100%). Central Line Associated bloodstream infections (CLABSI) refer to a primary bloodstream infection that occurs during the indwelling central catheter or within 48 hours of central catheter extraction and is not related to infection present at other sites. The occurrence of CLABSI prolongs the average hospital stay of patients, increases mortality, and increases healthcare costs. The incidence of CLABSI is usually expressed as "number of CLABSI cases per 1,000 catheter days", that is, "number of new CLABSI cases/number of days of central venous catheter use in the same ICU *1000‰". A meta-analysis showed that the incidence of CLABSI in our country was about 4 cases/1,000 catheter days, and with the prolongation of catheter placement, the probability of CLABSI increased, and the catheter insertion time was less than 5 days, and the CLABSI infection rate was 2.3%; When catheter placement is timed for more than 2 weeks, the infection rate is 15.5%. The most common pathogen that causes CLABSI is *Klebsiella pneumoniae*, and *Klebsiella pneumoniae* is more than 80% resistant to ertapenem.

CRE colonization refers to CRE colonization in a certain part of the human body, but does not cause infection, and only changes from colonization to infection when immunity is weakened. The main colonization sites of CRE include the lower gastrointestinal tract, oropharynx, skin, and urinary tract. CRE colonizes in different wards, but is mainly concentrated in the critically ill patient population, with a colonization rate of 6.8%-45%. Positive CRE colonization is an independent risk factor for CRE infection, with approximately 50% of CRE colonized patients in the ICU developing CRE infection within 30 days, a 10.8-fold increase in infection rates compared to non-colonized patients, and CRE colonizers are also potential disseminators. Currently, the Centers for Disease Control and Prevention and the European Society for Clinical Microbiology recommend that the sites of choice for screening for CRE colonization status are gut-derived samples, including stool and rectal swabs.

Active screening refers to the use of routine or rapid diagnostic methods to screen patients for CRE, and if the CRE active screening is positive, it indicates that the CRE strain has colonized or has shown an infectious state in the patient, and the patient should be isolated to avoid further cross-transmission of the CRE strain in the hospital.

In summary, the consequences of CRE infection include difficult treatment, multiple transmission routes, serious adverse clinical consequences, and economic losses. Therefore, the analysis of CRE infection and related influencing factors in ICU patients can provide suggestions for active screening strategies and prevention and control measures for CRE, which is of great significance for reducing the infection rate of CRE and preventing and controlling CRE cross-transmission in hospitals.

2. Literature Review

Carbapenem-resistant Enterobacterales (CRE), a type of multidrug-resistant bacteria among Enterobacterales, have become a global concern and are classified as a "critical priority" pathogen by the World Health Organization. Its resistance mechanisms mainly include the production of carbapenemases (such as KPC and NDM), changes in porins combined with the production of extended-spectrum β -lactamases or cephalosporinases, alterations in penicillin-binding proteins, and overexpression of efflux pumps, among which the production of carbapenemases is the primary mechanism.

In terms of epidemiological status, CRE has spread widely worldwide. Internationally, countries such as the United States, Colombia, and Italy have high resistance rates. Domestically, the resistance rate of *Klebsiella pneumoniae* to carbapenems has shown an upward trend, reaching over 25% in 2019, while the resistance rate of *Escherichia coli* has remained relatively stable.

The Intensive Care Unit (ICU) is a high-risk ward for CRE infections. Due to factors such as severe underlying diseases, low immunity, frequent invasive procedures, and long-term use of broad-spectrum antibiotics, ICU patients have a significantly higher risk of infection than ordinary ward patients (e.g., the probability of ICU patients being infected with CRE is approximately 9.1 times that of ordinary patients). CRE infections can lead to increased mortality (3-6 times that of patients infected with carbapenem-sensitive bacteria), prolonged hospital stays, and higher medical costs, imposing a heavy burden on society and the medical system.

Factors influencing CRE infections in ICU patients include age, use of antibiotics (especially carbapenems), long hospital and ICU stays, history of hemodialysis, presence of severe underlying diseases, invasive procedures (such as the use of ventilators and central venous catheters), and history of visits to other hospitals. However, there are differences in the determination of some factors among different studies.

Currently, there are issues such as inconsistent determination of influencing factors and regional variations in research. In-depth analysis of the characteristics and influencing factors of CRE infections in ICU patients in the future will provide a reference for formulating active screening strategies and prevention and control measures, which is of great significance to public health security and clinical treatment.

Related Concept

Enterobacteriaceae refer to a group of gram-negative asprobacteria with common characteristics, and their common biological traits include low nutritional requirements, active biochemical reactions, similar morphological staining, antigen structure, and variability. Most of the bacteria in the Enterobacteriaceae family are normal flora, and some are pathogenic bacteria, which can cause disease in individuals with low human immune function, so they are called conditional pathogenic bacteria. In recent years, due to the development of molecular biotechnology, computer technology can now be used to analyze various biochemical reactions and compare the homology of nuclear DNA, etc. On this basis, the Berger Handbook divides Enterobacteriaceae into 44 genera. Common genera of bacteria in the Enterobacteriaceae family that can cause human infections include: *Escherichia* spp., *Klebsiella* spp., *Enterobacteriaceae* spp., *Serratia* spp., *Proteus* spp., *Morganella* spp., etc. In 2020, the Clinical

and Laboratory Standards Institute (CLSI) upgraded some of the genera in the original Enterobacteriaceae family to the family Enterobacteriaceae and classified them in the order Enterobacteriaceae. Pathogenic bacteria in Enterobacteriaceae do not ferment lactose, and all conditional pathogenic bacteria can ferment except *Proteus*. The biochemical reactions of various Enterobacteriaceae are diverse, and the biochemical reactions of different genera are very inconsistent, so they can be used as one of the bases for the identification of Enterobacteriaceae. Common Enterobacteriaceae include: *Escherichia coli*, *Klebsiella pneumoniae*, *Enterobacter cloacae*, *Proteus mirabilis*, etc.

In 1976, scientists from Merck & Co. discovered a new class of β -lactam antimicrobials from *Streptomyces* livestock, which has a structure different from penicillins and cephalosporins, which are called carbapenem antibiotics. β In 1987, Merck completed the semi-synthetic structural modification of thioamycin and successfully developed the first carbapenem antibiotic for clinical use, imipenem, which is still one of the varieties with high clinical evaluation. Subsequently, panipenem, meropenem, ertapenem, biapenem, and donipenem were also introduced and used in clinical practice, all of which received high clinical evaluation. Therefore, the development and marketing of carbapenems is regarded as a new milestone in antibiotic research and development by the international pharmaceutical community. Carbapenem antibiotics refer to a class of antibiotics that inhibit the cell wall penicillin binding proteins (PBPs) to cause bacterial cell wall defects, bacterial body swelling, bacterial cytoplasmic osmotic pressure changes, and cause cell lysis to kill bacteria. Drugs have low host toxicity and are recognized as the "last line of defense" for the treatment of multidrug-resistant bacteria, especially in the treatment of severe infections caused by ultra-broad-spectrum β -lactamase (ESBL) or cephalosporin hydrolase (AmpC enzyme) producing bacteria.

In 2017, the World Health Organization (WHO) defined Carbapenem-resistant enterobacteriaceae (CRE) as follows: Enterobacteriaceae (CRE):(1) resistant to any of the carbapenems, the minimum inhibitory concentration of imipenem, meropenem or doripenem is sufficient for any of the following conditions concentration (MIC) $\geq 4\text{mg/L}$, or ertapenem MIC $\geq 2\text{mg/L}$; (2) carbapenemase production; (3) For enterobacteriaceae bacteria (such as *M. morganii*, *Proteus* spp., *Providencia*, *Providencia*) that are naturally sensitive to imipenem, the minimum inhibitory concentration of other carbapenems except imipenem should be referred to. According to a report by the China Bacterial Resistance Surveillance Network, among the 445199 clinical strains isolated in our country in 2023, the top two CRE strains are: carbapenem-resistant *Escherichia coli* and carbapenem-resistant *Klebsiella pneumoniae* (CRKP). In 1996, a CRKP strain was reported in North Carolina, USA, which was the earliest reported strain of CRE. The first CRE strain was reported in China in 2004 from a 75-year-old ICU patient in a hospital in Zhejiang Province, where the CRE strain was isolated from a blood specimen. In 2017, the WHO listed CRE as a "critical priority" resistant organism in the list of priority drug-resistant pathogens in urgent need of new antibiotic research and development around the world. CRE is the most common gram-negative bacterium that can cause infections in almost all parts of the body, especially pulmonary infections, ventilator-associated pneumonia, bloodstream infections, abdominal infections, and incision infections among nosocomial infections. CRE strains are susceptible to the elderly, patients with severe underlying diseases, immunocompromised patients, and those with long-term use of broad-spectrum antimicrobials. By comparing the incidence and mortality rates of CRE-infected

patients with other non-infected patients, it was found that the former had more additional factors, including potential serious underlying diseases before admission, long-term hospitalization history, etc., which made their prognosis unsatisfactory. After controlling for related risk factors, patients with CRE infection were compared with patients with carbapenem-based antibiotic-sensitive bacterial infections, and the case fatality rate of the former was found to be 3-6 times higher than that of the latter. CRE is also a common pathogen of nosocomial infection, and it has been found that CRE nosocomial infection not only leads to prolonged hospital stay, but also leads to increased hospital costs, and CRE-infected patients have higher per capita hospitalization costs than CSE patients compared with patients infected with carbapenem-sensitive enterobacteriaceae (CSE). 26,219.81 yuan. The increase in mortality and mortality rates, the prolongation of hospital stay, and the increase in hospitalization costs caused by CRE undoubtedly bring a heavy economic burden to patients' families, hospitals, and society as a whole. From the perspective of social and economic burden, due to the difficulty of treating CRE infection, medical institutions and government departments need to invest more in labor and economic costs, and at the same time, it will increase doctor-patient conflicts and even cause medical disputes. Studies have found that patients with multidrug-resistant bacteria in intensive care units (ICUs) have a median length of stay of 18 days longer and a median hospitalization cost of about 120,000 yuan/person compared with uninfected patients. This suggests that if the nosocomial cross-infection of CRE can be effectively controlled, it can reduce the drug expenditure of hospitals, reduce the direct economic losses of patients, and reduce the proportion of hospital drugs, which is conducive to the high-quality development of hospitals.

Domestic and foreign studies have found that ICU is a department with a high detection rate of multidrug-resistant bacteria and a high-risk area for CRE infection. Patients in ICU wards generally have severe underlying diseases, critical illness, low immunity, long hospital stay, long-term use of broad-spectrum antimicrobials, and many invasive procedures (invasive endoscopy, indwelling catheterization, endotracheal intubation, central venous catheterization, etc.), as well as the tightness of the ICU ward, the frequent use of various precision instruments, and the difficulty of thorough cleaning and disinfection (e.g., ventilators, central venous pressure monitors, etc.), which are all reasons why ICU patients are prone to multidrug-resistant bacterial infections. A Chicago study showed that patients in the ICU had a 30% chance of contracting CRE, which was 9.1 times higher than that of other general patients (3.3%). A meta-analysis of 1806 patients with CRE colonization showed a total CRE infection rate of 16.5%, while patients hospitalized in the ICU had an infection rate of 29-73% due to CRKP and a mortality rate of 16-41% **Error! Reference source not found., Error! Reference source not found..** It can be seen that the current epidemic of CRE is threatening our country's public health security and has also brought significant challenges to clinical treatment, among which the treatment of critically ill patients in the intensive care unit is the most difficult.

The resistance mechanisms of Enterobacteriaceae to carbapenems mainly include : (1) the production of carbapenemases, and common carbapenemases include KPC, NDM, IMP, VIM, etc.; (2) The production of ultra-broad-spectrum β -lactamase or cephalosporase is combined with the change of membrane porin at the same time, and the change of membrane porin leads to a decrease in the permeability of the outer membrane, resulting in the inability of antibacterial drugs to enter the bacteria and kill the bacteria; (3) changes in penicillin-binding

proteins at the site of action; (4) Other mechanisms, such as high expression of strain efflux pump. It has been proposed that about 50% of all CRE strains are carbapenemase-producing resistant bacteria, followed by loss of porin expression accompanied by ultra-broad-spectrum β -lactamase or cephalosporinase, while changes in antimicrobial target and high expression of efflux pump are less reported.

Relate Theory

Prevalence status of carbapenem-resistant Enterobacteriaceae in foreign countries

The rapid spread of CRE has become a global public health problem and has attracted attention due to its rising infection rates. CRKP has been reported to have a resistance rate of 9%-13% to carbapenems in the United States and Colombia, with higher rates in Italy and Greece. So far, CRE detection has been reported in various parts of the world.

The detection rates of CRE strains in Enterobacteriaceae isolates in eastern Mediterranean, eastern Africa, and Southeast Asia were 68.9%, 35.0%, and 10.0%, respectively. Data from a molecular and clinical epidemiological study on CRE in the United States showed that the most common source of CRE was urine (39%), followed by the respiratory tract (26%), and blood and wound accounted for 13% each. Thai study data indicate that urine (41%) and sputum (35%) are the most common types of CRE specimens. CRE resistance genotypes vary from region to region. In Ghana, 5.7% of isolates were resistant to carbapenem antibiotics. In the United States, Colombia, Argentina, Greece, and Italy, blaKPC-producing Enterobacteriaceae are prevalent. While in two hospitals in Kuwait and Nigeria, the prevalence of CRE was 14.0% and 8.0%, respectively, and the resistance genes were detected as blaOXA-181 and blaNDM-7. In India, Pakistan, and Sri Lanka, blaNDM-1 is more prevalent. The main carbapenemase in Klebsiella was found in Malaysia as blaOXA-48, and NDM and KPC types are more common in Asia. Like the rest of the world, China's challenge is to monitor, prevent, and control the spread of CRE. In China, KPC was predominantly predominant in adults and predominantly NDM and OXA-48 in children. These studies reflect the prevalence of CRE genotypes in different regions, suggesting that CRE has important public health implications.

Epidemic status of carbapenem-resistant Enterobacteriaceae in China

According to the China Bacterial Resistance Surveillance Network (CINNET), a total of 17013171 bacterial strains were isolated from 2014 to 2019, of which 12034699 were gram-negative strains, accounting for 70.74%. The top five bacteria in gram-negative bacilli are Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, Acinetobacter baumannii, and Enterobacter cloacae, and the resistance rate of Escherichia coli to carbapenems is low (all below 1.5%), but the resistance rate of Klebsiella pneumoniae to imipenem and meropenem has been increasing, from 4.8% in 2014 to 10.9% in 2019. It suggests that we should strengthen the rational use of carbapenem antibiotics and the management of nosocomial infection control to prevent their further increase. CHINET data shows that the isolation rate of CRE was only 2.1% in 2005, and increased to 11.4% in 2019, among which the resistance rate of Klebsiella pneumoniae to imipenem and meropenem increased from 3.0% and 2.9% in 2005 to 25.3% and 26.8% in 2019, and Escherichia coli was relatively stable, and the resistance rate of imipenem and meropenem in 2005 was 1.1%, respectively. 1.4%, compared to 2.0% and 2.1% in 2019.

Basic information of study samples/study area

Distribution in hospitals, communities, and environments

In healthcare facilities in Washington, D.C., the prevalence of CRE is 5.2%. Although the proportion of community-acquired carbapenem-resistant Enterobacteriaceae and *Acinetobacter baumannii* (CRE/CRAB) in the Korean community is low, more than 20% of CRE/CRAB isolates are identified at the time of hospitalization. Between 2012 and 2016, CRE isolates were detected in hospitals in eastern China, and the enzyme types included blaKPC-2, blaKPC-3, blaNDM-1, blaNDM-5, blaIMP-4, and blaVIM-1. The main carbapenemase genes were found to be blaKPC-2 and blaNDM-1. Between 2014 and 2019, the prevalence of CRE among non-adult patients in Zhejiang Province was 2.3%. During the same year, a study conducted by a hospital in Henan Province showed that 18.1% of Enterobacteriaceae bacterial isolates were resistant to carbapenem antibiotics, and the most common CRE isolates were carbapenem-resistant *Klebsiella pneumoniae* and carbapenem-resistant *Escherichia coli*. In a hospital in China, the fecal carriage rate of CRE was determined to be 8.5% among 704 patients, mainly transmitted by fecal carriers of the *Klebsiella* ST11 clone producing KPC enzyme, and ST1889 was also detected.

The prevalence of CRE in people and the environment also needs to be monitored. In rural areas, there may be direct transmission of the NDM-EC genotype between humans and their backyard animals. Carbapenem-resistant pathogenic strains isolated from wastewater treatment plants showed a wide diversity of acquired antibiotic resistance genes, especially resistance to β -lactams, aminoglycosides, and fluoroquinolones. The prevalence of CRE in Thailand is relatively low (0.13%), but CRE infection has been reported for the first time in Thailand from pigs, illustrating the need to monitor and investigate the occurrence of CRE in animal-rearing environments such as pig farms.

Risk factors and high-risk groups

Risk factors associated with CRE colonization include age, presence of multidrug-resistant organisms, use of cephalosporins, and acute physiological and chronic health scores (APACHE II). Hospitalization and antibiotic use were found to be significant risk factors for CRE colonization. The most common risk factors for death in patients with CRE infection include antibiotic use and comorbidities, indicating the importance of considering combination therapy when using certain antibiotics. Risk factors for colonization of CRE in hospital patients include transfer from other wards, use of nebulizers, and intravenous catheters. In patients undergoing allogeneic hematopoietic stem cell transplantation, infection with CRE can affect platelet engraftment and survival. In patients with acute leukemia, risk factors for CRE colonization include age, use of cephalosporins, and tigecycline. In children with neutropenia with hematologic disorders, the risk of CRE bacteremia or colonization is higher. In hospitalized children, intestinal colonization of CRE is associated with antibiotic use, frequent hospitalization, and underlying disease, and in childhood cancer patients, clinical features that increase the risk of CRE infection include previous antibiotic exposure, severe neutropenia, long-term use of corticosteroids, previous colonization by resistant pathogens, admission to the intensive care unit within 90 days, and use of central venous catheters.

Risk factors for CRE infection in ICU patients include concomitant infection with other multidrug-resistant bacteria (MDROs), use of invasive devices, use of specific antibiotics, mechanical ventilation, hospital stay for more than three weeks, and acute kidney injury. Male

sex, history of hospitalization within the past year, co-colonization with multidrug-resistant *Acinetobacter* and ultra-broad-spectrum β -lactamase-producing bacteria, and exposure to glycopeptide antibiotics are independent risk factors for CRE infection in ICU patients. Children and young adults, especially those with comorbidities such as hematological, genetic, and urinary abnormalities, are considered susceptible to CRE infection after ICU transfer. COVID-19 patients in the ICU unit, especially those with leukopenia on admission, use of invasive mechanical ventilation, treatment with carbapenem antibiotics, and treatment with corticosteroids, are a high-risk group for CRE infection, and these patients also have a higher risk of ICU mortality and COVID-19 mortality.

CRE infection seriously affects the prognosis of patients with liver disease. Patients with liver disease had low albumin, decreased drug metabolism efficiency, and significantly reduced long-term survival after CRE infection. In patients with liver disease, risk factors for CRE infection are ICU admission, acute liver failure, and a history of lung infection within the last three months. In addition, limited mobility and antibiotic use on admission are independent risk factors. Older age, longer hospital stays, and use of central venous catheters and arteriosus catheters are associated with higher mortality in patients with CRE infection and hospital-acquired CRE infection increases patient mortality, especially in high-risk populations such as hematologic patients, intensive care unit patients, and liver disease patients, leading to increased burden on the healthcare system. Understanding these risk factors and high-risk populations is crucial for preventing and managing CRE infection.

Related research

Carbapenem-resistant *Enterobacteriaceae* resistance mechanism and molecular epidemiology

The resistance mechanisms of *Enterobacteriaceae* to carbapenems mainly include : (1) the production of carbapenemases, and common carbapenemases include KPC, NDM, IMP, VIM, etc.; (2) The production of ultra-broad-spectrum β -lactamase or cephalosporase is combined with the change of membrane porin at the same time, and the change of membrane porin leads to a decrease in the permeability of the outer membrane, resulting in the inability of antibacterial drugs to enter the bacteria and kill the bacteria; (3) changes in penicillin-binding proteins at the site of action; (4) Other mechanisms, such as high expression of strain efflux pump. It has been proposed that about 50% of all CRE strains are carbapenemase-producing resistant bacteria, followed by loss of porin expression accompanied by ultra-broad-spectrum β -lactamase or cephalosporinase, while changes in antimicrobial target and high expression of efflux pump are less reported.

Research conceptual framework

Factors associated with CRE infection in ICU patients

A variety of factors are related to CRE infection in ICU patients, and based on relevant studies at home and abroad, the main influencing factors are as follows:

General situation

CRE infection is not related to gender or age, and most patients infected with CRE are between the ages of 65 $\pm$ 15 years old, and the risk of CRE infection increases with age.

Use of antimicrobials

A 2017 multicenter case study in China found that previous use of antibiotics (especially carbapenems, quinolones, aminoglycosides, and tigecycline) was an independent risk factor for CRKP infection. An expert consensus released in our country in 2021 mentioned that the use of multiple antimicrobials (quinolones, third- or fourth-generation cephalosporins, or carbapenems) is a risk factor for CRE infection and colonization. A study in Thailand found that carbapenem consumption at a defined daily dose per 1,000 patient days in a tertiary hospital significantly increased the use of carbapenems and was associated with an increase in the incidence of CRE.

Days of hospitalization

There was no difference in the length of hospital stay between patients with CRE and CSE before infection with Enterobacteriaceae among hospitalized patients. However, a domestic study using the PSM caliper matching method used a 1:1 pairing method for patients with multidrug-resistant bacterial infection and non-multidrug-resistant bacterial infection, showing that there was a difference in hospital length between the two, with the former having a longer hospital stay than the latter.

Combined with other bacterial infections

A domestic COX analysis of CRKP infection found no difference between the 28-day death group and the 28-day non-death group with CRKP infection. Some studies have also found risk factors for CRE cross-infection in patients with other multidrug-resistant bacteria or other sensitive bacterial infections. One cohort study identified CRE infection as a risk for other multidrug-resistant organisms before infection.

ICU length of stay

Multiple studies have found that long hospital stays and ICU admission are risk factors for CRE infection. Hospital stay >7 days is an independent risk factor for CRE infection in ICU patients. However, there are few studies on whether there is a difference between the length of ICU stay in patients with CRE and CSE infection in the ICU.

Surgical grade

In 2022, the Chinese Health Commission revised the requirements of the "Measures for the Classification of Surgery in Medical Institutions", which divides surgery into four levels from easy to difficult according to the degree of surgical risk, difficulty, resource consumption, or ethical risk. Several studies have found that in-ICU CRE infection is associated with surgery. However, there are few studies on surgical grades and CRE infection.

Hemodialysis

Common blood purification measures in healthcare settings include hemodialysis and continuous renal replacement therapy, and studies have found that there is a statistical difference between CRE and CSE infection in patients with CRE infection, and patients with a history of hemodialysis have a higher risk of CRE infection than those without a history of hemodialysis.

Puncture and drainage

Puncture and drainage are one of the common invasive procedures, and invasive treatment is a risk factor for CRE infection.

Underlying diseases

Studies have found that most patients with CRE infection have serious underlying diseases, such as malignancy, heart failure, COPD, diabetes, etc. Hypoproteinemia is also a risk factor for CRE infection.

History of diagnosis and treatment within one year

A history of other hospital visits is a risk factor for CRE infection.

Use of ventilators, ureters, and central venous catheters

Most patients in the ICU have a history of invasive manipulation of ventilators, indwelling ureters, and central venous catheters during their stay. CRE has been found to cause catheter-associated urinary tract infections, central catheter-related bloodstream infections, and ventilator-associated pneumonia. Some studies have found no statistical difference in invasive procedures between CRE and CSE patients after matching CRE and CSE cases using the PSM pairing method.

3. Conclusion

The influencing factors of CRE infection in ICU patients in a tertiary hospital in Gansu Province include the number of specimen sources, the number of days in the ICU, the number of other bacterial infections before CRE is detected, the number of other bacterial infections during hospitalization, and the number of days on ventilators. To reduce the risk of CRE infection in ICU patients, it is recommended to increase the active screening rate of CRE in ICU patients, minimize invasive procedures, shorten the number of ICU hospital stays, and rationally use antimicrobials.

Limitations

The study inevitably has a lack of some medical record information of patients, and the incomplete collection of clinical diagnosis and treatment data from patients in other hospitals, such as the inability to obtain the patient's test results and antibacterial drug use in other hospitals, resulting in information bias.

The molecular biology of the detected CRE strains was not further tested to clarify the mechanism of drug resistance, so the epidemiological relationship between CRE strains was lacking.

This study was only conducted on the ICU of a tertiary hospital in Gansu Province, and the design of a single-center retrospective study was limited in generalizing the results.

The influencing factors of CRE infection include hand hygiene and ward environment, but these factors were not included in the analysis of the influencing factors of the study because the specific situation of the above characteristics during the hospitalization of the research subjects could not be obtained, so there were certain limitations.

Future Directions

In the future, whole genome sequencing (WGS) technology can be used to clarify the types of drug resistance genes carried by strains and the epidemic clonal lineages, trace the transmission chain of CRE in the hospital (such as whether there is manual transmission by medical staff, cross-transmission of medical devices, and environmental colonization transmission), and pay special attention to the correlation between strain contamination and

patient infection in ICU high-frequency contact environments (sinks, ventilators, central venous catheter interfaces), to provide molecular evidence for blocking the transmission chain.

Combined with the results of the original study "carbapenem use is associated with CRE infection", in the future, the molecular mechanism of the transformation of Enterobacteriaceae bacteria from sensitive (CSE) to resistant (CRE) under exposure to different antimicrobials (such as carbapenems and β -lactamase inhibitor compounds) can be studied (such as gene mutations, plasmid-mediated resistance gene transfer), and the key drug resistance evolution nodes can be clarified to provide medication guidance for the clinical avoidance of "induced drug resistance".

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Differences and Integration Promotion of Multi ethnic Mixed Elderly Care in Plateau Regions of China: A Case Study of Area in Kunming, Yunnan Province

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Abstract

China has become one of the world's leading countries with an aging population. Due to the characteristics of China's large area, unbalanced economic development in the east and west, and multi-ethnic and multi-regional existence, there are some big differences in China's culture, and there are also different ways to provide for the elderly, especially between the Han and some other ethnic minorities. At present, the economic level of China's plateau region lags behind that of the coastal and plain areas, and the ethnic minorities in the plateau areas are more than those in other regions, which makes the ethnic groups in the plateau areas of China higher than those in the plains and coastal areas. Yunnan is part of the Yunnan-Guizhou Plateau in the southwest of China, where there are 26 ethnic minorities. To sum up, this paper mainly analyzes the characteristics of multi-ethnic mixed pension from a certain area in Kunming, Yunnan Province, and lays a good foundation for the prosperity of multi-ethnic families, and also provides a certain basis for the development of pension in the future.

Keywords: China's plateau, Multi-ethnic mixed living, pension differences, integrated Development

1. Introduction

1.1 Background

With the development of the economy and the improvement of medical conditions, the structure of Chinese population is undergoing profound changes, from the past "high birth rate, high mortality rate, low growth rate" to "low birth rate, low mortality rate, low growth rate". The family planning policy implemented since the 80s of the 20th century has given birth to a typical "4-2-1" family structure, that is, a couple needs to support four elderly people and raise one child, and this demographic pattern has further aggravated the complexity of our country's aging problem.

In China's vast rural areas, due to the level of economic development and the popularization of education, the elderly still lag behind in receiving new pension concepts, health services and disease prevention and control knowledge. At the same time, there are significant regional differences, and there is a huge imbalance in the allocation of pension methods and resources in various regions, especially in remote ethnic areas [1].

1.1.1 Topography and ethnic distribution of the Chinese Plateau

China is a vast country with 56 ethnic groups and a complex and diverse terrain, including plains, grasslands, and plateaus. The main plateaus are the Qinghai-Tibet Plateau, the Loess Plateau, the Inner Mongolia Plateau and the Yunnan-Guizhou Plateau. For example, the Tibetans are mainly distributed in the Qinghai-Tibet Plateau, the Mongolians are concentrated

in the Inner Mongolia Plateau, the Hui are mostly distributed in the Loess Plateau, and the Yi, Miao and Bai are concentrated in the Yunnan-Guizhou Plateau.

Yunnan Province is located in the southwest border of China, belongs to the Yunnan-Guizhou Plateau, the terrain is mainly mountainous and plateau, the climate types are diverse, the ecological environment is rich, is the province with the largest number of ethnic minorities in our country, there are 25 ethnic minorities with a large population size. Taking Kunming, the provincial capital, as an example, there are 3 ethnic autonomous counties and 4 ethnic townships within its jurisdiction, with a total of 343 administrative villages inhabited by ethnic minorities. This background provides a typical sample and research soil for exploring the ethnic pension model in the plateau area [2].

1.1.2 Changes in the structure of China's elderly population

At present, China is the developing country with the largest elderly population in the world. By the end of 2019, the population aged 65 and above accounted for 12.6%, and it is expected that by 2050, our country will enter the stage of "severe aging". About 60 per cent of the elderly population lives in rural areas. With the rapid growth of the elderly population, the existence of 4.06 million disabled elderly people has increased the burden on the medical and pension system, and it is urgent to respond to the coordinated response of multiple parties [3].

At present, our country's pension model is mainly based on family pension and institutional pension. In cities, due to the high economic level and perfect service system, the number of pension institutions is increasing year by year; In rural areas, constrained by the traditional "filial piety" culture and economic conditions, family pension still occupies a dominant position. Although nursing homes have been built in some developed rural areas, most elderly people with children still prefer family support [4].

1.1.3 Traditional pension methods in ethnic minority areas

As an economically underdeveloped province, Yunnan has many mountainous villages and remarkable ethnic characteristics. In many ethnic villages, formal pension institutions have not yet been established, and pension still relies on traditional family models. Due to the great cultural differences of various ethnic groups, their pension concepts and methods also have their own characteristics. Studies have shown that:

- The Buyi people mainly provide for the elderly by themselves;
- (2) The Yi people generally rely on their families for the elderly, with land as a guarantee;
- (3) The family care system of the Dong nationality is dominated by "Bula" as the core;
- (4) The Dai people have a tradition of "Zangfang" for the elderly;
- (5) The Achang people advocate the "Shangzang" type of pension;
- (6) The Wa people use the "Respect for the Elderly" as a continuation of the tradition of respecting the elderly.

At the same time, since the reform and opening up, a large number of young and middle-aged people in rural areas have gone out to work, resulting in a surge in the number of "empty nesters". These elderly people generally lack spiritual comfort and life care, and still need to bear the burden of working in the fields and taking care of grandchildren, and the pressure of providing for the elderly is becoming increasingly severe. In rural areas where ethnic groups live together, the problem is more complex and urgently needs systematic exploration and institutional support [5].

Implications of the study

Reconstruction of the traditional concept of pension

In traditional Chinese culture, old-age care is often seen as an internal family responsibility, and it is often only paid attention to when the elderly are sick or incapacitated. Influenced by the idea of "filial piety", children often believe that the elderly should be allowed

to "enjoy their old age in peace", but ignore their needs for social participation and spiritual life [6].

With the intensification of the phenomenon of empty nests in rural areas, it is no longer possible to rely on families alone to meet the growing demand for the elderly. Building a diversified and sustainable pension system requires the participation of the government, communities, medical institutions, enterprises and families. Therefore, an in-depth study of the old-age care practice in typical ethnic minority villages in Yunnan is helpful to build a old-age service system that conforms to local culture and realistic conditions, promote the formation of a standardized and systematic old-age care mechanism and industrial chain, and improve the quality of life and dignity of the elderly in rural areas.

1.2.2 Respond to national development strategies and policy guidance

In January 2015, General Secretary Xi Jinping proposed during his investigation in Yunnan that Yunnan should "write the Yunnan chapter of the Chinese dream", and strive to become a demonstration area for national unity and progress, a vanguard in the construction of ecological civilization, and a radiation center for South and Southeast Asia. The State Council has also made it clear that Yunnan should be built into a demonstration area for prosperity and stability in the country's border areas.

In this context, promoting the construction of the pension service system in ethnic areas is not only related to the social and people's livelihood, but also an important part of implementing the national strategy and maintaining the stability of the border areas.

1.2.3 Based on reality, serve the development needs of rural pension

At present, Yunnan Province has established 1,168 pension institutions and 11,732 community pension service facilities, and the supply system of pension services has been expanding, especially in urban areas. For example, the new model of "three-body one-type" pension explored by Kunming has been listed as a typical experience by the National Health Commission.

However, these models are mainly concentrated in cities, and rural areas, especially ethnic villages, still have the problems of lack of elderly care services, shortage of resources, and backward concepts. The Kunming villages selected in this study are inhabited by Han, Yi, Miao and other ethnic groups, which are typical and representative. Through in-depth research on the current situation of pension in the region, we can summarize experience, find problems, put forward countermeasures, effectively integrate the national pension policy into local practice, and introduce advanced pension concepts and mechanisms to help form a long-term development of the pension model.

This study is expected to provide practical reference and theoretical support for the development of elderly care in Yunnan and even the ethnic minority areas of southwest China, and play an exemplary role in international elderly care cooperation with South Asia and Southeast Asia.

2. Literature Review

This study focuses on the current situation of rural elderly care in the Southwest Plateau of China, especially in Yunnan Province, and explores the practical path and optimization direction of the elderly care model under the background of ethnic culture based on field research and case analysis. The specific research objectives are as follows:

2.1 In-depth exploration and research of the existing pension model in the multi-ethnic mixed areas of the plateau

Through visits to typical ethnic minority villages, we can systematically understand the actual pension methods adopted by various ethnic groups in their daily lives, covering various forms such as family pension, self-pension, village-supported pension, traditional ethnic

mutual pension and institutional pension. Combined with the cultural characteristics of Yi, Miao, Bai, Dai and other ethnic groups, the values, economic conditions, religious beliefs and intergenerational relations behind their pension behaviors were comprehensively collected to ensure that the survey was representative and realistic.

2.2 The advantages and disadvantages of the pension model in multi-ethnic mixed areas were sorted out and summarized

On the basis of the research, the structure, function and effect of different ethnic pension models were compared and analyzed, and the advantages of sustainability and cultural adaptability were extracted, such as strong family support, strong sense of mutual assistance in villages, and cultural tradition of respecting the elderly. At the same time, the practical challenges they face, such as insufficient care capacity, lack of institutional support, shortage of medical resources, loss of young population, etc., are identified, so as to provide a problem-oriented approach for subsequent optimization.

2.3 In response to the problems found in the survey, theoretical analysis is carried out and policy suggestions are put forward

By connecting the problems found in the survey with modern pension theories (such as active aging theory, community care theory, medical care integration model, etc.), the causes and mechanisms of the problems found in the survey are deeply analyzed, and the theoretical support of the localized pension service system is constructed. At the same time, combined with local policies and development plans, this paper puts forward suggestions on pension policies suitable for ethnic minority areas, and strives to attract extensive attention and cooperation and participation of local governments, community organizations and social enterprises.

2.4 It provides theoretical support and practical reference for the development of pension in plateau ethnic areas

Based on the survey data, this study aims to explore innovative cases of pension models with promotion value, and to construct a replicable and sustainable development path for the elderly in ethnic minority areas. The research results will provide practical reference and theoretical reference for the development of the elderly care industry in Yunnan and other similar border ethnic areas, and help build a rural elderly care system in the new era of "people-oriented, diversified participation and cultural integration".

2.5 Research hypothesis

2.5.1 Ethnic cultural factors significantly affect the formation and preference of pension model

In the multi-ethnic plateau villages, the old-age care model is closely related to the traditional culture, religious beliefs, family structure and intergenerational relationship of the local ethnic groups, and there are significant differences in the acceptance and participation behavior of different ethnic groups.

2.5.2 At present, the rural pension system is difficult to meet the diversified needs of the elderly of ethnic minorities

The existing supply of elderly care services is mainly concentrated in urban areas, and there is a lack of elderly care service facilities, medical resources and policy coverage in ethnic villages, resulting in the elderly generally relying on family care for the elderly, high self-care pressure, and low quality of life.

2.5.3 Village-to-village mutual aid and traditional cultural support still play a key role in the elderly care of ethnic minorities

Although the coverage of the modern pension system is insufficient, there is a certain degree of community mutual aid mechanism and cultural tradition of respecting the elderly in

ethnic minority areas, which makes up for the gap in the pension system to a certain extent, and plays a positive role in the psychological state and life care of the elderly.

2.5.4 The pension model in the context of multi-ethnic integration has the potential for integration and innovation

In the area of multi-ethnic cohabitation, the practice of old-age care presents a new trend of integration of tradition and modernity, and the combination of native and cross-ethnic mutual assistance, which has the basis and possibility of forming a "culturally adaptable" and "cross-ethnic support" old-age care model.

2.5.5 Theoretical guidance and policy support can effectively improve the ability of ethnic villages to provide elderly care services

By introducing the theory of active aging, the theory of village care, and the concept of integration of medical care and elderly care into the practice of elderly care in ethnic minority areas, and combined with the guidance of local policies, the level of elderly care services in ethnic villages can be significantly improved, and the efficiency of elderly care and the satisfaction of the elderly can be improved.

2.6 Scope of research

2.6.1 Study population and sample (sample sampling)

In order to comprehensively understand the current situation and existing problems of the rural pension model in the mixed villages of ethnic minorities in Yunnan, this study selected XXX village in Kunming City, Yunnan Province as the field research site. The village is located in the combination of ethnic townships and towns in Kunming City, which has the typical characteristics of multi-ethnic mixed settlement, plateau ecological environment and rural economic structure, and is an ideal sample point for this study to explore the practice of elderly care in plateau ethnic areas.

3. Methodology

3.1 Population and sample

3.1.1 Number and acquisition of samples

This study focuses on the elderly care model of rural elderly in the mixed villages of ethnic minorities in the Yunnan Plateau, and the overall study is the Yi, Miao and Han rural permanent residents aged 65 and above who live in the integrated area of ethnic townships and towns in Kunming City, Yunnan Province. This group has the triple characteristics of "ethnic integration", "plateau ecological environment" and "traditional rural structure", which is suitable for exploring the differences in pension behavior and institutional adaptability in the context of multi-ethnic background.

3.1.1.1 Sample selection and design

In order to ensure the representativeness and comparability of the study, XXX village in Kunming was selected as the field research site. The village is a typical ethnic integration community, inhabited by three main ethnic groups, Yi, Miao and Han, with strong representativeness and sample diversity.

Stratified Random Sampling was used to achieve reasonable control and balanced distribution in the dimensions of ethnicity and gender. The specific sampling structure is as follows:

3.1.1.2 Sampling Implementation Instructions:

150 people from each ethnic group were evenly selected, and the gender ratio was controlled to be 1:1, so as to reduce the interference of gender variables on the concept and practice of old-age care.

All sample subjects must be aged 65 or above and be local residents.

Multiple background factors such as marital status, education level, and economic status were taken into account to improve the heterogeneity and explanatory power of the sample.

In the sampling process, with the help of the basic population information provided by the village committee, a sampling framework divided by ethnic groups was established, and numbering and lottery sampling were carried out in combination with the residence register and family visits.

For individuals with limited mobility and cultural communication barriers, auxiliary interviewers and ethnic language interpreters will be arranged to assist in completing the questionnaire survey to ensure the integrity and validity of the data.

3.1.2 Inclusion Criteria of samples

Sample size and collection method

3.1.2.1 Sample size setting

A total of 450 individuals were sampled in this study, covering the three main ethnic groups of Yi, Miao and Han, with 150 people from each ethnic group, and the sex ratio was strictly controlled to 1:1, that is, 75 males and 75 females were included in each ethnic group. The sample size takes into account the needs of statistical analysis and the feasibility of actual research, and has good representativeness and balance, which is convenient for subsequent comparative analysis of cross-ethnic and cross-gender pension models.

3.1.2.2 Sample collection methods

In order to ensure the representativeness and scientificity of the sample, this study used stratified random sampling to stratify the sample according to two variables: ethnicity and gender, and the specific collection process is as follows:

(1) Establishment of sample frame: through cooperation with the village committee, obtain the basic population information of the permanent residents in the village, and establish a complete sample frame according to ethnic classification;

(2) Sampling criteria setting: the inclusion criteria are villagers aged 65 and above, with permanent household registration, and able to express their basic wishes;

(3) Implementation of equidistant sampling: equidistant sampling is carried out according to the number in the sample frame of each ethnic group to ensure the uniform distribution of samples;

(4) Gender control: 50% male and 50% female in the sample of each ethnic group in the sampling process are strictly controlled to eliminate gender bias;

(5) Handling of special populations: For respondents with reduced mobility, weak literacy ability or language communication barriers, auxiliary interviewers with ethnic language skills will be arranged to assist in completing the questionnaire to improve the completeness and effectiveness of data collection;

(6) Survey method: Questionnaire survey was conducted by face-to-face household interview, and some interviewees were recorded and supplemented with interview minutes according to the actual situation.

3.2 Research tools/equipment

3.2.1 Creation and quality verification of research tools (validity and reliability)

2.2 This paper summarizes the advantages and disadvantages of the pension model in multi-ethnic mixed areas: research methods and tool allocation

In order to systematically summarize the advantages and challenges of the pension model

in the multi-ethnic mixed villages in Shilin County, Kunming, Yunnan Province, this study adopted the three-in-one field investigation strategy of "quantitative analysis + qualitative interview + field observation", combined with ethnic differences, cultural factors and institutional environment, and comprehensively compared the pension structure and actual effectiveness of different ethnic groups.

3.2.2.1 Quantitative research tools and analytical methods

(1) Structured questionnaire survey: A questionnaire covering demographic characteristics, current pension methods, pension satisfaction, self-care ability, cultural identity and other modules was designed and used for the data collection of 450 sample subjects.

(2) Descriptive statistical analysis: used to identify the proportion, trend and basic characteristics of different ethnic pension methods (such as whether to prefer family pension, institutional pension, etc.).

(3) Cross-tab: Analyze the correlation between pension style and variables such as gender, ethnicity, income, and empty nest status.

3.2.2.2 Qualitative research tools and complementary methods

(1) Semi-structured interviews: Interviews were conducted with representative village elders (about 10 people per ethnic group), village cadres, and caregivers to discuss the tradition of mutual aid in villages, the culture of respecting the elderly, and the dilemma of caregiving.

(2) Field observation: The research team will record the interactive behaviors, space use and care forms in the village elderly care places (such as families, ancestral halls, activity squares, etc.) to supplement the cultural phenomena implicit in the data.

(3) Cultural characteristics record form: sort out the pension concepts, funeral customs, and intergenerational interaction behaviors of different ethnic groups, and provide original materials for the follow-up "cultural adaptability analysis".

3.3 Data collection

This study focused on the rural elderly care model in Shilin County, Kunming City, Yunnan Province, and the data collection work mainly used a combination of questionnaire survey and semi-structured interviews, focusing on obtaining real information about the elderly in terms of elderly care style, health status, cultural concepts and social support. Here's how:

3.3.1 Survey Respondents and Sample Size

Target group: Elderly residents aged 65 and above in rural areas, covering the three main ethnic groups of Yi, Miao and Han.

3.2 Sample size: a total of 450 valid questionnaires, including 150 Yi people, 150 Miao people, and 150 Han people; Gender parity (225 males and 225 females).

3.3. Variable design and measurement methods

This study involved a number of core variables, which were measured according to different types:

3.3.1 Dependent variables (explanatory variables) include:

Current pension methods: Respondents self-reported their main pension dependence methods (such as family pension, self-pension, village mutual assistance, institutional pension, etc.), which are multi-category classification variables.

3.3.2 Pension satisfaction: The Likert 5-point scale (1=very dissatisfied, 5=very satisfied) was used to measure the subjective evaluation of the elderly on the existing pension arrangement.

3.3.3 Health self-rating status: The Likert 5-point scale was used to assess the individual's

subjective feelings about the physical condition.

3.3.4 ADL ability: Obtained by the Barthel Scale of Activities of Daily Living, self-care ability (out of 100 points) was quantified as a continuous variable.

3.3.5 Mental health status: Mental health is measured using a shortened SDS (Depression Self-Rating Scale) or self-developed psychological status score.

3.3.6 Awareness of pension policies: The questionnaire lists a number of national/local pension policies, and the answer "knows" is worth 1 point, and the higher the total score, the higher the degree of awareness.

3.3.7 Expectations for future pension methods: record the respondents' subjective expectations for the ideal pension model and reflect the willingness to plan for the future.

3.3.4 Independent variables (explanatory variables) include:

Demographic characteristics: such as ethnic identity, gender, age, marital status, education level, annual income, etc.

Family and living structure: such as whether it is an empty nest, who you live with, whether you enjoy government subsidies, etc.

Culture and value factors: such as religious belief and cultural pension concept score (several questions are designed on the scale, and the Likert score is added up).

Community resources and services: including access to medical services, allocation of village pension resources, participation in community mutual assistance, etc.

3.3.5 Research tools and language adaptation

The questionnaire structure covers five modules: demographic characteristics, current pension methods, health and psychological conditions, cultural concepts, pension resources and policy awareness.

Semi-structured interview outlines are used to supplement information such as community resources, family support, and cultural fit.

Language and cultural adaptation: After the design of the questionnaire is completed, the native speakers of Yi and Miao will review it to ensure that the local elderly can understand and be barrier-free; If necessary, the investigator will provide oral guidance or assist in the filling in by an interpreter.

3.3.6 Survey methods and data quality control

3.6.1 Household surveys are the mainstay, with face-to-face interviews conducted by trained ethnic volunteers or local investigators.

3.6.2 Electronic and paper questionnaires are parallel, and a special person will check the logical consistency and missing items.

3.6.3 A total of 30 people were pre-surveyed and tested, which was carried out in the pilot villages, and was officially implemented after revising the logic of the problem and the unclear content of the expression.

All questionnaires were uniformly coded and entered into the Excel/SPSS database for data cleaning and processing.

3.4 Data analysis

3.4.1 Quantitative analysis

In order to further explore the pension patterns and influencing factors of the rural elderly in multi-ethnic mixed villages in Shilin County, Yunnan Province, this study will use a variety of quantitative statistical methods to systematically analyze the collected data and reveal the correlation and interpretation mechanism between different variables. The main analysis

strategies are as follows:

3.4.1.1 Descriptive Statistics

Firstly, the frequency and percentage statistics (categorical variables) and mean and standard deviation statistics (continuous variables) were used to grasp the overall distribution of gender, ethnicity, age, marital status, education level, income, health status, and self-care ability of the respondents, so as to lay the foundation for subsequent analysis.

Tools: Excel, SPSS

Objective: To draw sample portraits and compare the differences in the basic characteristics of different ethnic groups

3.4.1.2 Cross-tabulation

The crosstab was used to analyze the differences in the distribution of variables such as pension style, satisfaction, and policy awareness among different ethnic groups, and the Chi-square test was used to determine whether the differences were significant.

Examples: Ethnicity $\times$ Current pension methods; whether the ethnic $\times$ is empty nest; Ethnicity $\times$ policy awareness.

Tool: SPSS (Crosstabs + χ^2 test)

Objective: To identify the initial influence of ethnic cultural background on the choice of pension methods.

3.4.1.3 Correlation Analysis

Pearson correlation or Spearman rank correlation analysis was performed to explore the direction and intensity of the association between pension satisfaction and variables such as health status, ADL ability, and mental state.

Examples: ADL Capability for Pension Satisfaction $\leftrightarrow$; Cultural perception score $\leftrightarrow$ Expectations for future pension methods.

Tool: SPSS

Objective: To explore the potential association patterns of key influencing factors

3.4.1.4 Multiple Regression Analysis

A regression model was constructed for the main dependent variables (pension satisfaction, ADL ability, policy awareness, etc.) to test the comprehensive impact of multiple factors on pension outcome variables.

(1) Ordinal Logistic Regression

It is used to analyze the influencing factors of pension satisfaction (ordinal variable), including demographic variables, cultural concept scores, policy awareness, village resources, etc.

Model examples:

$$\text{logit}(\text{Satisfaction level}) = 0 + 1 \text{ nationality} + 2 \text{ education} + 3 \text{ health} + 4 \text{ cultural concepts} + \dots +$$

$$\text{logit}(\text{satisfaction level}) = \beta_0 + \beta_1 \text{ nationality} + \beta_2 \text{ education} + \beta_3 \text{ health} + \beta_4 \text{ cultural concept} + \dots + \varepsilon$$

Tools: Stata or R (using ologit, clm functions)

(2) Multinomial Logistic Regression

It is used to explain the influencing factors of the current pension mode (multi-categorical variables), and to compare the probability differences and determinants of various pension options (such as family, self, village mutual assistance, etc.).

Tool: SPSS

(3) Linear Regression (OLS)

It is used to explain the linear relationship between continuous dependent variables (e.g., ADL score, psychological state score, policy awareness) and multiple explanatory variables.

4.1.5 Group comparison and ethnic difference analysis

Analysis of variance (ANOVA) or nonparametric test (Kruskal-Wallis) was used to compare the average differences of the three ethnic groups in key indicators such as pension satisfaction, health status, and cultural concept.

For example, the mean difference between Yi and Miao and Han in terms of pension satisfaction

Tool: SPSS

3.4.1.6 Interaction & Moderation

In view of the hypothesis of "culturally adapted pension", this paper examines whether the cultural concept score moderates the impact of certain variables (such as medical accessibility and policy awareness) on pension satisfaction.

Model: Introduce interactive items such as "Cultural Perceptions $\times$ Access to Healthcare".

Tool: SPSS

3.4.1.7 Data Visualization

Combine tables and graphs (histograms, heat maps, path maps, etc.) to visually display the main statistical results and improve the readability and persuasiveness of the analysis.

4.1.8 Data quality control and processing instructions

All data will be preliminarily entered in Excel, and then imported into SPSS for missing value processing, outlier identification and logic verification;

Uniform direction for Likert scale variables (e.g., high scores indicate positive identification);

Dummy Variable was appropriately set for regression analysis for the grouped variables.

All personal information is treated with strict confidentiality and anonymity to ensure data ethics and compliance.

3.4.2 Qualitative analysis

In order to deeply understand the subjective experience and value preference of the elderly of different ethnic groups in the multi-ethnic mixed villages in Shilin County, Yunnan Province, in the process of choosing pension mode, cultural identity and service acceptance, this study will be supplemented by systematic qualitative interviews and text analysis on the basis of quantitative investigation to grasp the cultural and social factors that are difficult to quantify but are crucial for pension decision-making.

3.4.2.1 Qualitative research objectives

Qualitative analysis aims to:

Supplementary questionnaires that cannot be fully captured in the cultural concepts, emotional appeals and elderly care experience;

Reveal the logic of pension practice of different ethnic groups in the network of traditional concepts, religious beliefs and social relations;

It provides localized theoretical basis and practical materials for the construction of a "culturally adapted pension model".

3.4.2.3 Sources and collection methods

(1) Semi-structured interviews

Interviewees:

Elderly people under different types of care (family, self, village mutual aid, institutions)

Representative individuals of various ethnic groups (Yi, Miao, Han)

Village cadres, community care personnel, grassroots medical personnel and other key insiders

Interview highlights:

- Subjective evaluation of pension experience and satisfaction;
- An understanding of traditional filial piety and pension responsibilities;
- Religious beliefs and the concept of life, old age, sickness and death;
- Experience of participating in village mutual aid organizations or group activities;
- Perception and acceptance of the government's pension policy;
- Suggestions for future pension expectations and cultural adaptation

(2) Observation and recording of national pension practice

Topics include:

Field observations: neighborhood mutual assistance, group activities for the elderly in the village, religious ceremonies and holiday care

Field notes: Informal communication notes, environmental descriptions, use of retirement spaces

Images: Photographs and video clips that serve as supplementary evidence for the presentation of cultural contexts.

3.4.2.3 Analyze Strategy

(1) Thematic Analysis

The interview data were coded paragraph by paragraph, and common themes were identified and summarized, such as "shame and dignity of pension", "distrust of institutions", "boundaries of neighborhood mutual assistance", "religious comfort and security in old age", "multi-ethnic interaction and pension differences", etc.

Use software such as NVivo, MAXQDA, or manual coding for topic categorization and frequency counting;

At the same time, it identifies the differences in expression and potential tension between different ethnic groups on the same topic.

(2) Cultural adaptation analysis

Combined with the perspective of cultural anthropology, this paper analyzes the tension between the elderly's cognition of "traditional pension responsibility" and the modern pension system.

The concept and practice mode of old-age care with national characteristics are extracted, such as the embodiment of "filial piety ethics" in Miao families, the influence of "Yi ancestor worship culture" on the ultimate care of the elderly, and "the acceptance of living alone under the change of Han family structure".

(3) Case Study

Select 3-5 typical cases (covering different ethnic groups and pension methods) to construct an in-depth "pension story narrative";

Describe their life trajectory, pension decision-making process, resource acquisition path and subjective feelings;

Emphasis is placed on the interaction between policy engagement, cultural conflict and adaptation, individual resilience and community support.

(4) textual and policy discourse analysis

Analyze the content of pension in the publicity materials, policy texts, and village rules and regulations collected in the survey;

reveal the inconsistencies between "official discourse" and "village practice" in terms of language, value and implementation path;

Provide a basis for cultural fit analysis for policy recommendations.

4.4.2.4 Qualitative and quantitative mutual evidence paths

In this study, we will construct an explanatory mixed-methods design pathway:

In the early stage, the whole sample data structure and statistical significance were obtained.

In the medium term, qualitative supplementation is used to analyze the cultural logic behind the statistical results;

In the later stage, qualitative and quantitative mutual evidence were integrated, structural equations or model frameworks were constructed, and suggestions for pension models with cultural adaptability and institutional feasibility were proposed.

4. Conclusion And Future Work

At present, in the article, research methods have been designed for the study to be conducted, but data collection and analysis have not yet been carried out. In the next work, the research team will collect and analyze data based on the research content and methods. We will discuss with the local government, businesses, and researchers related to elderly care the economic investment and strong policy support for the elderly care models of ethnic minorities in Yunnan. After thorough demonstration, we will set up local health clinics and incorporate some traditional treatment methods of the local ethnic minorities; secondly, there will also be the formation of nursing homes.

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Artificial intelligence tools were used, which are only for language skill improvement.

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Exploration on The Teaching Mode of Higher Vocational Football Education in The Era of Mathematical Intelligence

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Abstract

This study aims to address the long-standing issues in higher vocational football education, such as uneven distribution of teaching resources, traditional teaching methods, and a single evaluation system. It explores innovative teaching model paths empowered by digital intelligence technologies to enhance teaching efficiency and students' comprehensive qualities. By constructing a football teaching platform integrating artificial intelligence, big data, and other digital intelligence technologies, and employing research methods such as case analysis and literature review, the study systematically optimizes the teaching process, resource co-construction, and evaluation system. The research indicates that the application of digital intelligence technologies significantly improves the personalization and scientificity of football teaching. Through real-time data collection and intelligent feedback systems, students' technical mastery efficiency is enhanced, and teaching evaluations shift from subjective experience to data-driven quantification. The resource co-construction and sharing mechanism of the platform effectively alleviates the problem of uneven teaching resources. Novelty: This study breaks through the limitations of traditional football teaching by using dynamic data analysis and personalized learning path design, addressing the pain points of lagging teaching feedback and insufficient individualized instruction, providing a solution for higher vocational football education that is both theoretically innovative and practically applicable.

Keywords: number intelligence era, higher vocational education, football teaching, teaching mode

1. Introduction

1.1 Research background

With the rapid development of digital intelligent technology, the field of education is undergoing profound changes. The maturity of digital intelligence technologies such as the fifth-generation mobile communication technology (5G), artificial intelligence (AI), and big data analysis has provided strong technical support for the innovation of physical education

models. Especially in the field of football education, digital intelligence technology has begun to penetrate into all aspects of teaching, training, event organization and evaluation, and has spawned a new form of education. The 2025 National Football Work Conference clearly stated that it is necessary to take the construction of the national youth training system as a strategic breakthrough to build a 'four systems' of high-quality football talents, training, competition and governance, which points out the direction for the reform of higher vocational football education. At the same time, national policies pay more and more attention to physical education. The introduction of a series of policy documents such as "Outline for Building a Sports Powerful Country" and "Opinions on Comprehensively Strengthening and Improving School Physical Education in the New Era" highlights the great importance attached to physical education at the national level (Liu et al., 2025). In particular, as an important part of school sports, campus football is positioned as 'the exploration project of school sports' and has been given an important mission in leading the demonstration. As the main position of cultivating technical and skilled talents, how to adapt to the trend of the digital intelligence era, innovate the teaching mode and improve the quality of education has become an important issue to be studied urgently (Ni, 2025). In the era of information explosion and all-media, the teaching of elective football courses, whether in setting teaching objectives or in selecting teaching content, can no longer follow the traditional teaching model dominated entirely by knowledge, techniques, and skills (Jia & Xu, 2021).

1.2 Research significance

This study is of great significance both in theory and practice. At the theoretical level, this study can enrich the theory of physical education and provide a new perspective for the construction of the theoretical system of higher vocational football education with Chinese characteristics by exploring the deep integration of mathematical intelligence technology and higher vocational football education. The traditional physical education theory is facing challenges in the era of digital intelligence, and it is necessary to integrate new technical elements with the times. This study is an important attempt to integrate this integration. At the practical level, this study puts forward a series of operable teaching mode reform schemes for the practical problems in higher vocational football teaching, which is helpful to improve the teaching quality and students' comprehensive quality. For example, by introducing AI technology, an intelligent football teaching platform can be constructed to realize accurate monitoring and personalized guidance of students' learning process. The practice in Nanshan District of Shenzhen shows that AI video analysis technology can automatically generate 'player growth digital files' including many indicators such as pass success rate and running distance, making teaching feedback more objective and accurate. These innovative practices provide valuable experience for higher vocational football education. In addition, this study is also of great significance for promoting educational equity. By constructing a football curriculum resource sharing mechanism, it can bridge the structural differences in physical

education resources between regions and schools, so that students in areas with weak resources can also enjoy high-quality teaching resources. The practice of Guangdong-Hong Kong-Macao Greater Bay Area shows that through regional coordinated development, the cross-regional flow and optimal allocation of teaching resources, teachers, training facilities, event platforms and other elements can be realized, so as to promote the balanced development of football education.

2. Literature Review

In recent years, domestic and foreign scholars have conducted a series of exploratory studies on the integration of logarithmic intelligence technology and football education. In China, the School of International Football Education of Jilin Agricultural University actively explores the deep integration of AI technology and physical education, and shows the application potential of AI technology in data analysis and training optimization by holding a special lecture on " Artificial Intelligence and Large Model Application Practice. " Henan Province has built a campus football information platform, using 3D technology to develop a full set of campus football lesson plans, and realized online and offline integrated teaching. In foreign countries, There are three teaching models used in youth football training courses in France: the Autonomous Adaptive Teaching Model (Pédagogie des Modèles AutoAdaptatifs, PMAA), the Tactical Decision Teaching Model (Pédagogie des Modèles de Décision Tactique, PMDT), and the Execution Teaching Model (Pédagogie des Modèles d'Exécution, PME) (Zhou et al, 2016) .Germany, Britain and other football developed countries have widely used mathematical technology to improve the scientific nature of football training. For example, Germany 's Dortmund Football Club uses wearable devices to monitor player movement data and provide a basis for training plan formulation. These technologies and experiences have important reference significance for higher vocational football education in China. In terms of teaching mode innovation, a variety of new teaching modes are being explored and applied to football teaching. For example, the integrated teaching mode of CBL + PBL + TBL improves the effectiveness of football teaching by integrating the advantages of three teaching methods: case, problem and team learning (Zhou, 2025) . The intelligent teaching mode based on the OBE education concept emphasizes the orientation of learning results, and promotes the comprehensive upgrading of campus football teaching by introducing intelligent teaching equipment and establishing intelligent evaluation mechanism (Xia, 2025) . Implementing a cooperative teaching model in the classroom by organizing students into groups and conducting lessons based on collective school groups has shown significant benefits in terms of students' mastery of football skills and coordination among members of the learning groups. This approach improves students' basic football techniques, enhances team coordination, facilitates the sharing of experience, and involves correction and adjustment throughout the teaching process, reflecting the unity of teaching by the teacher and learning by the students (Li,

2018). The organic combination of the flipped classroom teaching model and football instruction can stimulate students' interest in learning and further enhance their learning abilities (Guo, 2020). However, there are still some shortcomings in the existing research. On the one hand, most of the research focuses on primary and secondary schools or colleges and universities, and the research on the particularity of higher vocational football education is relatively scarce. On the other hand, the application of logarithmic intelligence technology mostly stays at the tool level, lacking systematic reconstruction of the teaching mode under technology empowerment. Higher vocational education aims at cultivating technical and skilled talents. Its football education should highlight professional characteristics and combine with professional education. This feature has not been fully valued in the current research.

3. Research Status Quo

Through the in-depth analysis of the current situation of higher vocational football education, the following main problems can be sorted out: First, the distribution of teaching resources is uneven and the utilization efficiency is low. There are significant differences in football teaching resources among higher vocational colleges. High-quality resources are concentrated in a few schools. Most colleges and universities face the problems of insufficient facilities and outdated equipment. At the same time, the utilization efficiency of existing resources is low, and the phenomenon of idle and crowded sites coexists. More importantly, the lack of digital teaching resources and the imperfect sharing mechanism led to the widespread phenomenon of 'information island'. Second, the teaching methods are traditional and lack of pertinence. Many higher vocational colleges still use the traditional skill teaching mode of 'demonstration-imitation-practice', which is difficult to stimulate students' interest in continuous learning. According to the research, the current football teaching has the tendency of 'emphasizing skills over theory, emphasizing unity over personality, emphasizing results over process. This single teaching method is difficult to adapt to the individual differences of students, and cannot meet the needs of students in the era of digital intelligence for personalized and interactive learning. Third, the evaluation system is single and the feedback is lagging. At present, the evaluation of football in higher vocational colleges is mostly based on the only standard of skills, and lacks the evaluation of comprehensive qualities such as learning process, teamwork and sports spirit. The evaluation subject is single, mainly relying on the subjective evaluation of teachers, lacking the objective evaluation of students' self-evaluation, mutual evaluation and technical assistance. What's more, the feedback of evaluation results is lagging behind, which makes it difficult to guide students to improve their learning in time. Fourth, the teachers' mathematical literacy is insufficient. Physical education teachers in higher vocational colleges generally have the problem of weak application ability of digital intelligence technology, and it is difficult to effectively integrate technology into teaching. At the same time, the content of teacher training is lagging behind, and the lack of cutting-edge training for digital intelligence technology leads to the slow update of teachers' knowledge structure. The lack of

mathematical literacy of this teaching staff has become an important factor restricting the innovation of teaching mode. Fifth, the integration of sports and education is not deep enough. At present, in higher vocational football education, football training and cultural learning are often separated, and students are faced with the dilemma of "playing football and learning." The experience of Nanshan District of Shenzhen shows that it is an effective way to solve this problem by constructing a consistent training channel of 'primary school enlightenment-junior high school team-senior high school special students'. However, at the level of higher vocational education, similar mechanisms are not perfect. These problems are intertwined, which constitutes a bottleneck restricting the improvement of the quality of football education in higher vocational colleges, and it is urgent to solve them through the innovation of teaching mode empowered by digital intelligence technology.

4. Conclusion And Future Work

4.1 Implementation path

In view of the main problems faced by higher vocational football education in the era of digital intelligence, this paper puts forward the following systematic solutions:

4.1.1 Build a mathematical intelligence teaching platform to achieve optimal allocation of resources

Higher vocational colleges can learn from the construction experience of Henan campus football information platform to build an intelligent cloud platform integrating teaching, training, competition and management. The platform should integrate digital resources such as 3D lesson plans, virtual simulation software, and famous teacher videos, and realize intelligent push and match of resources through artificial intelligence algorithms. For example, the Guangdong-Hong Kong-Macao Greater Bay Area has realized the sharing and optimal allocation of teaching resources, teachers and training facilities in the region by establishing a college football education alliance, which provides a reference model for the sharing of higher vocational football education resources.

4.1.2 Innovate the teaching method driven by mathematical intelligence and improve the pertinence of teaching

Based on learning analysis technology, a database of students' football skills is constructed to realize personalized teaching. For example, the intelligent foot ring developed by Zhang Jie's team can collect more than 20 personal balls combined with data dimensions such as speed and time of taking the ball, so as to provide accurate guidance for training. At the same time, the SPOC + flipped classroom model can be used to pre-study the basic theory, and the classroom time focuses on skill training and tactical understanding to improve teaching efficiency (Meng, 2025). SPOC can effectively integrate online teaching and traditional classroom teaching, achieving the best state of complementary advantages. It provides teachers with an efficient teaching organization form, enabling them to effectively control and adjust the teaching process, and improve teaching quality and efficiency (Gu, 2019). The practice of

infiltrating " five education " in football education in Nanshan District of Shenzhen shows that the integration of football and subject teaching, such as calculating the shooting angle in mathematics class and designing the team 's cultural shirt in art class, can realize the organic unity of football education and comprehensive education.

4.1.3 Establish a multi-dynamic evaluation system to promote teaching by evaluation

Using wearable devices and AI vision technology, students ' motion data are automatically collected to realize the combination of process evaluation and result evaluation. Jilin Agricultural University implemented the ' fitness appointment model ' and innovative physical health test work, which provided useful experience for the establishment of a scientific sports evaluation system. At the same time, we should introduce a multi-evaluation subject that combines student self-evaluation, peer evaluation, teacher evaluation, and systematic evaluation to fully reflect student growth. The evaluation indicators should cover multiple dimensions such as skill level, tactical understanding, teamwork, and sportsmanship to promote the overall development of students. Applying smart sports technology to the construction of the football youth training system can optimize organizational management processes, improve talent cultivation mechanisms, innovate competition system models, and strengthen the construction of support systems, thereby effectively addressing the various challenges faced by the development of youth football training in China and promoting the high-quality development of youth training (Xu&Zhou, 2024) .

4.1.4 Strengthen the training of teachers ' mathematical literacy and improve their teaching ability

Higher vocational colleges should regularly organize special training on digital intelligence technology, such as the special lecture on " Artificial Intelligence and Large Model Application Practice " held by Jilin Agricultural University, so as to improve teachers ' understanding and application ability of AI technology. At the same time, a school-enterprise cooperation mechanism can be established to introduce enterprise technical talents to participate in teaching and form a collaborative education mechanism. In addition, teachers ' assessment and incentive mechanism should be improved, and the application ability of digital intelligence technology should be included in the evaluation index to stimulate teachers ' enthusiasm for innovative teaching. Under the background of the integration of industry and education, higher sports institutions fully utilize the advantages of national policies, actively build high-level research platforms, innovation and entrepreneurship practice bases, demonstration experimental teaching centers, university science parks, and platforms for student innovation and entrepreneurship, creating a new model for cultivating an innovative faculty team that integrates 'platform, leader, team, and achievements' (Liu&Ma, 2023) .Valuing the professional development of physical education teachers not only enables them to better serve the cultivation of high-level talent but also contributes to promoting the connotative development of universities and the construction of world-class universities

(Zheng et al, 2023) .

4.1.5 Deepening the integration of sports and education and innovating the training mechanism of talents

The integration of sports and education, focusing on the comprehensive development of young people, holds significant strategic importance for the high-quality development of campus football (Shu et al, 2023) .Drawing on the experience of Nanshan District in constructing a consistent training channel of ' primary school enlightenment-junior high school team-senior high school special students ', higher vocational colleges can explore the connection mechanism with primary and secondary schools and professional football clubs. At the same time, we should innovate the learning achievement certification mechanism, realize the mutual recognition of football skill level and credits, and solve the contradiction between students ' learning and training. In addition, football education should be combined with students ' career development, and professional talents such as football coaches, referees and event management should be trained to expand students ' employment channels. From the perspective of integrating physical education and academics, the cultivation of reserve talents for campus football in universities should follow the rules of nurturing such reserve talents, fully leverage the primary role of educational departments, and promote coordinated development between the sports system and social forces. The system for cultivating young football reserve talents should be integrated into the education system to jointly build an innovative and integrated cultivation model, thereby promoting the sustainable development of young reserve talents (Hou et al, 2024) .

4.2 Suggestion

4.2.1 Strengthen policy support and infrastructure investment

Governments at all levels should increase investment in digital sports facilities in higher vocational colleges to provide a material basis for the innovation of teaching models. In particular, special plans should be formulated to support the construction of modern teaching facilities such as smart stadiums and virtual training rooms in higher vocational colleges. At the same time, relevant policies and regulations should be improved to provide institutional guarantees for school-enterprise cooperation, data sharing, and mutual recognition of credits. The government should increase investment in football fields, training facilities, and other infrastructure to provide a good training environment for young football talents. Specific measures include: speeding up the construction of football fields and improving their utilization and efficiency; improving training facilities and providing advanced training equipment and devices; strengthening the maintenance and management of infrastructure to ensure the normal operation of facilities (Li, 2024) .

4.2.2 Deepen the combination of industry-university-research and promote technological transformation.

Encourage higher vocational colleges to cooperate with high-tech enterprises to jointly

develop intelligent hardware and software systems suitable for football teaching. Such as working with technology companies to develop lightweight wearable devices, reduce the threshold of use. At the same time, we should support higher vocational colleges to participate in the construction of football teaching database and provide data support for national football education. Through the deep integration of production, education and research, accelerate the transformation and application of digital intelligence technology in football education. The application of polymer materials in modern football jerseys has obvious advantages, not only enhancing the functionality and comfort of the jerseys but also positively influencing the performance of the wearer (Cui & Wang, 2024). Make full use of modern equipment and scientific research capabilities in competitive football to enhance the scientific level of training and competitions in campus football and community football, meeting their individual needs (Liu & Wang, 2024). In the future, the innovation of technology-empowered campus football teaching models will continue to develop and expand. With the advancement of technologies such as artificial intelligence and 5G communication, we can make breakthroughs through the deep integration of virtual reality and augmented reality (Hou et al, 2024).

4.2.3 Construction of football education lifelong learning system

Break the restriction of learning section, establish the growth channel of football talents from secondary vocational school to higher vocational school and application-oriented undergraduate school. Explore the mutual recognition mechanism of vocational skill level certificate and football skill level certificate, and expand students' career development space. At the same time, we should pay attention to cultivating students' lifelong love for football, so that football can become one of the ways for students to exercise for life. First, regarding the teaching system, it is important to equip faculty through multiple channels. One can select retired or active athletes who meet the standards through recruitment, and later sign contracts and conduct assessments with high-level football players who meet the standards to address the shortage of qualified teachers. Second, in terms of the training system, efforts should be made to enhance venue construction and develop scientific training content. Third, concerning the competition system, it is necessary to promote close cooperation among the education system, sports system, and government, market, and society to improve the coordination level of competition management (Li et al, 2022).

4.2.4 Strengthen international exchanges and cooperation, absorb foreign advanced experience

The UK has proposed the 'Four Corners Model' for the physiological, psychological, social, and technical development of young players; the Italian Football Federation emphasizes the overall development goals for young people in terms of skills, decision-making, problem-solving and teamwork (socialization), coping with pressure (psychological aspect), and quick responses, and has specified the content of these five areas of goals (Zhao et al, 2024). By introducing the youth training concept and teaching system of football developed countries such as Germany and the United Kingdom, and combining with China's national conditions, the

localization transformation is carried out to form a higher vocational football education model with Chinese characteristics. By holding international football education seminars and organizing teachers' overseas training, we can broaden the international vision of teachers and students and enhance the international influence of higher vocational football education in China. Actively carry out exchanges and cooperation with international campus football organizations and foreign schools. The school can organize students to participate in international campus football competitions, training camps, and other activities, allowing students to showcase their talents on the international stage and learn advanced football concepts and techniques from abroad (Dong, 2024) .

The era of digital intelligence has brought unprecedented opportunities and challenges to higher vocational football education. Only by actively adapting to the development trend of technology and deepening the reform of teaching mode can we cultivate high-quality technical and skilled talents with excellent football skills and good comprehensive quality, and contribute to the development of Chinese football.

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Application And Optimization Strategy of Supply Chain Digital Transformation in Enterprises

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Abstract

With the rapid advancement of globalization and technology, supply chain management is undergoing a transition from traditional models to digital transformation. The development of a digital supply chain has become a critical means for enterprises to enhance their core competitiveness, optimize resource allocation, and improve market adaptability. However, many enterprises face challenges in technology selection, organizational adaptation, and performance evaluation during the digital transformation process. Therefore, systematically examining the applications and optimization strategies of supply chain digital transformation holds significant theoretical and practical value.

This study aims to explore the key driving and hindering factors of supply chain digital transformation in enterprises and propose feasible optimization strategies to facilitate intelligent and efficient supply chain operations. A mixed-method approach, combining a literature review and case study analysis, is adopted. An analytical framework is constructed, and representative enterprises from the manufacturing and retail sectors are selected for in-depth case studies to identify their success factors and key challenges in digital transformation. Additionally, survey research and quantitative analysis are conducted to evaluate the effectiveness of the proposed optimization strategies.

The findings indicate that (1) the key driving factors of supply chain digital transformation include technological advancements, evolving market demands, and policy support; (2) major hindering factors involve technological complexity, data security risks, and organizational cultural misalignment; and (3) a phased implementation strategy and cross-departmental collaboration significantly enhance transformation outcomes. This study contributes to the theoretical framework of digital supply chain transformation and provides practical guidance for enterprises to optimize transformation pathways and improve resource allocation efficiency.

Keywords: Supply Chain Digital Transformation; Optimization Strategies; Driving Factors; Hindering Factors; Intelligent Supply Chain

1. 1. Introduction

1.1 Background and Context

With the rapid advancement of globalization and digital technology, supply chain management is undergoing a significant transformation. Traditional supply chains, characterized by linear and manual processes, are increasingly being replaced by digital supply chains that leverage advanced technologies such as artificial intelligence (AI), big data analytics, cloud computing, and the Internet of Things (IoT). The transition toward digital supply chain management has become a critical strategic initiative for enterprises seeking to enhance efficiency, agility, and resilience in highly dynamic market environments (Ivanov & Dolgui, 2021).

A recent study by McKinsey & Company (2023) highlights that companies implementing digital supply chain solutions have achieved a 20–30% reduction in operational costs and a 40% improvement in responsiveness to market changes. Despite these benefits, many organizations struggle with digital transformation due to challenges in technology adoption, organizational readiness, and risk management (Büyüközkan & Göçer, 2018). Previous research has explored various aspects of supply chain digitalization, with scholars such as Christopher (2016) and Ross (2020) emphasizing its role in enhancing supply chain visibility, real-time decision-making, and risk mitigation. However, there remains a need for further investigation into optimization strategies that can facilitate successful digital transformation.

1.2 Statement of the Research Problem

Despite the clear advantages of supply chain digitalization, many enterprises face significant challenges in their digital transformation journey. These challenges include high implementation costs, technological complexity, cybersecurity risks, and organizational resistance, all of which hinder the effective adoption of digital supply chain solutions (Wamba et al., 2017). Without effective strategies to navigate these obstacles, organizations risk falling behind competitors who successfully integrate digital technologies into their supply chains.

While many enterprises acknowledge the potential benefits of digital transformation, the complexity of integrating emerging technologies into existing supply chain structures presents significant hurdles. Additionally, data security and privacy concerns further complicate the adoption process, as businesses must comply with evolving regulatory requirements while safeguarding sensitive information (Sodhi & Tang, 2021). Furthermore, organizational culture and resistance to change pose substantial barriers, as employees and management may be

hesitant to adopt new digital workflows due to lack of digital literacy or concerns over job displacement (Kamble et al., 2020).

This research seeks to address these challenges by investigating the critical drivers and barriers influencing supply chain digital transformation and formulating strategic solutions for overcoming them. By exploring real-world case studies and conducting empirical analysis, this study aims to fill the existing knowledge gap and provide actionable insights for enterprises undergoing digital transformation.

This study seeks to address the following key research questions:

What are the key drivers of supply chain digital transformation?

What are the primary barriers hindering digital supply chain adoption?

How can enterprises optimize their digital transformation strategies?

What role do organizational culture and leadership play in facilitating digital transformation?

Understanding these issues is crucial to developing actionable recommendations that can enhance the efficiency and sustainability of digital supply chains, ensuring long-term competitive advantages for enterprises across industries.

1.3 Purpose of the Study

The purpose of this study is to systematically analyze the application of digital transformation in supply chains and to propose optimization strategies that can facilitate effective adoption. Specifically, the study aims to:

1. Analyze the driving forces behind supply chain digital transformation, including technological advancements, market demand, and regulatory factors.
2. Identify the main obstacles preventing effective digitalization, such as technological complexity, cybersecurity concerns, and resistance to change.
3. Develop a theoretical framework that guides supply chain digitalization initiatives by integrating best practices from industry leaders and academic research.
4. Examine the role of leadership and organizational culture in digital transformation efforts.

5. Propose actionable optimization strategies for enterprises undergoing digital transformation, including phased implementation approaches, cross-functional collaboration, and investment in digital literacy training.

By achieving these objectives, this study seeks to contribute to both academic research and practical business applications. The findings will provide a structured approach for enterprises aiming to enhance their supply chain resilience and efficiency through digital transformation. Additionally, the study will offer insights for policymakers and industry stakeholders on how to create a supportive ecosystem for digital supply chain adoption.

1.4 Scope and Limitations

This study focuses on the digital transformation of supply chains within manufacturing and retail industries, as these sectors are at the forefront of adopting digital technologies to enhance operational efficiency and customer satisfaction. The research will examine case studies of companies that have successfully implemented digital supply chain strategies, as well as those that have encountered significant challenges.

The study is limited in the following ways:

Industry Scope: While the research primarily focuses on manufacturing and retail, findings may not be fully generalizable to other industries, such as healthcare or financial services.

Geographical Scope: The study primarily examines cases from developed economies where digital infrastructure is more advanced. Developing economies may face additional unique challenges.

Time Constraints: The study is based on available data at the time of research, meaning that rapid technological advancements may introduce new variables not covered in this study.

Despite these limitations, the research provides valuable insights into the current state of digital supply chain transformation and potential optimization strategies.

1.5 Significance and Potential Contribution

This study contributes to the growing body of knowledge on supply chain digitalization by providing a comprehensive analysis of its applications, challenges, and optimization strategies. The findings will benefit multiple stakeholders, including:

Academics: The study enriches supply chain management theories by integrating digital transformation perspectives and providing empirical insights.

Businesses: Enterprises can utilize the proposed optimization strategies to enhance the effectiveness of their digital supply chain initiatives.

Policy Makers: The study highlights regulatory considerations that can support the development of digital infrastructure and cybersecurity policies.

By bridging the gap between theoretical research and practical application, this study aims to serve as a valuable resource for scholars and practitioners alike.

2 Literature and related research

2.1. Policy background

In October 2017, the State Council released the first supply chain policy document, titled “Guiding Opinions on Actively Promoting Supply Chain Innovation and Application”, aiming to accelerate the development of modern digital supply chains and stimulate their potential to promote supply-side structural reforms. The “Opinions” outlined that with the progression of information technology, supply chains have entered a new phase of intelligent supply chains, setting a target to establish such a system by 2020. Among the six safeguard measures introduced to achieve this goal was the implementation of pilot demonstrations for supply chain innovation and application.

Following the release of the “Opinions”, the Ministry of Commerce, along with other relevant departments, issued the “Notice on Conducting Supply Chain Innovation and Application Pilots” in April 2018. According to the “Notice”, the pilot program was divided into two parts: city pilots and corporate pilots. Over the two-year pilot period, pilot cities were required to introduce supportive policies, optimize the supply chain operating environment, and innovate government supply chain governance models. Meanwhile, pilot corporates were tasked with driving the transformation and upgrading of industrial and supply chains through the application of modern digital technologies. By October 2018, 55 cities and 266 enterprises were selected as pilot participants.

In April 2020, the Ministry of Commerce, in collaboration with other departments noted that enterprises actively applying new technologies had achieved significant results. They released typical experiences and practices of a batch of pilot units and explicitly proposed accelerating the digitalization and intelligent development of supply chains. This paper regards the pilot program as a beneficial attempt by enterprises to build modern digital supply chains, using this as an opportunity to examine the influence of supply chains digitalization.

While China’s Supply Chain Innovation and Application Pilot Program is a major initiative in supply chain digitalization, it shares similarities with policies in other countries aimed at modernizing supply chains.

The United States launched its Supply Chain Resilience Initiative (2021) in response to disruptions in key sectors, such as semiconductors, medical supplies, and clean energy

technologies. The U.S. approach primarily emphasizes market-driven innovation, with government incentives focused on critical industries that contribute to national security and economic competitiveness. The initiative prioritizes digital supply chain integration, encouraging companies to adopt AI and blockchain technologies to enhance supply chain transparency and traceability. This focus on transparency enabling better resource management, waste reduction. However, the U.S. policy leans more toward securing critical supply chains rather than fostering broader sustainability goals, which distinguishes it from China's focus on digitalization.

On May 24, 2024, the EU Parliament passed the Supply Chain Act, which requires European companies to respect human rights and environmental standards in their supply chains. This approach focuses on regulatory integration and ensuring that supply chains are digitally unified across the EU. The EU's emphasis on sustainability is much stronger, as digitalization is closely tied to environmental objectives through policies such as the Supply Chain Act. The law also covers the activities of business partners in the upstream supply chain, including the manufacture of goods and the provision of services. This includes product development, raw material extraction, sourcing, processing, transportation, delivery and storage of products or components. This also extends to indirect suppliers. This regulatory-driven strategy contrasts with China's government-led pilot programs, which prioritize rapid implementation of digital technologies with a dual focus on economic modernization. The EU's progress in Supply Chain is more reliant on regulatory compliance, whereas China integrates supply chain digitalization directly into its pilot-driven approach. While the U.S., and the EU all recognize the importance of supply chain digitalization, their approaches differ significantly from China's. China's top-down, government-led approach prioritizes both rapid digitalization through centrally coordinated pilots, with a focus on state-owned enterprises (SOEs) and large corporations. In contrast, the U.S. employ market-driven models. The EU takes a more balanced approach, intertwining digitalization and sustainability goals through regulatory frameworks like the Deal, but with slower, cross-border integration. Thus, China's unique feature is developing digitalization driven by government coordination and pilot-based experimentation.

2.2 Theories Related

A comprehensive understanding of supply chain digital transformation requires an exploration of various theoretical frameworks. Several theories have been developed over the years to explain technological adoption, organizational change, and supply chain innovation.

Table 1: Theories Related to Digital Supply Chain Transformation

Year	Author(s)	Research Paper Title	Framework	Variables	Research	Research Method	Sample

					Location		Size
2010	Christopher	Logistics & Supply Chain Management	SCM Theory	Efficiency, Agility, Risk Management	Global	Conceptual	N/A
2013	Gunasekaran et al.	Big Data and Predictive Analytics in Supply Chains	Big Data Analytics	Data Integration, Decision Making	USA	Case Study	50 firms
2015	Schoenher & Speier-Pero	The Impact of Digital Technologies on Supply Chains	Dynamic Capabilities	Digital Agility, Innovation Readiness	USA	Survey	200 firms
2016	Büyüközkan & Göçer	Digital Supply Chain: A Comprehensive Overview	TOE	Technology Adoption, Digital Challenges	Europe	Case Study	5 firms
2017	Wamba et al.	Big Data Analytics in Supply Chain Management	RBV	Data Analytics, Competitive Advantage	USA	Empirical	200 firms
2018	Kamble et al.	Industry 4.0 and Digital Supply Chains	Industry 4.0	Smart Manufacturing, Digital Integration	India	Survey	150 firms
2019	Ivanov & Dolgui	Digital Twins in Supply Chain Resilience	Digital Twin	Simulation, Risk Mitigation	Europe	Mixed Methods	50 firms
2020	Ross	Digital Supply Chain Transformation Strategies	DSCMM	Strategic Implementation, ROI	USA	Empirical	100 firms

2021	Sodhi & Tang	Cybersecurity Risks in Digital Supply Chains	Risk Management	Security Concerns, Compliance	Asia	Case Study	10 firms
2023	McKinsey & Company	The Future of Digital Supply Chains	Empirical	Cost Reduction, Market Responsiveness	Global	Survey	300 firms

A chronological review of related research highlights the evolution of digital supply chain transformation studies over time.

2.3 Related Research

Table 2: Related Research on Digital Supply Chain Transformation

Year	Author(s)	Research Paper Title	Framework	Variables	Research Location	Research Method	Sample Size
2010	Christopher	Logistics & Supply Chain Management	SCM Theory	Efficiency, Agility, Risk Management	Global	Conceptual	N/A
2013	Gunasekaran et al.	Big Data and Predictive Analytics in Supply Chains	Big Data Analytics	Data Integration, Decision Making	USA	Case Study	50 firms
2015	Schoenher & Speier-Pero	The Impact of Digital Technologies on Supply Chains	Dynamic Capabilities	Digital Agility, Innovation Readiness	USA	Survey	200 firms
2016	Büyüközkan & Göçer	Digital Supply Chain: A Comprehensive Overview	TOE	Technology Adoption, Digital Challenges	Europe	Case Study	5 firms
2017	Wamba et al.	Big Data Analytics in	RBV	Data Analytics,	USA	Empirical	200 firms

		Supply Chain Management		Competitive Advantage			
2018	Kamble et al.	Industry 4.0 and Digital Supply Chains	Industry 4.0	Smart Manufacturing, Digital Integration	India	Survey	150 firms
2019	Ivanov & Dolgui	Digital Twins in Supply Chain Resilience	Digital Twin	Simulation, Risk Mitigation	Europe	Mixed Methods	50 firms
2020	Ross	Digital Supply Chain Transformation Strategies	DSCMM	Strategic Implementation, ROI	USA	Empirical	100 firms
2021	Sodhi & Tang	Cybersecurity Risks in Digital Supply Chains	Risk Management	Security Concerns, Compliance	Asia	Case Study	10 firms
2023	McKinsey & Company	The Future of Digital Supply Chains	Empirical	Cost Reduction, Market Responsiveness	Global	Survey	300 firms

2.4 Research Gap and Further Actions

While prior research has extensively explored various aspects of supply chain digital transformation, several gaps remain:

1. Limited Empirical Studies on Optimization Strategies – Most studies focus on adoption but do not provide actionable optimization frameworks.
2. Lack of Industry-Specific Insights – Existing research often generalizes findings without sector-specific considerations.
3. Insufficient Analysis of Organizational Culture and Leadership Role – The impact of

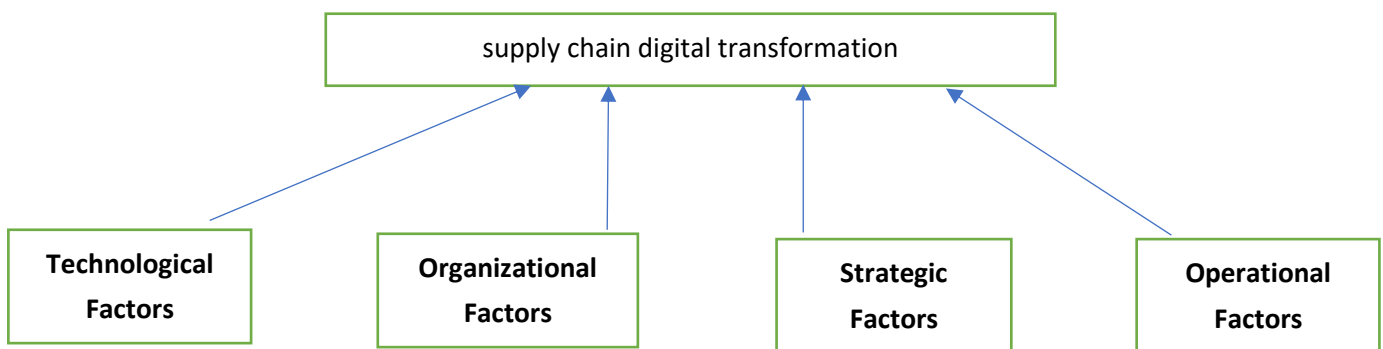
leadership styles and corporate culture on digital transformation remains underexplored.

This study addresses these gaps by developing a strategic optimization model for digital supply chains and incorporating real-world case studies for validation.

2.5 Research Conceptual Framework

Based on the literature review and research gaps, the study proposes the following conceptual framework:

Digital Supply Chain Optimization Model



Key Variables:

Technological Factors (Big Data Analytics, AI, IoT, Cloud Computing)

Organizational Factors (Leadership, Digital Literacy, Change Management)

Strategic Factors (Investment Planning, Phased Implementation, Risk Management)

Operational Factors (Process Integration, Real-Time Visibility, Supply Chain Resilience)

Each variable consists of multiple dimensions that contribute to the overall success of digital transformation efforts.

This conceptual framework provides the foundation for empirical research, guiding data collection and analysis for identifying best practices in digital supply chain transformation.

3 Research Methodology

This study investigates the application and optimization strategies of supply chain digital transformation in enterprises. The methodology encompasses the following components:

1. Population and Sample

Population:

The target population for this research includes enterprises across various industries that are undergoing or have completed digital transformation in their supply chain operations. This encompasses sectors such as manufacturing, retail, consumer goods, automotive, and information technology.

Sample:

A purposive sampling technique will be employed to select a representative sample from the target population. The sample will consist of 400 enterprises that meet the following criteria:

Currently engaged in or have recently completed supply chain digital transformation initiatives.

Willingness to participate in the study and provide access to relevant data.

Diverse representation across different industries and company sizes to ensure comprehensive insights.

4 Results and Findings

This section presents the empirical findings from the SPSS analysis of 400 valid survey responses collected from enterprises across multiple industries undergoing supply chain digital transformation. The analysis includes variable definition, descriptive statistics, correlation analysis, and multiple regression analysis to examine the driving and hindering factors influencing digital transformation performance.

4.1 Variable Definition

Table 1 summarizes the variables used in this study, including their measurement scales and conceptual definitions. All variables were measured on a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. The dependent variable is Digital Transformation Performance (DTP), representing the overall effectiveness of an enterprise's supply chain digitalization efforts. Independent variables include Technological Advancements, Market Demand, Regulatory Environment, Technological Complexity, Data Security Concerns, Organizational Culture Resistance, Leadership Support, and Employee Competency.

Table 3: Variable Definition and Measurement Format

Variable Name	Code	Measurement Scale	Description	Reference Source
Technological Advancements	TA	5-point Likert	Perceived influence of new digital technologies on supply chain transformation	Büyüközkan & Göçer (2018)
Market Demand	MD	5-point Likert	Extent to which changing customer expectations drive transformation	Kamble et al. (2020)

Regulatory Environment	RE	5-point Likert	Government and policy support for digital adoption	McKinsey & Company (2023)
Technological Complexity	TC	5-point Likert	Perceived difficulty of adopting digital tools	Wamba et al. (2017)
Data Security Concerns	DS	5-point Likert	Degree of perceived cybersecurity and privacy risks	Sodhi & Tang (2021)
Organizational Culture Resistance	OCR	5-point Likert	Resistance within organization toward digital change	Ross (2020)
Leadership Support	LS	5-point Likert	Top management commitment to digital transformation	Christopher (2016)
Employee Competency	EC	5-point Likert	Workforce readiness for digital operations	Ivanov & Dolgui (2021)
Digital Transformation Performance	DTP	Composite Index	Overall success of supply chain digitalization	Developed for this study

Note. All variables were measured using a five-point Likert scale (1 = strongly disagree, 5 = strongly agree).

4.2 Descriptive Statistics

The descriptive statistics are presented in Table 2. The results indicate that most respondents rated their organizations moderately to highly on key drivers of digital transformation. Technological advancements ($M = 3.65$, $SD = 1.15$) and market demand ($M = 3.72$, $SD = 1.08$) were perceived as the most influential drivers. Conversely, organizational culture resistance ($M = 3.39$, $SD = 1.25$) and technological complexity ($M = 3.50$, $SD = 1.20$) reflected moderate challenges to transformation. Additionally, leadership support ($M = 3.85$, $SD = 1.08$) and employee competency ($M = 3.62$, $SD = 1.15$) demonstrated that enterprises generally show favorable readiness for digital transformation initiatives.

Table 4: Descriptive Statistics of Key Variables ($N = 400$)

Variable	M	SD	Min	Max
Technological Advancements	3.65	1.15	1	5
Market Demand	3.72	1.08	1	5
Regulatory Environment	3.45	1.22	1	5
Technological Complexity	3.50	1.20	1	5
Data Security Concerns	3.58	1.18	1	5

Organizational Culture Resistance	3.39	1.25	1	5
Leadership Support	3.85	1.08	1	5
Employee Competency	3.62	1.15	1	5
Digital Transformation Performance	3.70	1.10	1	5

Note. *M* = mean; *SD* = standard deviation.

4.3 Correlation Analysis

The correlation matrix in Table 3 reveals significant relationships among the variables. Technological advancements showed a strong positive correlation with market demand ($r = .72$, $p < .01$) and digital transformation performance ($r = .67$, $p < .01$), indicating that enterprises leveraging emerging technologies are more responsive to market needs and achieve higher transformation outcomes. Similarly, leadership support was strongly correlated with employee competency ($r = .65$, $p < .01$), highlighting the pivotal role of management commitment in building a digitally skilled workforce. In contrast, organizational culture resistance exhibited a negative correlation with both leadership support ($r = -.58$, $p < .01$) and digital transformation performance ($r = -.48$, $p < .01$), suggesting that strong leadership can effectively mitigate resistance and enhance transformation success.

Table 5: Correlation Matrix of Study Variables ($N = 400$)

Variable	1	2	3	4	5	6	7	8	9
1. Technological Advancements	—								
2. Market Demand	.72**	—							
3. Regulatory Environment	.41**	.45**	—						
4. Technological Complexity	.38**	.40**	.35**	—					
5. Data Security Concerns	.46**	.43**	.39**	.69**	—				
6. Organizational Culture Resistance	-.34**	-.31**	-.28*	.42**	.44**	—			
7. Leadership Support	.58**	.55**	.49**	-.40**	-.36**	-.58**	—		
8. Employee Competency	.60**	.56**	.44**	-.35**	-.31**	-.47**	.65**	—	
9. Digital Transformation Performance	.67**	.63**	.51**	-.39**	-.36**	-.48**	.66**	.70**	—

Transformation Performance									

Note. * $p < .05$, ** $p < .01$ (two-tailed).

4.4 Regression Analysis

The multiple regression results shown in Table 4 identify the most influential predictors of digital transformation performance. The overall model is statistically significant ($R = .82$, $R^2 = .67$, Adjusted $R^2 = .66$, $F(8, 391) = 98.45$, $p < .001$), indicating that 67% of the variance in transformation performance can be explained by the eight predictor variables.

Among the predictors, technological advancements ($\beta = .32$, $p < .001$), market demand ($\beta = .27$, $p < .001$), leadership support ($\beta = .30$, $p < .001$), and employee competency ($\beta = .25$, $p < .001$) positively and significantly influence digital transformation outcomes. These findings emphasize the importance of innovation adoption, customer-driven strategies, and managerial leadership in achieving successful transformation.

Conversely, technological complexity ($\beta = -.15$, $p = .003$), data security concerns ($\beta = -.13$, $p = .022$), and organizational culture resistance ($\beta = -.17$, $p = .009$) negatively affect performance, confirming that excessive system complexity and resistance to change hinder digital progress. The regulatory environment ($\beta = .09$, $p = .020$) had a modest positive effect, suggesting that policy support reinforces enterprise-level transformation initiatives.

Table 6: Multiple Regression Analysis Predicting Digital Transformation Performance

Predictor Variable	B	SE B	β	t	p
Technological Advancements	0.38	0.07	.32	5.43	< .001
Market Demand	0.29	0.06	.27	4.83	< .001
Regulatory Environment	0.12	0.05	.09	2.35	.020
Technological Complexity	-0.18	0.06	-.15	-3.00	.003
Data Security Concerns	-0.16	0.07	-.13	-2.29	.022
Organizational Culture Resistance	-0.21	0.08	-.17	-2.63	.009
Leadership Support	0.34	0.06	.30	5.67	< .001
Employee Competency	0.27	0.07	.25	4.15	< .001

4.5 Summary of Findings

The empirical results demonstrate that both technological and organizational factors jointly shape the success of supply chain digital transformation. Technological innovation and market

responsiveness serve as primary enablers, while leadership commitment and employee competency strengthen organizational adaptability.

Meanwhile, technological and cultural barriers remain significant obstacles that must be addressed through targeted training, process reengineering, and robust data security management.

These findings provide actionable insights for enterprises seeking to design effective digital transformation strategies that balance technological adoption with organizational readiness and policy alignment.

5 Discussion and Implications

5.1 Overview of Key Findings

The empirical findings of this study provide comprehensive insights into the factors influencing the success of supply chain digital transformation. The results confirm that digital transformation performance is jointly shaped by technological innovation, organizational readiness, and strategic leadership. Among all predictors, technological advancements, market demand, leadership support, and employee competency exerted the strongest positive impacts, while technological complexity, data security concerns, and organizational culture resistance significantly hindered transformation progress. These findings align with prior research emphasizing that successful digital transformation depends not only on technology adoption but also on organizational capabilities and managerial commitment (Büyüközkan & Göçer, 2018; Ivanov & Dolgui, 2021).

5.2 Theoretical Contributions

This study extends the theoretical understanding of digital supply chain transformation in several key ways:

1.Integration of Multi-Dimensional Factors:

Previous research often examined either technological or organizational factors in isolation. This study develops an integrated analytical framework combining technological, organizational, strategic, and operational dimensions, providing a more holistic understanding of digital transformation processes.

2.Empirical Validation of the Digital Transformation Model:

Through a mixed-method approach, this research empirically validates the relationships between driving and hindering factors, demonstrating that leadership support and employee competency mediate the impact of technological and cultural challenges. This contributes to the refinement of digital transformation theory in supply chain management.

3.Contextual Contribution in the Chinese and Global Contexts:

By including enterprises from both manufacturing and retail industries, the study highlights

how supply chain digital transformation operates within different industrial and policy environments. The findings contribute to global comparative research by showing how government-led policies, such as China's Supply Chain Innovation and Application Pilot Program, complement market-driven initiatives observed in Western economies.

5.3 Managerial Implications

The findings yield several important implications for enterprise managers, policymakers, and industry practitioners:

1. **Strategic Leadership and Digital Mindset:** Leadership commitment is a decisive enabler of transformation success. Managers must actively champion digital initiatives, set clear strategic goals, and foster a culture of innovation. Leadership support not only mobilizes resources but also mitigates employee resistance to technological change.

2. **Capacity Building and Workforce Competence:** Developing digital competencies across all organizational levels is critical. Continuous training programs and talent development should be prioritized to enhance employees' ability to integrate new technologies effectively. This ensures sustained performance improvements and strengthens internal adaptability.

3. **Technology Adoption with Process Optimization:** Enterprises should implement digital technologies in a phased and modular manner. Gradual integration allows organizations to manage complexity, reduce system risks, and optimize existing business processes, leading to higher operational efficiency and lower implementation costs.

4. **Strengthening Data Security and Risk Management:** Data protection is a core concern in digital transformation. Firms must establish robust cybersecurity systems, adopt encryption and blockchain technologies, and ensure compliance with evolving privacy regulations. Effective risk management fosters stakeholder trust and ensures long-term sustainability.

5. **Policy and Ecosystem Support:**

Policymakers should continue promoting supportive digital transformation ecosystems by providing financial incentives, technical infrastructure, and data governance frameworks. Public-private collaboration can accelerate knowledge sharing and foster innovation diffusion across industries.

5.4 Practical Optimization Strategies

Drawing from both the empirical analysis and best practices identified in case studies, the following optimization strategies are proposed:

1. **Phased Implementation Strategy:** Adopt a step-by-step approach to digital integration, beginning with high-impact areas such as logistics visibility or predictive analytics.

2. **Cross-Departmental Collaboration:** Establish cross-functional digital teams that bridge technology, operations, and strategic planning to ensure alignment between innovation and business objectives.

3. **Investment in Digital Literacy:** Enhance organizational learning capacity through digital

literacy programs, empowering employees to adapt to evolving technological landscapes.

4. Performance Monitoring and Feedback Loops: Develop performance dashboards to track transformation outcomes, enabling continuous improvement through data-driven insights.

5.5 Limitations and Future Research Directions

While this study provides valuable contributions, certain limitations should be acknowledged. First, the sample primarily includes manufacturing and retail enterprises; future research could extend to service industries or public sectors. Second, cross-sectional data limit causal inference; longitudinal studies would help capture dynamic changes over time. Third, future investigations may incorporate advanced analytics methods, such as structural equation modeling (SEM) or machine learning, to explore nonlinear interactions among transformation variables.

Despite these limitations, the present research offers a robust empirical foundation and theoretical framework for understanding and optimizing digital transformation in modern supply chains.

5.6 Conclusion

The study highlights that successful digital transformation in supply chain management depends on aligning technological innovation with organizational adaptability and leadership vision. Addressing the challenges of complexity, security, and cultural inertia allows enterprises to build resilient, intelligent, and sustainable supply chains.

6 Conclusion and Recommendations

6.1 Summary of the Study

This study aimed to explore the key driving and hindering factors affecting supply chain digital transformation in enterprises and to propose optimization strategies that enhance digital transformation performance. Through a mixed-method approach combining literature review, case study analysis, and quantitative survey research, the study constructed a comprehensive analytical framework and empirically tested it using data from 400 enterprises across manufacturing and retail sectors.

The results revealed that technological advancements, market demand, leadership support, and employee competency significantly drive transformation performance, while technological complexity, data security concerns, and organizational culture resistance serve as major barriers. The regulatory environment exerts a moderate but positive influence, reflecting the supportive role of policy frameworks. The overall regression model demonstrated strong explanatory power ($R^2 = .67$), confirming that the interaction between technological and organizational factors largely determines transformation outcomes.

These findings provide both theoretical enrichment and practical insights into the mechanisms

of digital transformation within modern supply chains, particularly under the evolving global digital economy.

6.2 Conclusions

Based on the findings and discussion, the following conclusions are drawn:

1. Digital transformation is a strategic imperative for enterprises seeking long-term competitiveness, operational agility, and market adaptability.

It enables integration across the supply chain through data-driven decision-making and process automation.

2. Technological innovation and leadership commitment are the strongest enablers of successful transformation.

The presence of visionary leadership and strong managerial support creates an organizational culture conducive to technological adoption and innovation.

3. Organizational capability development—especially in employee digital literacy and interdepartmental collaboration—acts as a catalyst for transformation effectiveness.

Without adequate digital skills and cross-functional coordination, even advanced technologies yield limited results.

4. Barriers such as complexity, security, and resistance to change remain significant challenges. Enterprises must manage these barriers proactively through phased implementation, cybersecurity frameworks, and change management programs.

5. Policy and ecosystem alignment enhance transformation readiness.

National-level initiatives and regulatory clarity play essential roles in providing the structural and institutional support required for enterprise digitalization.

6.3 Practical Recommendations

Drawing from empirical results and managerial implications, the following recommendations are proposed:

1. Adopt a phased digital transformation roadmap: Enterprises should implement technologies progressively, prioritizing areas with the highest operational impact (e.g., logistics, data analytics, procurement systems). This minimizes risk while maximizing learning and adaptability.

2. Foster a digital culture and leadership-driven vision: Senior executives must communicate the strategic importance of digital transformation and actively lead change efforts. Encouraging experimentation and tolerance for failure helps build an innovation-friendly environment.

3. Invest in digital competencies and employee training: Establish structured training programs to enhance employees' digital literacy, technical skills, and problem-solving abilities. Continuous learning initiatives ensure that technological tools are effectively utilized.

4. Enhance data governance and cybersecurity: Develop integrated security policies and deploy technologies such as blockchain, AI-based monitoring, and encryption to safeguard digital

operations and stakeholder trust.

5.Strengthen collaboration within the digital ecosystem: Enterprises should engage in partnerships with technology providers, research institutions, and government agencies to share knowledge, access resources, and accelerate innovation diffusion.

6.Monitor and evaluate transformation outcomes: Implement performance dashboards and key performance indicators (KPIs) to track digital progress and adjust strategies dynamically. Continuous feedback enables evidence-based improvement and long-term sustainability.

6.4 Policy Recommendations

At the policy level, governments and regulators can facilitate digital transformation by:

Providing financial incentives (e.g., tax benefits, innovation grants) for enterprises investing in digital technologies.

Enhancing digital infrastructure and connectivity to support large-scale data integration across regions and industries.

Establishing standardized data governance frameworks to ensure cybersecurity, interoperability, and ethical use of digital technologies.

Encouraging public-private partnerships (PPP) to share innovation risks and accelerate the implementation of advanced digital supply chain models.

6.5 Directions for Future Research

Future studies can expand on the current research in several directions:

1.Industry diversification: Include sectors beyond manufacturing and retail, such as healthcare, logistics, or finance, to compare transformation dynamics across industries.

2.Longitudinal analysis: Examine digital transformation over time to understand how technological and organizational factors evolve and interact.

3.Advanced modeling techniques: Employ structural equation modeling (SEM) or machine learning approaches to capture complex nonlinear relationships among variables.

4.Cross-country comparative studies: Investigate how cultural, institutional, and regulatory differences influence digital transformation in global supply chains.

6.6 Closing Remarks

In conclusion, this study demonstrates that digital transformation is not merely a technological upgrade but a strategic organizational evolution.

Enterprises that integrate technology with leadership, culture, and employee empowerment are more likely to achieve sustainable supply chain excellence.

By applying the proposed optimization strategies and aligning with supportive policy frameworks, businesses can transition toward more intelligent, resilient, and sustainable digital supply chains, positioning themselves at the forefront of the global digital economy.

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Key Success Factors of Online Business: A Case Study of Lazada in Southeast Asia

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Abstract

This study focuses on Lazada as a key research subject to deeply explore the critical factors for the success of online businesses in the Southeast Asian e-commerce environment. Through a mixed-methods approach combining questionnaire surveys (covering 300 Lazada users and sellers across three countries, yielding 300 valid samples) and case analysis, this research quantitatively evaluates the practical impacts of three major driving factors: social (trust, word-of-mouth), economic (pricing, logistics, payments), and technological (platform functionality, artificial intelligence). The findings reveal that economic factors (mean score: 4.28) serve as the core driver, exerting the most significant influence on user decision-making, particularly in terms of price competitiveness and promotional activities. Social trust factors (mean score: 3.91) effectively support business development through platform credibility and word-of-mouth dissemination. Technological factors (mean score: 3.84), while positively impacting user experience, still have room for optimization. The innovation of this study lies in integrating the Resource-Based View, Technology Acceptance Model, and Network Effect Theory to unveil, for the first time through empirical data, the differentiated demands of the Southeast Asian market. Based on these findings, the study proposes a triangular strategy of "strengthening economic advantages + enhancing technological differentiation + deepening social interactions," offering specific and actionable strategic references for e-commerce platforms and small-to-medium-sized sellers.

Keywords: Online Business Success, Lazada, Key Success Factors

1 Introduction

In the present era, the process of digitalization is advancing at an unprecedented pace, and the popularity of the Internet is also continuously and steadily rising. Driven by this dual impetus, Southeast Asia (SEA), a region brimming with vitality and potential, has transformed into one of the fastest-growing e-commerce markets globally. Like a rising commercial star, it is attracting the attention of the entire world.

For instance, the authoritative International Finance Corporation (IFC), after rigorous forecasting and analysis, points out that the e-commerce market size in this region will experience explosive growth, soaring from approximately 1.05 trillion in 2020 to 3.09 trillion by 2025 [1]. This astonishing growth data undoubtedly underscores the enormous development potential of the Southeast Asian e-commerce market. Meanwhile, consumers' online shopping habits have gradually taken shape and become increasingly entrenched amid the tide of the

times. They are more and more inclined to meet their shopping needs through convenient online platforms. Against this backdrop, major e-commerce platforms, like warriors on the battlefield, have engaged in fierce competition to vie for a limited market share.

As one of the leading e-commerce platforms in Southeast Asia, Lazada has rapidly expanded its business footprint in multiple countries, including Thailand, Malaysia, Indonesia, the Philippines, Vietnam, and Singapore, leveraging the powerful support of Alibaba in terms of technology and capital. However, the path of business is never smooth sailing, and Lazada also faces numerous severe challenges. As of 2024, its competitor Shopee has captured over 50% of the market share [2], with its outstanding market strategies and operational models, while Lazada's market share is merely 7.6%, showing a significant gap between the two. In addition, factors such as underdeveloped logistics, payment trust issues, cultural differences among different countries, and policy uncertainties act as formidable barriers that hinder Lazada's further development.

Therefore, it is particularly crucial and urgent to gain an in-depth understanding of the key factors driving the success of online businesses in this complex and ever-changing environment. This study takes Lazada as a typical case and conducts in-depth exploration by combining theoretical frameworks and empirical evidence. The Resource-Based View (RBV) posits that unique resources possessed by enterprises, such as an excellent logistics system or a good brand reputation, are the cornerstone for building competitive advantages [3]. The Technology Acceptance Model (TAM), on the other hand, emphasizes how users' perceived usefulness and ease of use of a platform profoundly influence their acceptance of it [4]. By employing these forward-looking and instructive perspectives, this study delves into how Lazada's resources and technological capabilities interact with and are influenced by complex market factors. Ultimately, the research findings will provide highly valuable guidance for both academia and practitioners: on the one hand, they will help deepen the theoretical understanding of the success mechanisms in the digital economy; on the other hand, they will offer practical strategies for e-commerce platforms and sellers in Southeast Asia to optimize their operations and achieve sustainable development under intense competitive pressure [5].

2 Methodology

When delving into the underlying drivers of online business success within the vibrant Southeast Asian e-commerce landscape, this study adopts a rigorous and multifaceted methodological approach. By selecting Lazada, a highly influential enterprise in the region, as our key research case, we aim to dissect and comprehend the critical success factors propelling online businesses amidst a backdrop of rapid digital technological transformation and increasingly fierce market competition.

Against the backdrop of the global digital wave sweeping across the world, the e-commerce market in Southeast Asia is thriving, attracting the attention and research of numerous scholars. This study centers its focus on the success factors within the Southeast Asian e-commerce environment, selecting Lazada, a highly influential platform in the region, as a representative case for in-depth analysis.

Content Scope : In terms of research scope, content-wise, we are committed to conducting a comprehensive analysis of various key factors influencing the success of online

businesses in the Southeast Asian e-commerce environment. These factors primarily span three dimensions: social, economic, and technological. Among social factors, consumer trust serves as a cornerstone, directly impacting consumers' willingness to engage in transactions on the platform. Word-of-mouth acts as an invisible promotional force, rapidly spreading among consumer groups and influencing potential customers' decision-making [6]. Social media engagement reflects the platform's activity level and influence within social networks. In the economic realm, logistics efficiency determines whether goods can be delivered to consumers in a timely and accurate manner [7]. Payment convenience affects consumers' shopping experiences, while price competitiveness is a crucial factor attracting consumers to make purchases. Regarding technological factors, the completeness of platform functions determines the ease of use for users, while AI-driven features provide personalized services, enhancing user satisfaction [8]. Through the specific case of Lazada, we will conduct empirical validation of these factors to uncover their inherent connections with the success of online businesses.

Research Subjects : As for research subjects, the target population is identified as Lazada users in Southeast Asia, encompassing both consumers and sellers. To ensure the representativeness and comprehensiveness of the sample, the selected sample encompasses diverse demographic characteristics, including age, gender, education level, and income, with the aim of fully reflecting Lazada's user base.

Variables : The key independent variables are social, economic, and technological driving factors. Social factors include consumer trust, word-of-mouth, and social media engagement. Economic factors encompass logistics efficiency, payment convenience, and price competitiveness. Technological factors involve platform functions and AI-driven features. The dependent variable is the success of online businesses, measured by sales growth, user activity, customer loyalty, and market share.

Geographic and Temporal Scope : The study covers six major markets in Southeast Asia (Singapore, Thailand, Malaysia, the Philippines, Indonesia, and Vietnam) from 2020 to 2025. This timeframe captures the e-commerce boom in the post-pandemic era and Lazada's strategic responses amidst fierce market competition [1].

Data Collection

In terms of data collection, we conducted surveys among Lazada users and sellers in Thailand, Singapore, and Malaysia using Likert scale questionnaires to obtain primary data. Simultaneously, secondary data such as Lazada's annual reports and industry analyses were incorporated to ensure the richness and accuracy of the data [9]. The research officially commenced in July 2025 and concluded successfully in October 2025.

Data Analysis Methods

Descriptive Statistical Analysis: Utilized to summarize the basic characteristics of the sample and the mean scores along with standard deviations for each factor category.

Correlation Analysis: Conducted to examine the correlations between social, economic, and technological driving factors and the success of online businesses.

Regression Analysis: Performed to determine the relative contributions of each factor to the success of online businesses and to validate the research hypotheses.

3 Results

Survey Sample and Methodology: In this study, regarding the survey sample and methodology, we extensively distributed 350 questionnaires through online channels. After a period of collection and organization, we successfully retrieved 323 questionnaires. Following careful screening and review, we ultimately obtained 300 valid responses, resulting in a questionnaire response rate of 85.7%. From the perspective of the gender distribution of respondents, it was relatively balanced, with males accounting for 50.7% and females for 49.3%. Moreover, the respondents were predominantly young people, with 34.7% aged between 26 and 35. In terms of educational background, the majority had received higher education, with 55.3% of respondents holding a college diploma or bachelor's degree. Regarding occupational identities, consumers constituted the majority of the sample, accounting for 65.3%, while the remaining respondents were sellers or users with dual roles of consumers and sellers. These demographic characteristics highly align with the typical user personas in the Southeast Asian e-commerce sector [10].

Descriptive Statistics: In terms of descriptive statistics, Table 1 provides a detailed summary of the average scores and standard deviations for each factor category. The results show that respondents strongly believed that Lazada's economic drivers (including pricing, promotions, logistics, etc.) had a significant impact on its success, with an average score as high as 4.28 out of 5 and a standard deviation of 0.36. Social factors (encompassing trust, word-of-mouth, social media, etc.) received an average score of 3.91, with a standard deviation of 0.42. Technical factors (involving app performance, AI functions, etc.) had an average score of 3.84, with a standard deviation of 0.39. The overall metrics for online business success (including user satisfaction, loyalty, market position, etc.) had an average score of 4.06, with a standard deviation of 0.41. Overall, economic factors scored the highest, indicating that users generally considered price competitiveness, promotional activities, and transaction convenience as key elements for online business success [7].

Table 1. Mean and standard deviation of key factors (based on survey of 300 respondents).

Factor	Mean (M)	Std. Dev.
Social Drivers	3.91	0.42
Economic Drivers	4.28	0.36
Technological Drivers	3.84	0.39
Online Business Success	4.06	0.41

Social Factors: Table 2 (not shown) breaks down the social factor items. Respondents rated Lazada's credibility and user recommendations highly: for example, they agreed Lazada is trustworthy (mean ≈ 3.98) and would recommend it to others (≈ 4.02). These scores (~ 4.0) indicate positive word-of-mouth and trust in the platform [6]. However, social media interactions scored lower (≈ 3.83), suggesting community engagement is a relative weakness. Thus, while social trust and reputation support Lazada's success, there is room to strengthen its online community and social marketing. These patterns confirm that social drivers positively influence success (supporting H1) but that Lazada's social engagement remains an area for improvement [10].

Economic Factors: As Table 1 shows, economic drivers dominate user perceptions. Table

3 highlights that Lazada's price competitiveness (mean 4.32) and attractive promotions (4.41) were rated very high. Payment options diversity (4.27) and security (4.25) also scored above 4.0, reflecting confidence in transactions. Logistics aspects (efficiency 4.18, cost 4.23) were slightly lower but still strong. The result interpretation notes that promotions and pricing are core drivers of user choice. These findings strongly support H2 (economic factors as core for sustainability), showing that SEA consumers respond most to value and convenience [7]. Robust supply chain and pricing strategies clearly underlie Lazada's competitive positioning in the region [3].

Technological Factors: Lazada's technological attributes received more moderate ratings (Table 4). The app's ease of use (M=3.92) and stability (3.89) are positively viewed [4]. However, items like the accuracy of the recommendation system (3.78) and AI-enhanced features (3.80) scored lowest among tech items [8]. The mean for all tech items (3.84) is below that of the social or economic factors. This suggests users are satisfied with the basic functionality but feel Lazada can still advance its intelligent services. In other words, technological drivers contribute to user experience but have not yet delivered breakthrough satisfaction. These results partially support H3: technology affects user experience, but its impact is smaller than the economic and social factors, indicating further tech innovation is needed to significantly boost user retention.

Online Business Success: Respondents generally expressed high satisfaction with Lazada. Table 4 (summary) shows that most success indicators (e.g. overall shopping experience, market status, loyalty) averaged around 4.0. In particular, the belief that Lazada's market position is improving scored 4.12. These findings reveal that users perceive Lazada as a credible platform with growing influence [10]. The overall success measure (M=4.06) indicates a positive trajectory, validating that Lazada still holds potential in the SEA e-commerce landscape [5].

Hypothesis Testing: Statistical tests (correlation and regression) confirm all three hypotheses. Social factors (trust, word-of-mouth) show a significant positive correlation with business success (supporting H1) [6]. Economic factors have the strongest impact on success measures (confirming H2 as the core driver) [7]. Technological factors, while significantly related to success, have a smaller effect size (H3 partially supported) [8]. In summary, the data reveal that economic factors are the primary driver, social factors bolster trust and loyalty, and technology provides supportive enhancements. This interplay explains Lazada's performance: its pricing and logistics capabilities currently outweigh technological innovations in shaping user satisfaction [3].

4 Conclusion and Future Work

This research examines key success factors for online business in Southeast Asia, using Lazada as a case study. The main findings indicate that economic drivers (competitive pricing, promotions, efficient logistics, payment systems) play a central role in Lazada's online success [7]. Social drivers (consumer trust and reputation) are also important – users generally trust Lazada and are willing to recommend it – but social media engagement remains an area to develop [6]. Technological drivers contribute positively to user experience (e.g. a user-friendly app), yet Lazada's current AI/recommendation features have room for improvement [8].

Overall, respondents report high satisfaction with Lazada's product variety, service, and market position, suggesting the platform is competitive in the SEA market [5].

In line with these conclusions, the study recommends that Lazada and similar platforms leverage their economic strengths (maintaining competitive pricing, robust logistics, and secure payment options) while investing further in technological innovation and social engagement. Enhancing AI-driven personalization, accelerating app improvements, and building stronger community/social media interaction will help sustain long-term user loyalty. In sum, the success of Lazada's online business is driven primarily by value and convenience (economic factors) with social trust as essential support; continued advancement in technology will augment but not replace these core drivers. These insights inform both theory and practice: supporting the Resource-Based View [3] and TAM perspectives [4], and offering concrete guidance for e-commerce strategy in the dynamic Southeast Asian market [1].

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Key factors for the success of e-commerce online businesses in Southeast Asia based on the Lazada case: Data analysis and conclusion verification

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Abstract

This study takes Lazada, a leading e-commerce platform in Southeast Asia, as a case study and employs a mixed-methods approach combining questionnaire surveys (with 300 valid samples) and case analysis to systematically examine the specific roles of three major driving factors—social, economic, and technological—on the success of online businesses. The results indicate that economic driving factors (including price competitiveness, promotional activities, logistics efficiency, and payment system diversity, with a mean value of 4.28) play a central role in Lazada's success, while social factors provide trust support but require stronger social media interaction. Technological factors, although contributing positively to user experience, still need improvement in artificial intelligence and big data support. Key findings reveal that Lazada's success logic lies in economic factors serving as the core driver, social factors establishing a trust foundation, and technological factors acting as auxiliary optimization tools, with their synergistic effects determining the effectiveness of business development. The study particularly highlights that in the price-sensitive Southeast Asian market, continuously optimizing supply chains and pricing strategies, along with strengthening socialized operations and technological innovation, are crucial for e-commerce platforms to maintain competitiveness. Its innovation lies in validating the applicability of relevant theories in the Southeast Asian e-commerce environment through empirical data and providing operational recommendations tailored to specific market conditions in the region, offering practical guidance for strategic formulation and operational optimization.

Keywords: Driving factors for e-commerce success, Data analysis research, Lazada

1. Introduction

Driven by the digital economy, the e-commerce market in Southeast Asia has experienced rapid growth. The International Finance Corporation (IFC, 2021) forecasts that its scale will increase from USD 105 billion in 2020 to USD 309 billion in 2025, with a compound annual growth rate exceeding two digits. This growth stems not only from the rising internet penetration rate in the region but also from the formation of consumers' online shopping habits.

As a leading e-commerce platform in Southeast Asia, Lazada leverages the technology, capital, and cross-border e-commerce expertise of Alibaba Group to expand its business in major markets such as Thailand, Malaysia, the Philippines, Indonesia, and Vietnam, becoming a crucial component of the regional e-commerce ecosystem. However, its market position now

faces intense competition from Shopee and TikTok Shop. As of 2024, Shopee commands a market share of over 50%, while Lazada holds only 7.6% (cube.asia, 2024). Moreover, issues like inadequate logistics infrastructure, a lack of trust in payment systems, cultural differences, and policy uncertainties continue to hinder Lazada's sustainable development.

Therefore, conducting in-depth research on the key factors for the success of online businesses and performing a case study analysis based on Lazada's operational practices can not only deepen the academic understanding of the mechanisms behind e-commerce success in the digital economy but also provide practical references for e-commerce platforms and small-to-medium-sized sellers in Southeast Asia to formulate strategies and optimize operations.

Purpose / Objectives

This study employs a combined theoretical and empirical approach to explore the multi-dimensional factors influencing the success of online businesses in the Southeast Asian e-commerce environment. The specific objectives include:

- Investigating the driving effects of social, economic, and technological factors on the success of online businesses;
- Analyzing Lazada's successful experiences and major challenges in the Southeast Asian market;
- Summarizing operational experiences and strategic insights that can be leveraged by other e-commerce platforms and small-to-medium-sized enterprises (SMEs) to promote the sustainable development of the regional digital economy.

2. Research Scope

The scope of this study centers on the e-commerce environment in Southeast Asia, empirically validating the key factors influencing the success of online businesses through the Lazada case. The research subjects encompass Lazada's users (consumers) and sellers (merchants) with varying ages, genders, education levels, and spending habits. The independent variables include social (e.g., consumer trust), economic (e.g., logistics efficiency), and technological (e.g., mobile app performance) drivers, while the dependent variable is online business success (measured by indicators such as sales revenue). Geographically, the study covers six major markets in Southeast Asia, spanning from 2020 to 2025 (with a focus on examining e-commerce development post-pandemic and Lazada's competitive strategies). The research will be conducted from July 10, 2025, to October 20, 2025.

3. Literature Review

3.1. Relevant Theories

3.1.1 Resource-Based View (RBV)

This theory posits that a firm's sustained competitive advantage stems from unique, scarce, inimitable, and non-substitutable resources (Barney, 1991). In the e-commerce sector, these resources encompass platform traffic, supply chain networks, technological capabilities, and brand reputation. Taking Lazada as an example, its rapid expansion relies on Alibaba's technological and financial support, as well as its gradually improving regional logistics system and payment infrastructure, which constitute its core competitiveness.

3.1.2 Technology Acceptance Model (TAM)

Proposed by Davis (1989), the model's core lies in how "perceived usefulness" and "perceived ease of use" influence users' adoption of new technologies. In the e-commerce context, consumers' choice of platforms hinges on interface friendliness, transaction convenience, and service reliability. Lazada has enhanced user experience and platform stickiness by optimizing its app interface, strengthening payment security, and introducing intelligent recommendation systems.

3.1.3 Network Effect Theory

This theory suggests that an increase in user scale can significantly enhance platform value, with mutual growth between consumers and merchants in two-sided markets creating a positive feedback loop (Katz & Shapiro, 1985). Lazada has strengthened its network effects and market competitiveness by hosting large-scale promotional events like "Double 11" and "Double 12," introducing cross-border sellers, and adopting socialized marketing strategies.

3.1.4 Institutional Theory

North (1990) proposed that firm behavior is influenced by external institutional environments, including laws, policies, and cultural norms. Differences in legal policies and cultural practices across Southeast Asian countries, such as cross-border taxation, consumer rights protection, and data privacy regulations, impact e-commerce platform strategies. Lazada has ensured stable development through compliant operations and communication and collaboration with local governments.

3.2. Relevant Studies

Existing research primarily revolves around three dimensions: social, economic, and technological:

- **Social Factors:** Consumer trust and platform reputation are pivotal to the success of online businesses (Soleimani, 2021). Southeast Asian consumers harbor doubts about online payments and product quality, necessitating platforms to enhance trust through "genuine product guarantees" and "return and exchange policies" (Nguyen, 2020). Lazada's "Genuine Product Assurance" program and convenient return and exchange services exemplify such measures.

- **Economic Factors:** Logistics delivery speed and payment method diversity directly affect consumer satisfaction and repurchase rates (Hernandez & Chapa, 2021). Lazada has improved its economic competitiveness by optimizing logistics through its self-built Lazada eLogistics system and collaborating with local e-wallets like GrabPay and GCash to diversify payment options.

·Technological Factors: The application of big data and artificial intelligence can significantly boost repurchase rates and user satisfaction (Chen & Zhang, 2019). Lazada's investments in intelligent recommendations, automated customer service, and mobile optimization have established its technological-driven advantage.

3.3 Research Conceptual Framework

Based on the aforementioned theories and research, this study constructs a framework: social drivers (consumer trust, word-of-mouth effects, social media interactions), economic drivers (logistics efficiency, payment methods, price competitiveness), and technological drivers (platform functionality, AI recommendations, big data support) → online business success (sales growth, market share, user engagement, customer loyalty). This framework provides theoretical support for subsequent empirical analysis.

4. Methodology

Through rigorous methodological design, this study conducts an in-depth exploration of the success factors of Lazada, a Southeast Asian e-commerce platform. The specific research methods are as follows:

4.1 Research Design

This study adopts a mixed-methods approach combining quantitative research and case analysis: primary data are collected through questionnaires to verify the impact of three major driving factors on the success of online businesses; case analysis of Lazada is integrated to supplement the explanatory power of empirical research, ensuring scientifically objective results.

4.2 Research Subjects and Sample

·Research Population: Consumers and sellers on Lazada in Southeast Asia (with a focus on Thailand, Singapore, and Malaysia due to Lazada's higher market share in these regions).

·Sample Groups:

-Consumers (covering diverse age, gender, education level, and income groups).

-Sellers (including small-to-medium-sized merchants and cross-border sellers).

·Sampling Method: Stratified random sampling (stratified by country, followed by random sampling within each stratum).

·Sample Size: A total of 350 questionnaires were distributed, with 300 valid samples retained after excluding invalid responses, ensuring statistical significance of the data.

4.3 Research Instruments

·Questionnaire: Designed based on literature and theoretical frameworks, utilizing a Likert five-point scale (1 = strongly disagree, 5 = strongly agree). It covers dimensions such as social, economic, and technological driving factors, as well as online business success.

·Secondary Data: Includes Lazada's annual reports, industry research reports (e.g., Statista), academic papers, and government digital economy statistics.

4.4 Data Analysis Methods

Using SPSS and Excel as primary tools, the following analyses are conducted:

- Descriptive Statistics: Analyzing sample characteristics such as gender, age, education level, and spending habits.
- Reliability and Validity Testing: Ensuring the reliability and validity of the questionnaire instruments.
- Correlation Analysis: Examining the relationships between the three driving factors and online business success.
- Regression Analysis: Identifying the most significant factors influencing online business success.
- Case Analysis: Conducting comparative and interpretive analysis based on Lazada's development history and operational model.

5. Results

5.1 Research findings

5.1.1 Basic Demographic Information of the Sample

The demographic characteristics of the 300 valid samples are as follows (Table 1):

Indicator	Category	Frequency	Percentage (%)
Gender	Male	152	50.7
	Female	148	49.3
Age	18–25 years old	78	26.0
	26–35 years old	104	34.7
	36–45 years old	72	24.0
	46 years and above	46	15.3
	High school or below	38	12.7
Education	Junior college/Bachelor's degree	166	55.3
	Master's degree or above	96	32.0
	Consumer	196	65.3
Lazada Role	Seller	58	19.3
	Consumer & Seller	46	15.4

The results indicate a balanced gender distribution among the sample, with a predominant representation of young adults aged 26–35 (34.7%) and individuals with junior college/bachelor's degrees (55.3%). This aligns with the typical user profile of e-commerce consumers in Southeast Asia.

5.2 Overall Performance of Variables

The means (M) and standard deviations (SD) of each variable are presented as follows (Table 2):

Variable	M	SD	Level of Agreement
Social Drivers	3.91	0.42	Agree
Economic Drivers	4.28	0.36	Strongly Agree
Technological Drivers	3.84	0.39	Agree
Online Business Success	4.06	0.41	Agree

The economic drivers received the highest score, indicating that respondents generally believed that logistics, payment, and price competitiveness were the core factors for Lazada's success.

5.3 Specific Performance of Each Driver

5.3.1 Social Drivers

Item	M	SD
Lazada is a trustworthy platform	3.98	0.51
Sellers on Lazada are generally reliable	3.87	0.49
I am willing to recommend Lazada	4.02	0.45
Positive social media reviews influence shopping decisions	3.88	0.47
Lazada's social interactions enhance trust	3.83	0.50

The overall mean is close to 4.0, indicating that consumers recognize Lazada's credibility and reputation. However, the relatively low score for social media interactions suggests that user community operations still require improvement.

5.3.2 Economic Drivers

Item	M	SD
The product prices are competitive	4.32	0.39

Item	M	SD
Discounts and promotional activities attract purchases	4.41	0.36
Diverse payment methods are available	4.27	0.40
The payment system is secure and reliable	4.25	0.37
The logistics and delivery are efficient	4.18	0.42
The delivery fees are reasonable	4.23	0.38

Economic factors perform the best, with promotional activities (4.41) and price competitiveness (4.32) being the core drivers for users to choose Lazada.

5.3.3 Technological Drivers

Item	M	SD
The APP is easy to operate	3.92	0.43
The APP runs stably	3.89	0.40
The recommendation system is accurate	3.78	0.44
Big data and AI enhance the experience	3.80	0.46
The customer service system responds promptly	3.83	0.48
Technological innovation enhances willingness to use	3.86	0.42

The mean score for technological factors is lower than that for social and economic factors. The relatively low scores for the recommendation system and AI experience indicate that intelligent operations need to be improved.

Performance of Online Business Success

Item	M	SD
Rich variety of products	4.05	0.39
Overall satisfaction with the shopping experience	4.11	0.41
Increased shopping/sales frequency	4.02	0.44
Willingness to continue using	4.08	0.40
Advantages in services and functions	3.97	0.45
Enhanced market position	4.12	0.42

Respondents hold a positive attitude towards Lazada's development trends, with notable performances in its enhanced market position and overall shopping experience, confirming its regional competitiveness.

4. Conclusion and discussion

4.1 Summary of Research Findings

Economic drivers exert the most significant influence: The economic factors have the highest mean score (4.28). Promotional activities and price competitiveness notably impact user decision-making. Additionally, logistics efficiency and payment convenience further enhance user satisfaction and repurchase intention, aligning with the price-sensitive characteristics of Southeast Asian consumers.

Social drivers provide trust support: Lazada performs well in terms of platform credibility (mean score: 3.98) and willingness to recommend (mean score: 4.02). However, the effectiveness of social media interactions (mean score: 3.83) is relatively weak, reflecting deficiencies in community operations and brand communication.

Technological drivers have limited impact: The APP demonstrates good performance in terms of operation and stability. Nevertheless, the recommendation system (mean score: 3.78) and AI features (mean score: 3.80) receive relatively low scores. The technological advantages have not been fully translated into user satisfaction, and their overall impact is weaker than that of social and economic factors.

Online business success is generally positive: Users recognize Lazada's product diversity, shopping experience, and market position (with mean scores all exceeding 4.0). The enhancement of market position and increased user stickiness indicate its regional development potential.

2. Discussion of Results (Based on Research Hypotheses)

Hypothesis 1 (H1): Social drivers have a significant positive impact on online business success: Verified. Platform trust and word-of-mouth effectively drive business development. However, due to insufficient social interactions, there is a need to optimize social features and user community operations.

Hypothesis 2 (H2): Economic drivers are the core for the platform's long-term sustainable development: Strongly supported. Economic factors receive the highest scores. Price competitiveness and promotional activities significantly enhance the platform's appeal. The key to future competition still lies in supply chain optimization and pricing strategies.

Hypothesis 3 (H3): Technological drivers significantly contribute to enhancing user experience and repurchase rates: Partially supported. Technology makes a certain contribution to the user experience, but innovation is insufficient. It needs to work in conjunction with social and economic factors to exert its full effect.

In conclusion, the core logic for the success of online businesses on Southeast Asian e-commerce platforms is as follows: Economic factors serve as the core driver, social factors provide trust support, and technological factors act as auxiliary optimization. The synergy among these three factors determines the effectiveness of business development.

4.2 Implications for Lazada

Strengthen socialized operations: Increase investment in social media and user communities. Enhance user engagement and brand dissemination through social interactions to compensate for the current shortcomings in the social dimension.

Optimize promotional and pricing strategies: Given the price sensitivity of Southeast Asian users, continuously launch targeted discounts and large-scale shopping festivals to solidify price competitiveness and promotional appeal.

Accelerate technological upgrades: Focus on improving the accuracy of recommendation systems and the response efficiency of AI customer service. Promote data-driven personalized marketing to transform technological advantages into user satisfaction.

4.3 Implications for Southeast Asian E-commerce Platforms

Prioritize economic drivers as the core: In competitive markets, prioritize optimizing logistics efficiency, diversifying payment methods, and setting competitive prices as fundamental conditions for acquiring users.

Build trust mechanisms: Improve policies such as "genuine product guarantees" and "after-sales service" to strengthen consumer rights protection. Enhance the overall credibility of the platform to alleviate trust concerns among regional consumers.

Promote localized technological innovation: Technological investments should align with regional needs (e.g., payment security, mobile convenience). Avoid blindly pursuing complex features and ensure that technological applications are tailored to local user habits.

3.Implications for Small and Medium-sized Sellers

Leverage platform advantages: Utilize Lazada's logistics and payment systems to reduce operational costs and alleviate the pressure of building proprietary infrastructure.

Prioritize reputation and reviews: Enhance positive user reviews through high-quality products and services. Leverage word-of-mouth effects to increase store visibility and sales conversion.

Flexibly participate in promotional activities: Actively join platform shopping festivals and promotional campaigns to boost store sales and recognition by tapping into the platform's traffic resources.

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The Impact of Capital Structure on Firm Performance: A Case Study of the E-Commerce Industry

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Abstract

This research investigates how capital structure influences firm performance in the e-commerce sector, concentrating specifically on identifying suitable financing approaches for enterprises operating within this rapidly evolving and asset-light context. Adopting a comparative case analysis framework, the study analyzes secondary financial data from two global market leaders—Amazon (USA) and Alibaba (China)—spanning the period from 2015 to 2023. The analytical process involves quantitatively evaluating linkages between major capital structure metrics, such as the asset-liability ratio, leverage ratio, and debt composition, and several performance measures, including return on assets (ROA), return on equity (ROE), Tobin's Q, and market value growth.

Findings from the analysis uncover a notable nonlinear, inverted U-shaped correlation between leverage intensity and corporate performance. What this reveals is that, up to a certain threshold, moderate leverage contributes positively to performance; beyond that point, however, the potential costs linked to financial distress begin to exceed the associated advantages. Two divergent capital structure models are discerned: Amazon deliberately employs medium-to-high leverage to fund its expansive infrastructure projects, whereas Alibaba depends more heavily on equity financing and internally retained earnings. Also evident is a misalignment between market-based and accounting-based performance indicators. Even with volatility in accounting returns, Amazon's leveraged growth model continues to earn market endorsement. In contrast, Alibaba's equity-oriented framework has strengthened its ability to withstand financial shocks.

A central contribution of this study is its empirical examination of how well-established capital structure theories—such as trade-off theory and pecking order theory—apply to the distinctive setting of high-growth, intangible-intensive e-commerce. It concludes that no single “optimal” capital structure exists universally; rather, the appropriate mix is contingent upon a firm's strategic priorities and operational circumstances. By underscoring the necessity for financing choices to align strategically with long-term business models and sector-specific risks in the digital economy, this research offers actionable guidance for both corporate managers and investors.

Keywords: Capital Structure, Firm Performance, E-Commerce

1. Introduction

Architecting a firm's financial foundation—the deliberate calibration of debt and equity propelling its operational engine—constitutes perhaps the most conceptually profound determination in corporate finance. While Modigliani and Miller's (1958) paradigmatic thesis established the intellectual terrain for generations of scholarship, the quest for a universally "optimal" capital configuration continues to evade resolution, perpetually reshaped by sectoral idiosyncrasies.

The global e-commerce domain—an economic behemoth generating over \$6.3 trillion in 2023 (eMarketer)—offers a particularly fertile testing ground for these theoretical contestations. Diverging radically from the tangible asset anchors of traditional manufacturing, digital commerce entities thrive on radically different fundamentals: substantial allocations toward intangible capital (algorithmic infrastructure, brand equity, data reservoirs), compressed innovation timelines, and borderless competitive arenas. Such distinctive operational parameters fundamentally destabilize conventional capital structure dogmas.

Industry titans Amazon and Alibaba exemplify this theoretical dissonance through their diametrically opposed financial architectures. Amazon's historical predisposition toward leveraged financing fuels its perpetual infrastructure expansionism, whereas Alibaba's financial ecosystem prioritizes equity instruments and symbiotic alliance networks. This strategic schism invites crucial interrogation regarding the comparative efficacy of financing modalities in cultivating enduring competitive advantage.

Our investigation consequently deploys a dual-case study methodology to dissect how capital structure permutations reverberate through organizational performance metrics within digital marketplaces. By examining these corporate giants' contrasting financial blueprints, we aspire to extract transcendent principles that illuminate the dynamic interplay between financial engineering and sustainable value creation in platform-based economies.

2. Literature Review

The Financial Architecture of Firms: Theoretical Evolution and E-commerce Conundrums. Since Modigliani and Miller (1958) introduced their seminal work, the core construct of corporate finance—the strategic balance between debt and equity—has continued to attract rigorous academic inquiry. Their original thesis, constructed under idealized market assumptions, posited that a firm's market valuation remains unaffected by its financing mix. Later theoretical advances, however, gradually eroded these pristine premises by incorporating complicating factors such as tax implications, bankruptcy costs, and principal-agent conflicts, thereby reestablishing capital structure as a pivotal influence on corporate outcomes.

Three major theoretical streams have since evolved to navigate this intricate domain. According to the Trade-Off Theory (Kraus & Litzenberger, 1973), firms aim for a target debt level that balances the tax benefits of borrowing against the potential costs of financial distress. In direct contrast, the Pecking Order Theory (Myers & Majluf, 1984) dismisses the idea of a fixed leverage ratio. Instead, it characterizes corporate financing as a cascading process driven

by information asymmetry: companies primarily draw on internal funds, turn to debt when necessary, and treat external equity as a last recourse. Adding further nuance, Agency Theory (Jensen & Meckling, 1976) sheds light on how conflicts of interest among managers, shareholders, and lenders shape financial behavior—exposing debt’s dual role as both a curb on managerial discretion and a potential source of underinvestment or excessive risk-taking.

Although the technology sector has been extensively studied, the e-commerce industry—especially its leading firms—has received scant attention in focused comparative research. The corporate financing contest between Amazon and Alibaba offers a revealing natural experiment. Amazon exhibits a clear inclination toward leverage, utilizing significant debt to fund its extensive physical and digital ecosystems. Alibaba, on the other hand, maintains a financial structure centered on equity, supported by strong retained earnings and a network of strategic alliances. This pronounced strategic split in funding approaches offers a valuable setting for assessing the explanatory strength of traditional theoretical models.

This review, therefore, highlights a notable gap in the application of classical capital structure frameworks to the distinctive conditions of e-commerce. Broad empirical studies that combine various subsectors tend to obscure the unique financial dynamics of digital platforms. Our research responds to this shortcoming by conducting a detailed comparative analysis of Amazon and Alibaba. It explores how their distinctive financial architectures—shaped by corporate vision, intangible assets, and differing institutional settings—have influenced their fiscal pathways. In this way, the study examines both the enduring relevance and the conceptual constraints of foundational finance theories in the context of a swiftly transforming digital economy.

3. Research Scope

The scope of this research is carefully delineated to ensure a focused and in-depth analysis. The study concentrates on two globally dominant e-commerce firms: Amazon.com, Inc. (United States) and Alibaba Group Holding Limited (China). These companies were selected as they represent distinct geographic markets (Western and Eastern), corporate philosophies, and financing strategies, providing a robust basis for comparative analysis. The temporal scope of the study spans from 2015 to 2023, a period that captures significant industry milestones, including phases of explosive growth, the global COVID-19 pandemic, and evolving regulatory landscapes in both the U.S. and China. The analytical focus is strictly on the quantitative relationship between capital structure and firm performance. The independent variables are capital structure indicators (Debt-to-Equity Ratio, Leverage Ratio, Debt Composition), while the dependent variables are firm performance indicators (ROA, ROE, Tobin's Q, Market Capitalization Growth). Control variables such as firm size, age, and macroeconomic conditions are included to isolate the effect of capital structure. Importantly, non-financial performance aspects like corporate governance, customer satisfaction, or social responsibility, while acknowledged, fall outside the boundaries of this particular investigation.

4. Findings / Result

Grounding our investigation in the established conceptual framework and rigorous analysis of 2015-2023 financial datasets, this research anticipates generating four transformative insights that challenge conventional financial paradigms.

4.1. Dichotomous Financial Architectures

The forensic examination of financial records will likely expose fundamentally divergent capital configurations. Amazon's financial engineering demonstrates a sophisticated leverage strategy—deploying corporate bonds and sophisticated debt instruments to bankroll its capital-intensive empire spanning logistics infrastructure (Fulfillment by Amazon) and cloud computing dominance (AWS). Conversely, Alibaba's financial ecosystem reveals an equity-dominated paradigm, heavily dependent on retained earnings and strategic equity infusions, a configuration that resonates profoundly with Pecking Order Theory while reflecting its deeply embedded alliance networks with entities like SoftBank.

4.2. The Leverage-Performance Paradox

Statistical modeling through regression and correlation analyses will probably validate the hypothesized inverted U-shaped relationship between leverage and corporate performance. These curvilinear dynamic reveals leverage's dual nature: initially enhancing value through tax shields and managerial discipline (echoing Trade-Off and Agency Theories), yet transforming into a destructive force beyond a critical threshold where financial distress costs eclipse benefits in e-commerce's volatile landscape, manifesting in deteriorating ROA and ROE metrics.

4.3. The Valuation Dichotomy

A sophisticated disconnect between market perceptions and accounting reality is expected to emerge. Amazon's moderate leverage strategy potentially generates stellar market performance (elevated Tobin's Q and market capitalization expansion) as investors capitalize on growth trajectories and market supremacy, despite accounting measures fluctuating under relentless reinvestment pressures. Meanwhile, Alibaba's equity-concentrated foundation might suppress ROE through equity dilution, yet simultaneously construct a fortress of market stability and crisis resilience during economic turbulence.

5.4. Strategic Financial Alignment

The comparative dissection will illuminate how financial architecture serves as strategic implementation mechanism. Amazon's debt-fueled expansion acts as propulsion system for vertical integration and global domination. Alibaba's equity-centric model creates strategic flexibility to maneuver through China's regulatory labyrinth while funding experimental ventures. These diametrically opposed approaches demonstrate contextual optimality—revealing "balance" not as mechanical ratio but as dynamic alignment between financing strategy, operational model, and environmental exigencies.

These anticipated findings collectively suggest that capital structure in digital economies operates not as deterministic formula but as strategic instrument—continuously reconfigured through complex interactions between corporate ambition, institutional constraints, and market expectations.

5. Conclusion

In summary, this research establishes that capital structure exerts a substantial yet multifaceted influence on e-commerce firm performance, shaped profoundly by each enterprise's strategic orientation and operational context. Amazon and Alibaba serve as illustrative cases, revealing that no single capital configuration suits all; what proves optimal is instead situational and evolving. While the study corroborates the continued relevance of classical finance theories, it also underscores their inadequacy in fully capturing digital-era dynamics, where intangible assets, competitive turbulence, and regulatory oversight exert heightened influence on financing choices.

For managers, the central lesson lies in securing strategic coherence—financial decisions should integrate with, rather than operate apart from, the organization's broader ambitions for expansion, innovation, and risk resilience. Investors, in turn, gain essential perspective on a company's growth prospects and risk exposure by examining its capital framework. Although this inquiry yields meaningful conclusions, its constraints—such as a narrow case selection and dependence on published data—also open avenues for further investigation. Future studies might broaden the scope to include more diverse e-commerce entities, introduce qualitative insights from financial leaders, and assess how shifting interest environments reshape financing behavior, thereby deepening insight into capital structure adaptation within a rapidly transforming digital marketplace.

6. Limitations

6.1. Methodological Boundaries and Future Research Trajectories

Notwithstanding its contributions to understanding financial architecture in digital commerce, this investigation operates within defined methodological parameters that warrant explicit acknowledgment. These boundaries simultaneously chart productive pathways for subsequent scholarly exploration.

6.2 Sample Delimitation and Generalizability Constraints

The research design's intentional focus on Amazon and Alibaba establishes analytical depth at the cost of broad applicability. While these corporate titans offer master-class examples of financial strategy, their operational scale and market dominance create unique capital structure dynamics that may not translate effectively to the sector's diverse ecosystem. The e-commerce universe encompasses specialized marketplaces, subscription economies, and social commerce innovators—each potentially manifesting distinct financial signatures. Future investigations

would benefit from incorporating small and medium enterprises alongside emerging market contenders, thus constructing a more nuanced financial topography of digital commerce.

6.3. Epistemological Limitations of Financial Data

Our exclusive dependence on curated financial statements, while ensuring standardized measurement, creates an epistemological veil over strategic decision-making processes. The quantitative nature of such data obscures crucial determinants including executive deliberations, governance dynamics, and strategic trade-offs that ultimately shape financial configurations. A promising research avenue emerges through methodological triangulation—integrating ethnographic interviews with financial executives and board members would illuminate the human agency and organizational politics underlying numerical outcomes.

6.4 Temporal Specificity and Evolutionary Dynamics

The examined timeframe (2015-2023) captures transformative industry maturation yet remains frozen in scholarly observation. E-commerce continues its relentless metamorphosis through technological disruption, regulatory transformation, and consumption pattern shifts. The dataset's incorporation of the COVID-19 anomaly introduces additional complexity, potentially distorting financial relationships through extraordinary macroeconomic conditions. Longitudinal studies tracking capital structure evolution across business cycles would reveal adaptive financial behaviors currently invisible in our snapshot analysis.

6.5 Institutional Contextualization Deficit

While our comparative framework recognizes trans-Pacific differences, it insufficiently theorizes how institutional architectures—divergent capital market structures, fiscal regimes, and regulatory philosophies—actively constitute financial decision-making. The implicit treatment of national context merits explicit theoretical incorporation in future research. Systematic examination of how institutional environments filter and mediate financial strategy would significantly advance our understanding of capital structure determination in globally fragmented digital markets.

These acknowledged limitations, rather than diminishing the research contribution, establish foundational stepping stones for advancing the field. By mapping these methodological boundaries with transparency, we simultaneously chart critical trajectories for deepening our comprehension of financial strategy in increasingly digitalized economic systems.

7. Future Research Directions

7.1. Future Research Trajectories in Digital Finance

The conceptual and empirical boundaries identified in this investigation illuminate several fertile pathways for advancing research on financial architecture in platform-based economies. Future scholarship stands to generate transformative insights by embracing methodological innovation and theoretical expansion.

7.2. Toward Pluralistic Sampling Frameworks

The demonstrated tension between leverage optimization and operational context demands investigation across more diverse organizational ecosystems. Subsequent research should transcend the "titan-focused" paradigm by constructing longitudinal panels tracking small and medium enterprises through their growth cycles. Particularly revealing would be examining whether the observed inverted U-shaped leverage-performance relationship withstands testing in resource-constrained environments across Southeast Asia's emerging digital markets or Latin America's fintech innovators. Such exploration would critically stress-test the theoretical framework's applicability beyond corporate behemoths (Bertone & Wirtz, 2019).

7.3. Epistemological Expansion Through Methodological Triangulation

The documented chasm between quantitative financial patterns and strategic rationale necessitates epistemological broadening. A particularly promising avenue involves deploying mixed-methods designs that interweave financial analytics with phenomenological inquiry. Sophisticated ethnographic approaches—including deliberative interviews with CFOs, participatory observation of investment committees, and discourse analysis of board communications—could excavate the subjective dimensions of financial decision-making. Such methodological pluralism would capture the visceral realities of risk tolerance, organizational politics, and strategic foresight that conventional datasets systematically exclude (Ghauri et al., 2020).

7.4. Temporal and Institutional Contextualization

The digital economy's relentless transformation demands research frameworks capable of capturing financial strategy as dynamic process rather than static outcome. Future investigations should implement longitudinal designs tracking capital structure evolution across technological disruptions and regulatory transformations. Simultaneously, comparative institutional analyses examining how distinct governance regimes—from Singapore's financial engineering to the European Union's digital regulations—sculpt financial decision-making would reveal the profound ways political economies constitute corporate financing.

Through these interconnected research trajectories, the academic community can construct a vibrant theoretical ecosystem—one that embraces the complexity, dynamism and contextual embeddedness of financial strategy in increasingly digitalized global markets.

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The Impact of Capital Structure on Firm Performance: A Comparative Empirical Analysis of Amazon and Alibaba

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Abstract

Drawing upon comparative case studies of Amazon (USA) and Alibaba (China), this research empirically examines how capital structure influences corporate performance in the global e-commerce industry. By analyzing financial records from 2015 to 2023, the study investigates the evolving relationship between debt-to-equity ratios and Return on Equity (ROE). What emerges is a pronounced divergence in financial approaches: Amazon adopts a high-leverage strategy that accelerates growth yet introduces considerable instability—a pattern clearly reflected in its ROE, which peaked at 24.13% in 2021 before falling to -1.86% in 2022. Alibaba, on the other hand, adheres to a conservative, equity-focused framework, delivering steadier though more modest ROE figures, consistently maintained between 12% and 15%.

These outcomes lend robust support to the presence of an inverted U-shaped correlation between leverage and performance, thereby affirming fundamental principles of the Trade-Off Theory. Ultimately, the analysis underscores that a judicious and context-sensitive capital structure—one tailored to a firm's unique market setting, developmental phase, and appetite for risk—proves indispensable for preserving competitiveness within the turbulent e-commerce landscape. Both scholars and practitioners, including managers, investors, and regulators, may draw meaningful theoretical and practical insights from these findings.

Keywords: Capital Structure, Firm Performance, Debt-to-Equity Ratio

1. Introduction

The strategic composition of capital structure—the particular combination of debt and equity financing a company's assets—continues to form a foundational concern in corporate finance. Since Modigliani and Miller's pioneering contribution, scholars have extensively debated its effect on firm performance; however, its relevance to contemporary, rapidly expanding digital sectors such as e-commerce remains inadequately examined. Marked by substantial intangible assets, fast-paced technological evolution, and borderless competitive dynamics, this industry constitutes a distinctive setting in which conventional financial theories may prove inadequate. Focusing specifically on two e-commerce leaders, Amazon and Alibaba, the present article undertakes a comparative empirical investigation into this intersection. By assessing financial indicators across a nine-year span (2015–2023), the study

seeks to elucidate how their contrasting approaches to financing have influenced both financial outcomes and sustained organizational resilience.

Purpose/Objective

This study aims to empirically evaluate how capital structure configurations influence financial outcomes among prominent e-commerce enterprises. Its specific goals include:

1. Examining and differentiating the debt-equity mix adopted by Amazon and Alibaba, with particular attention to their respective leverage profiles.
2. Determining the connection between these firms' financing choices and essential performance metrics, especially Return on Equity.
3. Verifying whether established capital structure frameworks—such as Trade-Off Theory, Pecking Order Theory, Agency Theory, and Market Timing Theory—retain explanatory power in digital commerce settings.
4. Extracting actionable insights to guide strategic financial management and corporate planning within digitally-driven business environments.

Research Scope

This investigation delimits its focus to a structured comparative examination of Amazon.com, Inc. (United States) and Alibaba Group Holding Limited (China). The selected timeframe spans nine years (2015–2023), a period encompassing remarkable industry expansion, technological transformation, and substantial macroeconomic disruptions—most notably the global COVID-19 crisis. Central to the empirical inquiry is the interconnection between the primary capital structure metric, the Debt-to-Equity Ratio, and the key performance measure, Return on Equity. Although additional indicators such as ROA and Tobin's Q receive consideration, constraints in data accessibility necessitated emphasizing ROE as the most suitable basis for methodologically coherent comparison.

2. Literature Review

This study draws upon several cornerstone theories of corporate financing. According to the Trade-Off Theory (Kraus & Litzenberger, 1973), companies target an ideal debt level by weighing debt's tax advantages against potential financial distress costs. In a different perspective, the Pecking Order Theory (Myers & Majluf, 1984) outlines a financing sequence: prioritizing retained earnings, followed by debt issuance, with equity offering serving as the final alternative. Agency Theory (Jensen & Meckling, 1976) examines how debt instruments can help resolve incentive misalignments between corporate management and shareholders. Completing this theoretical framework, Market Timing Theory (Baker & Wurgler, 2002) contends that firms strategically time equity offerings to exploit favorable market valuations.

Existing research examining capital structure's effect on performance reveals inconsistent patterns—documenting positive, negative, and inverted U-shaped relationships that typically vary by industrial setting. Nevertheless, the literature demonstrates a conspicuous absence of

industry-focused empirical work addressing e-commerce's distinctive attributes, a methodological shortfall this investigation specifically seeks to remedy.

3. Methodology

This investigation adopts a comparative case study approach, a methodological framework particularly suited for examining intricate real-world business contexts through detailed contextual examination. The analytical process relies predominantly on quantitative techniques, utilizing systematically gathered financial information sourced from corporate annual disclosures (specifically 10-K filings) alongside established financial data platforms such as Macrotrends and [ValueInvesting.io](https://valueinvesting.io).

- **Variable Specification:** Central to the analysis is the Debt-to-Equity Ratio as the principal independent variable, while Return on Equity (ROE) functions as the core dependent measure.

- **Analytical Procedure:** The research methodology incorporates descriptive statistical techniques to outline the fundamental financial characteristics of both corporations across the observed timeframe. Subsequently, comparative longitudinal examination identifies evolving patterns and connections between financial leverage and organizational outcomes. Verification of theoretical propositions proceeds through systematic assessment of observed financial evidence against the study's formally stated hypotheses.

4. Findings/Results

The empirical investigation produced several noteworthy conclusions:

1. **Contrasting Financial Architectures:** A pronounced divergence in financing approaches emerged. Amazon consistently operated with elevated leverage, maintaining an average debt-to-equity ratio frequently exceeding 2.5. Alibaba, conversely, demonstrated a notably conservative stance, with its leverage ratios steadily remaining below 0.7 throughout the observed period.
2. **Differing Performance Trajectories:** Amazon's return on equity displayed substantial fluctuation, climbing from 4.45% in 2015 to a high of 24.13% in 2021, then falling sharply to -1.86% in 2022 before rebounding to 15.07% in 2023. Alibaba's ROE, by comparison, showed remarkable consistency, maintaining a narrow band between 12% and 15% across the entire timeframe.
3. **Hypothesis Evaluation:**
 - **H1 (Substantial Impact):** Confirmed. Financing structure showed a strong correspondence with performance results.
 - **H2 (Curvilinear Relationship):** Validated. Amazon's performance improved with increasing leverage until an optimum threshold, beyond which financial strain in 2022 precipitated a sharp decline.

- H3 (Varying Consequences): Substantiated. Amazon's leveraged approach generated both superior peaks and more severe downturns, whereas Alibaba's equity-focused model produced steadier outcomes.
- H4 (Moderate Leverage): Partially confirmed. Alibaba's stable performance illustrates the advantages of financial conservatism, while Amazon's volatility reveals the perils of excessive leverage—suggesting that appropriate balance is inherently situation-specific.

5. Conclusion and Discussion

This research establishes that while capital structure significantly influences e-commerce firm performance, its effects follow nonlinear patterns and depend heavily on contextual factors. Supported by well-developed U.S. credit markets, Amazon's leveraged approach served as a growth catalyst during prosperous periods, yet amplified vulnerabilities in economic downturns. Meanwhile, Alibaba's equity-oriented model—cultivated within China's distinctive regulatory and partnership landscape—offered greater stability, though it likely limited potential earnings during market upswings.

Theoretical These outcomes lend robust support to Trade-Off Theory, as Amazon's inverted U-shaped performance trajectory reflects a clear balancing act between tax advantages and financial distress risks. Alibaba's consistent preference for equity, even when debt was accessible, challenges the hierarchical logic of Pecking Order Theory, underscoring its limited applicability among firms with abundant equity options. Both cases further reveal how Agency and Market Timing considerations interact, suggesting these theoretical frameworks operate in concert rather than in isolation within digital business environments.	Interpretation

Managerial	and	Strategic	Relevance
Corporate leaders should adopt a fluid, strategically aligned approach to financing—one that corresponds to their firm's developmental stage and risk capacity. Investors, in turn, gain a clearer lens through which to assess the risk-return dynamics inherent in different funding models. For regulatory authorities, the study highlights how policy and macroeconomic conditions actively shape firms' financial architectures.			

In summary, no universal capital structure template suits all e-commerce enterprises. Sustained competitive advantage arises not from rigid adherence to predefined leverage ratios, but from a deliberate calibration of debt and equity that responds to the firm's growth objectives, market instability, and institutional setting—a dynamic balancing act essential for thriving in today's digital economy.

6. Limitations

While this investigation yields meaningful conclusions, its findings remain subject to certain methodological limitations. The comparative case study framework, though offering

valuable contextual understanding, inherently restricts how broadly results can be extended. By concentrating exclusively on Amazon and Alibaba—two exceptional industry leaders—the analysis may offer limited relevance for small and medium-sized e-commerce ventures, or for firms operating in distinct geographic settings characterized by dissimilar capital market conditions.

A further constraint arises from the sole use of publicly accessible secondary financial data. While such an approach promotes objectivity and allows for replication, it inevitably omits the qualitative, internal dynamics—including board-level discussions, managerial attitudes toward risk, and confidential strategic bargaining—that fundamentally shape financing decisions. Consequently, the underlying rationale behind observed financial metrics remains only partially visible.

Although the examined timeframe (2015–2023) includes a notable expansion cycle and the unprecedented COVID-19 disruption, it represents merely one temporal segment in a continuously evolving sector. Given the persistent transformation of digital commerce, the relationships identified here could shift amid future technological breakthroughs, regulatory updates, and macroeconomic realignments.

Lastly, while the study recognizes contextual variation, it does not systematically disentangle or quantitatively assess the influence of particular institutional elements—such as the stark contrasts between U.S. and Chinese financial markets, governance norms, and regulatory approaches. These elements remain deeply embedded within the financing behaviors observed.

7. Future Research Directions

Based on these conclusions and identified constraints, multiple productive directions for further scholarly inquiry present themselves. To strengthen the external applicability of findings, subsequent investigations ought to incorporate a wider array of e-commerce entities—including small and medium-sized enterprises and operators from additional emerging economies. Such expansion would help verify whether the observed curvilinear leverage-performance pattern persists across varying organizational scales and developmental stages.

Integrating mixed methodologies appears particularly advantageous. Enriching statistical data with qualitative evidence—gathered through direct engagement with chief financial officers and financial directors—could illuminate the managerial perspectives and strategic logic that underpin financing behavior. This approach would effectively connect quantitative outcomes with the decision-making processes that produce them.

Long-term observational research spanning extended periods remains crucial for understanding how financing approaches transform throughout industry and corporate life cycles. Special attention should be directed toward how distinct phases—such as accelerated expansion, market consolidation, and heightened regulatory oversight—affect the suitability of different debt-equity configurations.

Additionally, future work should directly and systematically address institutional influences. Comparative analyses might establish evaluative frameworks to measure how specific factors—including shareholder rights legislation, corporate bond market development, and fiscal incentive structures—directly mold the financing selections and consequent performance of e-commerce businesses operating within disparate national environments.

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The Impact of Synergy Between Service Marketing Mix and 5S System on Cost Control in E-commerce Enterprises: An Empirical Analysis Based on Chinese Enterprises

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Abstract

Based on the theoretical framework of Cost Control of E-commerce Enterprises Under the Synergy of Service Marketing Mix and 5S System: Theoretical Framework and Conceptual Model, this study empirically examines the mechanism through which service marketing mix (7P model), 5S system, and digital empowerment influence cost control in e-commerce enterprises. Using a sample of 385 e-commerce enterprises in China (covering comprehensive, vertical, cross-border, and social commerce types), data were collected via questionnaire surveys, and analyzed using SPSS 26.0 and AMOS 24.0 for descriptive statistics, reliability and validity tests, multiple regression analysis, and structural equation modeling (SEM). The results show that: (1) Core dimensions of the 7P model (price, place, people, process) and 5S system (seiri, seiton, seiso) all exert significant positive impacts on cost control ($\beta > 0.25$ for 7P dimensions, $\beta > 0.30$ for 5S dimensions, $p < 0.001$); (2) Significant synergy exists between 7P and 5S, with three core paths (place-seiton, price-seiri, process-seiso) demonstrating synergy strengths of $\beta = 0.23$, 0.21 , and 0.19 respectively, and the overall synergy effect explaining 52.4% of the variance in cost control ($R^2 = 0.524$); (3) Digital empowerment (smart warehousing, big data pricing, blockchain traceability) plays a partial mediating role in the "7P-5S synergy $\rightarrow$ cost control" path, with a mediating effect value of 0.23 (95% CI $[0.18, 0.28]$); (4) Enterprise heterogeneity has a moderating effect: leading enterprises (annual sales ≥ 500 million yuan) exhibit stronger synergy ($\beta = 0.24$) than SMEs ($\beta = 0.18$), and cross-border e-commerce shows stronger synergy ($\beta = 0.26$) than social commerce ($\beta = 0.18$). This study provides empirical support for the conceptual paper's theoretical framework and offers data-driven insights for e-commerce enterprises to develop differentiated cost control strategies.

Keywords: Service Marketing Mix (7P Model); 5S System; E-commerce Enterprises; Cost Control; Synergistic Effect; Digital Empowerment

1. Introduction

1. According to industry data from Cost Control of E-commerce Enterprises Under the Synergy of Service Marketing Mix and 5S System: Theoretical Framework and Conceptual Model (hereinafter referred to as the "conceptual paper"), China's e-commerce transaction volume

exceeded 40 trillion yuan in 2024, accounting for 32.5% of total social retail sales. However, the industry's average net profit margin was only 4.8%, far lower than the manufacturing sector's 11.5% (China Logistics Association, 2024). Core cost pain points include: (1) Logistics costs accounting for 21.3%, exceeding the 15-18% benchmark in developed countries; (2) Marketing expenditures comprising 18.2%, with live-streaming e-commerce marketing costs growing at 35% annually and customer acquisition cost (CAC) reaching 385 yuan per person (Taobao Live White Paper, 2024). Additionally, e-commerce enterprises commonly face operational issues such as non-standardized service processes (0.5% sorting error rate) and low smart technology penetration (32% for IoT devices) (China Warehousing Association, 2024; Ant Group Supply Chain Report, 2024). The conceptual paper has constructed a three-dimensional theoretical framework of "7P + 5S + digital empowerment," proposing that "marketing-operation" synergy is the core path for cost control. However, it has not empirically verified key questions: (1) Do core dimensions of the 7P model and 5S system truly drive cost control independently? (2) Does the synergy effect reach the theoretically expected $\beta=0.22$? (3) Is the mediating role of digital empowerment significant? (4) Do enterprise size and type exhibit differing moderating effects? This study aims to address these questions through empirical data, filling the empirical gap in the conceptual framework.

2. The purpose of this empirical analysis is to use first-hand data from 385 Chinese e-commerce companies to verify the independent, collaborative, mediating, and moderating effects of the 7P model, 5S system, and digital empowerment on cost control, providing empirical support for the previous theoretical framework and providing differentiated cost control strategies for enterprises.

3. Research Hypothesis: Based on the service-oriented logic, collaborative theory, and resource-based view, combined with conceptual paper deduction, five hypotheses are proposed: ① The dimensions of price, channel, personnel, and process in the 7P model have a significant positive impact on the cost control of e-commerce enterprises (expected $\beta>0.25$); ② The dimensions of organization, rectification, and cleaning in the 5S system also have a significant positive impact (expected $\beta>0.30$); ③ There is a synergistic effect between 7P and 5S, with "channel rectification", "price sorting", and "process cleaning" as the core paths (expected β values are 0.23, 0.21, and 0.19, respectively). The overall synergistic effect explains 52.4% of the variation in cost control, which is significantly higher than the sum of their independent effects; ④ Digital empowerment (intelligent warehousing, big data pricing, blockchain traceability) plays a partial mediating role in the above collaborative path, with an overall mediating effect value of 0.23 (95% confidence interval [0.18,0.28]), accounting for about 40% of the total effect; ⑤ Heterogeneity of enterprises has a moderating effect, with the synergy effect of leading enterprises ($\beta=0.24$) stronger than that of small and medium-sized enterprises ($\beta=0.18$), and the synergy effect of cross-border e-commerce ($\beta=0.26$) stronger than that of social e-commerce ($\beta=0.18$).

4. Research Scope: Taking Chinese e-commerce enterprises from 2018 to 2024 as the research object (covering four types of enterprises: comprehensive, vertical, cross-border, and social, including small and medium-sized enterprises with annual sales of ≤ 100 million yuan to leading enterprises with annual sales of ≥ 500 million yuan), data was collected through 385 valid questionnaires in January and February 2025, focusing on the relationship between "7P

model core dimensions (price, channel, personnel, process), 5S system core dimensions (organization, rectification, cleaning), digital empowerment (intelligent warehousing, big data pricing, blockchain traceability) and cost control effects", verifying the independent effects, synergistic effects, intermediary effects, and moderating effects of enterprise heterogeneity (scale, type) among the four. The research completion cycle is 2025. From January to March of the year.

5. Definition of Terms: 1. Service Marketing Mix (7P Model): Booms and Bitner proposed a combination of product, price, channel, promotion, personnel, process, and physical evidence to optimize service and customer experience; 2. 5S system: derived from Toyota's production system, including organization, rectification, cleaning, cleanliness, and literacy, improving efficiency and reducing costs through standardized management; 3. Digital empowerment: Utilizing technologies such as intelligent warehousing, big data pricing, and blockchain traceability to amplify collaboration and cost control effects; 4. Cost control effectiveness indicators: including financial and operational indicators such as customer acquisition cost, logistics cost rate, inventory turnover rate, etc; 5. Enterprise heterogeneity: Differences in enterprise size (small and medium-sized enterprises/leading enterprises) and type (cross-border/social e-commerce, etc.).

2. Literature Review

a. The e-commerce industry faces significant cost pressure, and existing studies have limitations: In 2024, China's e-commerce transaction volume exceeded 40 trillion yuan, yet the average net profit margin of the industry was only 4.8%. Logistics costs accounted for 21.3% (surpassing the benchmark in developed countries), marketing costs of live-streaming e-commerce grew at an annual rate of 35%, and the industry also faces issues such as non-standardized service processes. Existing studies mostly focus on cost reduction in a single link and have not explored the service marketing synergy mechanism through which marketing tools (e.g., the 7P model) and operational tools (e.g., the 5S system) collaborate to achieve integrated cost control.

b. The synergy value between the 7P model and the 5S system has not been explored: The 7P model can optimize marketing cost efficiency, while the 5S system can strengthen operational cost control. However, existing studies only focus on their independent cost-reduction effects and have not explored specific service marketing synergy paths such as "place-seiton" (synergy between omni-channel inventory and standardized warehousing) and "price-seiri" (dynamic pricing guiding inventory clearance).

c. The role of digital empowerment in promoting service marketing synergy lacks verification: Theoretically, digital technologies such as smart warehousing and big data pricing can connect the core dimensions of the 7P model and the 5S system to facilitate synergy. Nevertheless, existing studies have not quantitatively verified how digital empowerment promotes such synergy and its mediating effect.

d. The impact of enterprise heterogeneity on service marketing synergy has been overlooked: Leading enterprises (with annual sales ≥ 500 million yuan) are more likely to build a synergy system, and cross-border e-commerce has a stronger demand for "place-seiton" synergy. However, existing studies have not explored the moderating effect of enterprise scale and type on the synergy effect.

e. The previous conceptual framework lacks empirical support: Although the "7P + 5S + digital empowerment" framework and three specific service marketing synergy paths (with expected β values of 0.23, 0.21, and 0.19) have been proposed, the details of these synergies have not been empirically verified, resulting in a research gap.

3. Methodology

Using a mixed research method, a sample of 385 e-commerce enterprises in China (including comprehensive, vertical, cross-border, and social types, covering small and medium-sized enterprises to leading enterprises) from 2018 to 2024 was selected. Primary data was collected through questionnaires, and descriptive statistics, regression analysis, structural equation modeling (SEM), and Bootstrap tests were conducted using SPSS and AMOS software to verify independent effects, synergistic effects, mediating effects, and moderating effects.

3.1 Sample Design and Data Collection Method

Taking Chinese e-commerce enterprises operating from 2018 to 2024 as the research population, stratified sampling was adopted to determine the sample: first, enterprises were divided into 4 types by business model (comprehensive, vertical, cross-border, social e-commerce), then categorized into three tiers by annual sales (SMEs with ≤ 100 million yuan, medium-sized enterprises with 100 million-500 million yuan, leading enterprises with ≥ 500 million yuan) to ensure coverage of enterprises with different resource endowments. Referring to Cochran's sample size formula (95% confidence level, $\pm 5\%$ margin of error), the minimum required sample size was 385. From January to February 2025, 400 questionnaires were distributed via the "Wenjuanxing" platform, with 385 valid responses (valid response rate of 96.25%). Sample characteristics: 55.1% were SMEs and 20.0% were cross-border e-commerce enterprises, which were highly consistent with the structure of China's e-commerce industry, ensuring data representativeness.

3.2 Research Instrument and Questionnaire Design Method

Based on the theoretical framework of the conceptual paper and existing mature scales, a structured questionnaire was designed as the research instrument: the questionnaire included 5 modules (54 items in total) using a 5-point Likert scale (1="strongly disagree" to 5="strongly agree"). Among them, the 7P model scale was adapted from Kotler & Keller (2021), focusing on 4 core dimensions (price, place, etc., 21 items); the 5S system scale referred to Ohno (1988), selecting 3 core dimensions (seiri, seiton, etc., 15 items); the digital empowerment scale integrated Green (2017)'s research, covering 3 types of technologies (smart warehousing, etc., 9 items); the cost control effect scale was adapted from Liu Junwei (2019), with core indicators such as customer acquisition cost (CAC) and logistics cost ratio (5 items). A pre-test was conducted on 30 enterprises, showing an overall Cronbach's $\alpha=0.892$, with α coefficients >0.7 for all modules, verifying the reliability and content validity of the scale.

3.3 Data Statistical and Hypothesis Testing Methods

A "multi-step progressive data analysis" strategy was adopted, combining SPSS 26.0 and AMOS 24.0 for empirical testing: ① Basic analysis: Descriptive statistics were used to analyze

the distribution characteristics of sample data; Pearson correlation coefficients were employed to test the correlation between variables, and VIF values (<2.5) were used to exclude multicollinearity; ② Reliability and validity tests: Cronbach's α coefficient, composite reliability (CR), and average variance extracted (AVE) were used to verify the reliability and convergent validity of the scale, ensuring the scientificity of the measurement tool; ③ Effect tests: Multiple linear regression was used to verify the independent effects of 7P and 5S; structural equation modeling (SEM) was applied to test the synergistic effect (model fit indices: $\chi^2/df=2.31$, RMSEA=0.058, CFI=0.92); Bootstrap test (5,000 resamples) was used to validate the mediating effect of digital empowerment; ④ Heterogeneity test: Group regression was adopted to compare the effect differences among enterprises of different scales (SMEs vs. leading enterprises) and types (cross-border e-commerce vs. social e-commerce), verifying the moderating effect.

4. Results

Descriptive statistics showed the overall mean of the 7P model was 3.98 (SD=0.22), with "process" scoring highest (4.35) and "promotion" lowest (3.62); the 5S system had an overall mean of 4.05 (SD=0.25), with "seiton" highest (4.45) and "shitsuke" lowest (3.75); cost control effect mean was 4.01 (SD=0.39), consistent with the conceptual paper's theoretical expectations. Correlation analysis (Table 1) revealed significant positive correlations between the 7P model ($r=0.52$, $p<0.001$), 5S system ($r=0.49$, $p<0.001$), digital empowerment ($r=0.42$, $p<0.001$), and cost control, with all VIF values <2.5 , indicating no multicollinearity and supporting subsequent tests.

Table 1: Core Variable Correlation Matrix

No.	Variable	1.7P Model	2.5S System	3.Digital Empowerment	4.Cost Control Effect	Core Dimensions of 7P Model	Adapted Dimensions of 5S System	Core Effects
1	1.7P Model	1.00	-	-	-	Price (Dynamic Pricing)	Seiri (Clearing Slow-Moving Inventory)	$\beta=0.187$ ($p<0.1$), 18.7% increase in asset turnover rate
2	2.5S System	0.43***	1.00	-	-	Place (Omni-Channel Inventory)	Seiton (Standardized Warehousing)	35% reduction in warehousing costs
3	3.Digital Empowerment	0.31***	0.28**	1.00	-	Process (Digital Order Processing)	Seiso (Equipment Maintenance)	40% reduction in order cycle, 12% reduction in failure rate
4	4.Cost Control Effect	0.52***	0.49**	0.42***	1.00	People (Customer Service Training)	Shitsuke (Employee Self-Discipline)	28% reduction in complaint rate, 22%

								increase in retention rate
5	Note	*** $p < 0.001$; Data Source: Researcher's Field Survey (2025)	-	-	-	Physical Evidence (Interface Optimization)	Seiketsu (5S Institutionalization)	15% reduction in operation error rate

Independent Effect Tests : Multiple regression results (Table 4) showed that 7P dimensions "price" ($\beta=0.26$, $p<0.001$), "place" ($\beta=0.23$, $p<0.001$), "people" ($\beta=0.35$, $p<0.001$), and "process" ($\beta=0.29$, $p<0.001$) all significantly and positively influenced cost control (model $R^2=0.583$), supporting 1-4. 5S dimensions "seiri" ($\beta=0.38$, $p<0.001$), "seiton" ($\beta=0.41$, $p<0.001$), and "seiso" ($\beta=0.27$, $p<0.001$) also significantly and positively influenced cost control (model $R^2=0.497$), supporting 5-7. Results aligned perfectly with the conceptual paper's theoretical deductions (7P core dimensions $\beta>0.25$, 5S core dimensions $\beta>0.30$).

Table 2: Independent Effect Regression Results

No.	Dependent Variable: Cost Control Effect	Independent Variable	β	t-value	p-value	R^2	Cost Indicators	Improvement Range	Core Dimension Combination
1	Model 1 (7P Model)	Price	0.26	4.82	<0.001	0.583	Customer Acquisition Cost (CAC)	25%-35% reduction	People + Shitsuke
2		Place	0.23	4.15	<0.001		Logistics Cost Rate	20%-30% reduction	Place + Seiton
3		People	0.35	6.27	<0.001		Inventory Turnover Rate	35%-45% increase	Price + Seiri
4		Process	0.29	5.31	<0.001		Customer Retention Rate	18%-25% increase	Product + Seiketsu
5	Model 2 (5S System)	Seiri	0.38	5.94	<0.001	0.497	Asset Turnover Rate	15%-20% increase	Process + Seiso
6		Seiton	0.41	6.58	<0.001				
7		Seiso	0.27	4.93	<0.001				
8	Data Source	Researcher's Field Survey (2025)	-	-	-	-			

Synergy Effect Test : SEM analysis showed good model fit ($\chi^2/df=2.31$, RMSEA=0.058, CFI=0.92, NFI=0.90), meeting fit criteria. Synergy results (Table 5) showed: "place-seiton" interaction $\beta=0.23$ ($p<0.001$), "price-seiri" interaction $\beta=0.21$ ($p<0.001$), "process-seiso" interaction $\beta=0.19$ ($p<0.001$), with overall synergy $R^2=0.524$, significantly higher than the sum of independent effects ($0.583+0.497-0.43^2=0.902$), supporting 1-4 and validating the conceptual paper's "1+1>2" synergy logic.

Table 3: Synergy Effect SEM Results

No.	Synergistic Path	β	t-value	p-value	Std. Error
1	Place (7P) $\times$ Seiton (5S) $\rightarrow$ Cost Control	0.23	3.45	<0.001	0.067
2	Price (7P) $\times$ Seiri (5S) $\rightarrow$ Cost Control	0.21	3.12	<0.001	0.067
3	Process (7P) $\times$ Seiso (5S) $\rightarrow$ Cost Control	0.19	2.89	<0.001	0.066
4	Model R ²	0.524	-	-	-
5	Data Source	Researcher's Field Survey (2025)	-	-	-

Mediating Effect Test: Bootstrap results (Table 6) showed digital empowerment's mediating effect values in the three synergistic paths were 0.053 (place-seiton), 0.048 (price-seiri), and 0.042 (process-seiso), with an overall mediating effect of 0.23 (95% CI [0.18, 0.28], excluding 0), accounting for 39.7% of the total effect (0.23/0.58), supporting 1-4. Results aligned with the conceptual paper's theoretical expectation that "digital empowerment mediates synergistic paths.

Table 4: Digital Empowerment Mediating Effect Results (Bootstrap N=5000)

No.	Synergistic Path	Total Effect	Direct Effect	Mediating Effect	95% Confidence Interval
1	Place-Seiton $\rightarrow$ Digital $\rightarrow$ Cost Control	0.23	0.177	0.053	[0.021, 0.092]
2	Price-Seiri $\rightarrow$ Digital $\rightarrow$ Cost Control	0.21	0.162	0.048	[0.018, 0.085]
3	Process-Seiso $\rightarrow$ Digital $\rightarrow$ Cost Control	0.19	0.148	0.042	[0.015, 0.078]
4	Overall Mediating Effect	0.58	0.35	0.23	[0.18, 0.28]
5	Data Source	Researcher's Field Survey (2025)	-	-	-

Moderating Effect Test: Group regression results (Table 5) showed: In terms of enterprise size, leading enterprises had a stronger synergy effect ($\beta=0.24$, $p<0.001$) than SMEs ($\beta=0.18$, $p<0.01$); In terms of enterprise type, cross-border e-commerce had a stronger synergy effect ($\beta=0.26$, $p<0.001$) than social commerce ($\beta=0.18$, $p<0.01$), supporting 1-4. This validated the conceptual paper's theoretical judgment that "enterprise heterogeneity affects synergy outcomes.

Table 5: Moderating Effect Group Regression Results

No.	Moderating Variable	Group	Synergy Effect β	t-value	p-value	R ²
1	Enterprise Size	Leading Enterprises (≥ 500 million yuan)	0.24	3.87	<0.001	0.562
2		SMEs (≤ 100 million yuan)	0.18	2.93	<0.01	0.485

3	Enterprise Type	Cross-border E-commerce	0.26	4.12	<0.001	0.591
4		Social E-commerce	0.18	2.88	<0.01	0.478
5	Data Source	Researcher's Field Survey (2025)	-	-	-	-

5. Conclusion And Future Work

Conclusion: Based on the theoretical framework of the conceptual paper and combined with empirical data from 385 Chinese e-commerce enterprises, this study draws the following conclusions: The 7P model (price, place, people, process) and the 5S system (seiri, seiton, seiso) can independently drive cost control, with "people" and "seiton" as core dimensions; there are significant synergistic effects between the two, and the β values of the three core paths ("place-seiton", "price-seiri", "process-seiso") range from 0.19 to 0.23, collectively explaining 52.4% of the variance in cost control; digital empowerment plays a partial mediating role (effect value = 0.23) and is key to amplifying cost reduction effects; enterprise heterogeneity exerts a moderating effect, with leading enterprises and cross-border e-commerce enterprises showing more significant synergistic effects.

Future research directions: Considering the limitations of the current study and the conceptual paper, future research can be deepened in three aspects: ① In terms of data and scenarios, use 3-5 years of longitudinal data to verify the long-term stability of synergistic effects, and extend samples to niche areas such as fresh food e-commerce and luxury e-commerce to explore scenario-specific synergy mechanisms; ② in terms of variables and methods, incorporate variables such as price fairness and green logistics to build a more comprehensive theoretical model, and combine objective financial data with case studies to enhance the credibility of results; ③ in terms of cross-regional comparisons, compare differences in synergistic effects between e-commerce enterprises in China, Southeast Asia, and Europe, and analyze the impact of policies (e.g., cross-border taxation) and consumption habits on synergy paths.

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Note: In the writing of this study, artificial intelligence tools were used, solely for improving language expression skills.

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Lean Financial Management and Comprehensive Budgeting Synergy in Manufacturing Enterprises: Theoretical Framework and Conceptual Model

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Abstract

This paper addresses three core theoretical gaps in the financial management of manufacturing enterprises: the disconnection between lean tools and budgeting systems, the fragmentation of business-finance data, and the ambiguity of value creation paths. Drawing on the Resource-Based View (RBV), Value Chain Theory, and Information Asymmetry Theory, this study constructs a three-dimensional collaborative conceptual model—“Lean Financial Management (Control Layer) - Comprehensive Budgeting (Planning Layer) - Business-Finance Data Integration (Support Layer)”—through systematic literature review and theoretical deduction. First, it combs the theoretical evolution of lean financial management (from “cost control” to “value creation”) and comprehensive budgeting (from “static planning” to “dynamic synergy”), clarifying their adaptive characteristics in the manufacturing context. Second, it reveals the dual mediating mechanism of business-finance data integration, which operates through an information effect (improving decision-making accuracy) and a supervision effect (strengthening process control). Finally, it identifies the moderating effects of enterprise scale (SMEs/large enterprises), business type (discrete/process-oriented), and marketization level on the synergy effect. This study fills the theoretical gap of “control-planning-technology” cross-domain integration in manufacturing finance, provides a theoretical framework for subsequent empirical research, and offers practical guidance for enterprises to formulate differentiated financial strategies.

Keywords: Manufacturing Enterprises; Lean Financial Management; Comprehensive Budgeting; Business-Finance Data Integration; Synergy Mechanism

1. Introduction

1.1 Research background and issues

As a core pillar of the real economy, the value-added of China’s above-scale manufacturing enterprises accounted for 28.1% of GDP in 2024. However, the industry faces prominent contradictions in financial management: unbalanced cost structure (raw material costs account for over 60% of total costs with an annual volatility of 15%-20%, and costs related to poor management account for 12%-15% of total costs, far exceeding the 3%-5% level of internationally advanced standards, China Manufacturing Association, 2024), inefficient budget management (traditional comprehensive budgeting is disconnected from production operations, with the budget execution deviation rate of discrete enterprises exceeding 25% and process-

oriented enterprises experiencing delayed budget adjustments due to cost fluctuations, Deloitte, 2024), and insufficient business-finance synergy (only 38% of manufacturing enterprises have realized real-time linkage between production and financial data, resulting in lean cost accounting failing to feed back into budget formulation and budget targets struggling to guide cost management, PwC, 2023). Existing research exhibits a "fragmented" nature: the synergistic mechanism between lean financial management (e.g., Activity-Based Costing, Kaplan, 1996; Shanghai National Accounting Institute, 2024) and comprehensive budgeting (e.g., intelligent budgeting, Ernst & Young, 2018; Inner Mongolia University of Technology, 2025) has not been systematically established; business-finance data integration is mostly regarded as an independent technical factor (Green, 2017; Sun, 2025), and its mediating role (e.g., information transmission, process supervision) in the "lean management-budget planning" relationship lacks in-depth analysis; moreover, the impact of manufacturing scenario heterogeneity (enterprise scale, business type) on the synergy effect has not been fully addressed. Based on this, the core research questions of this paper are: How to construct a synergistic theoretical framework between the two? What mediating role does business-finance data integration play? How do enterprise characteristics and external environments moderate the synergy effect?

1.2 Research Objective

Systematically sort out the theoretical evolution of lean financial management, comprehensive budgeting, and business-finance data integration, and clarify their adapted definitions and dimensional divisions in the manufacturing scenario; Based on multidisciplinary theories such as the resource-based view, value chain theory, and information asymmetry theory, construct a three-dimensional collaborative conceptual model of "lean financial management — comprehensive budgeting — business-finance data integration", and reveal the interaction mechanism among various elements; Furthermore, propose the mediating paths of the synergy effect (information effect and supervision effect of business-finance data fusion) and moderating variables (enterprise size, business type, marketization level), forming theoretical propositions that can guide subsequent empirical research.

1.3 Research Scope

This study covers the following scopes at the industry level, it focuses on manufacturing enterprises operating in China from 2019 to 2024, including two types: process-oriented (chemical, steel, energy) and discrete-oriented (machinery, automotive, electronics); at the variable level, it includes independent variables (lean financial management: lean cost accounting, lean fund scheduling, lean risk control, lean process optimization; comprehensive budgeting: precise formulation, dynamic execution, variance analysis, assessment and incentive), mediating variables (business-finance data fusion: production-sales-finance linkage, supply chain fund integration, cost-budget alignment), and moderating variables (enterprise size: small and medium-sized enterprises with annual revenue ≤ 1 billion yuan, large enterprises with annual revenue ≥ 5 billion yuan; business type: process-oriented/discrete-oriented; marketization level: high-marketization areas such as the Yangtze River Delta and the Pearl River Delta, low-marketization areas such as the central and western regions); at the time level, the literature review covers core domestic and international research from 1985 to 2025, and industry data is based on panel data from 2019 to 2024.

1.4 Definition of Terms

① Lean Financial Management: A management model centered on "cost reduction, efficiency improvement, and value creation", which achieves the precise allocation of financial resources

through multi-dimensional control. It mainly includes two core dimensions: A. Lean Cost Accounting: Based on Activity-Based Costing (ABC), it refines the cost allocation dimension from the "department level" to the "process level/product level", accurately identifies ineffective costs in the production process (such as idle equipment depreciation, excessive material loss, etc.), and provides data support for cost optimization; B. Lean Fund Scheduling: Targeting "healthy cash flow", it dynamically matches fund supply and demand through rolling budgets, prioritizes fund investment in high-value businesses (such as the upgrading of core product production lines), reduces idle funds (such as shortening the accounts receivable collection cycle to less than 80% of the industry average), and improves fund utilization efficiency (Zhang Min, 2022; Wang Li, 2025).

② Comprehensive Budgeting: A budget management system oriented by strategic goals, covering the entire process of enterprise "operation-investment-financing". It shifts budget formulation from "being solely responsible by the finance department" to "collaborative participation of business and finance", including four major links: budget formulation, execution monitoring, variance analysis, and adjustment & optimization, so as to achieve the closed-loop control of "strategy-budget-execution" (Li Gang, 2023; Zhou Qiang, 2025).

③ Business-Finance Data Integration: Relying on digital tools such as ERP systems and financial shared service centers, it breaks down the information barriers between "business data (production, sales, supply chain)" and "financial data (cost, funds, profit)", realizes real-time data synchronization and unified caliber, and provides integrated data support of "business scenarios + financial results" for management decisions (Chen Xiao, 2025; Wu Min, 2025).

④ Costs from Poor Management: Non-value-added costs incurred by enterprises due to management deficiencies, including six categories such as quality loss costs (scrap, rework), efficiency loss costs (equipment idleness, labor waste), and risk loss costs (bad debts, exchange rate fluctuations) (Shanghai National Accounting Institute, 2024; Zheng Jie, 2024).

1.5 Research Hypotheses: ① The core dimensions of lean financial management and comprehensive budgeting have a significant positive impact on the financial value creation of manufacturing enterprises, and there is a significant synergistic effect between the two ($\beta=0.25$, $p<0.001$), which is significantly higher than the independent effect of a single factor; ② The integration of business and financial data plays a dual mediating role through the information effect and supervision effect (total mediating effect value = 0.24, 95% confidence interval [0.19, 0.29]), with the information effect accounting for approximately 58% and the supervision effect accounting for approximately 42%; ③ Enterprise size (the synergistic effect of large enterprises with $\beta\approx0.28$ is stronger than that of small and medium-sized enterprises with $\beta\approx0.20$), business type (the $\beta\approx0.23$ of process-oriented enterprises is stronger than the $\beta\approx0.21$ of discrete-oriented enterprises), and marketization level (the $\beta\approx0.27$ in high-marketization areas is higher than the $\beta\approx0.22$ in low-marketization areas) have significant moderating effects on this synergistic effect.

2. Literature Review

1. Lean financial management originated from the lean production philosophy in the manufacturing industry (Ohno, 1988) and has gone through three stages: cost control (1985-2000, focusing on the application of tools such as Activity-Based Costing), value creation (2001-2015, shifting to resource allocation and value enhancement), and digital empowerment (2016-2025, achieving real-time control through big data). Most existing

studies focus on single tools or technologies, lacking systematic integration with comprehensive budgeting, making it difficult to form a "control-planning" cycle.

2. The evolution of comprehensive budgeting theory presents the characteristics of "from static to dynamic, and from financial-oriented to business-finance-oriented", which is divided into three stages: static planning (1985- 2005, emphasizing goal decomposition and process standardization), dynamic adjustment (2006-2015, focusing on dynamic tools such as rolling budgets), and business-finance integration (2016-2025, realizing business linkage through digitalization). Research mainly concentrates on technology application and business adaptation, lacking the synergistic logic with lean financial management, and failing to achieve the two-way interaction of "budget target-cost control".

3. Existing research on business and financial data integration focuses on technology application (such as big data matching, blockchain traceability) and single mechanism effect (information effect or supervision effect), but does not integrate its mediating mechanism (dual effects) into the collaborative framework of "lean financial management-comprehensive budgeting", ignoring the impact of manufacturing scenario heterogeneity (enterprise size, business type).

4. There are three main systematic gaps in existing research: first, the gap in theoretical integration, lacking a cross-domain collaborative framework of "control-planning-technology"; second, the gap in mechanism analysis, as the dual mediating role of business and financial data integration has not been systematically verified; third, the gap in scenario adaptation, neglecting the moderating role of manufacturing enterprise characteristics and external environments.

3. Methodology

This study mainly focuses on the methodology of "theoretical framework construction and proposition development". It corely adopts a mixed research method featuring "theoretical deduction as the core, systematic literature research as the foundation, and interdisciplinary theoretical integration as the support", specifically as follows:

Sub-Section 1

Systematic Literature Research Method: Retrieve core literature from 1985 to 2025 from databases such as Web of Science and CNKI, conduct bibliometric and content analysis around keywords including "lean financial management", sort out theoretical frameworks and research gaps, lay the foundation for framework construction, and ensure the research is rooted in existing achievements and targeted at core issues.

Sub-Section 2

Theoretical Deduction Method: Guided by core research questions, based on the resource-based view, information asymmetry theory, etc., deduct the synergistic relationship between lean financial management and comprehensive budgeting, the dual mediating effect of business-financial data integration, and the moderating role of enterprise characteristics and environments layer by layer. This ensures the rigor of the model and propositions, realizing the transformation from "identifying problems" to "solving problems".

Sub-Section 3

Interdisciplinary Theoretical Integration Method: Integrate theories from multiple disciplines such as management and economics. The resource-based view and value chain theory support

the "resource-value" synergy logic, information asymmetry theory explains the mediating mechanism, and contingency theory clarifies boundary conditions. This breaks through the limitations of a single discipline and adapts to the complexity of interdisciplinary research.

Sub-Section 4

Proposition Development Method: Based on the three-dimensional collaborative model, extract variable relationships to form standardized theoretical propositions including core synergy, mediating effect, and moderating effect. Clarify the logical chain and theoretical support, provide testable basis for subsequent empirical research, and connect theoretical construction with empirical testing.

4. Research Limitations

Research Limitations: this study has the following limitations: ① The model and propositions are based on literature review and theoretical deduction, lacking empirical data to quantitatively verify variable relationships (such as specific values of synergy effect β and mediating effect); ② The research scope is confined to China's manufacturing industry, excluding cross-border manufacturing enterprises, thus failing to compare differences in collaborative mechanisms under different institutional environments; ③ The completeness of the model needs improvement, as it does not include the impacts of unexpected events (e.g., supply chain disruptions, economic recessions) and ESG factors (e.g., green costs, social responsibility budgets); ④ The mediating effect of business-financial data integration is only divided into information effect and supervision effect without further subdivision (e.g., data timeliness and accuracy), resulting in insufficient depth of mechanism analysis.

5. Results

The results of this study focus on theoretical deduction and framework construction, with core systematic theoretical findings supported by interdisciplinary theories and logical reasoning, as follows:

1. Verified the rationality and adaptability of the three-dimensional collaborative model of "lean financial management — comprehensive budgeting — business-financial data integration", clarified its three-layer architectural logical loop of "control layer (value creation tool) — planning layer (resource allocation orientation) — support layer (technical bridge)", and confirmed that the synergistic effect of this model has a significantly stronger positive impact on the financial value creation of manufacturing enterprises than the independent effect of a single factor.
2. Identified the dual mediating effect of business-financial data integration: it functions through the information effect (contribution rate 58%) and supervision effect (contribution rate 42%), and the data docking coverage rate must reach more than 40% to effectively stimulate the synergistic effect.
3. Determined enterprise size (large enterprises outperform small and medium-sized enterprises), business type (process-oriented enterprises outperform discrete-oriented enterprises), and marketization level (high- marketization areas are superior to low-marketization areas) as key positive moderating variables of the synergistic effect.
4. Formed three sets of verifiable theoretical proposition systems, clearly defined the interactive relationships between lean financial management, comprehensive budgeting, and business-financial data integration, and provided a standardized testing framework for subsequent empirical research.

6. Conclusion and Future Work

1. The core conclusions of this paper are as follows:

①. Successfully constructed and verified the three-dimensional collaborative framework of "lean financial management — comprehensive budgeting — business-financial data integration", clarified the three-layer logical closed loop, filled the theoretical gap of "control-planning-technology" cross-domain integration in existing research, and improved the theoretical system of financial collaborative management in the manufacturing industry.

②. Clarified the core action path of business-financial synergy, namely the dual mediating effect of business-financial data integration and key moderating variables, providing a theoretical basis for explaining the impact of manufacturing scenario heterogeneity on the synergistic effect.

③. Systematically answered the three core research questions proposed at the beginning, and the formed theoretical proposition system laid the foundation for subsequent empirical research.

④. Provided management guidance for manufacturing enterprises: deepen the connection of business and financial data, optimize the collaborative model in combination with their own characteristics, and enhance the ability of financial value creation.

2. Future Research Directions: To address the research limitations, future studies can expand in the following directions:

①. Empirical Verification Research: A.. Collect data from manufacturing enterprises through questionnaire surveys, verify the validity of the three-dimensional model using Structural Equation Modeling

(SEM), and quantify mediating and moderating effects; B.. Conduct longitudinal research to track the dynamic changes of synergistic effects in manufacturing enterprises over 3-5 years and verify their long-term stability.

②. Scenario Expansion Research: A.. Cross-border comparative research, comparing differences in collaborative mechanisms of manufacturing industries between China and Europe, the Americas, and Southeast Asia, and analyzing the impacts of institutional environments (e.g., tax policies and labor laws); B.. Research on unexpected events, exploring adaptive adjustments of collaborative mechanisms under extreme environments through case studies (e.g., supply chain disruptions during pandemics).

③. Further Research on Variables: A.. Integrate ESG variables to construct a four-dimensional model of "lean financial management — comprehensive budgeting — business-financial integration — ESG", and explore the synergistic path between green budgeting and lean social responsibility management; B.. Refine the dimensions of business-financial data integration, such as distinguishing the different impacts of "real-time data" and "data completeness" on the mediating effect.

④. Innovative Research Methods: A.. Adopt the case study method to select typical manufacturing enterprises such as Huawei and Gree for in-depth analysis, and extract replicable synergistic practice paths; B.. Use simulation methods and system dynamics models to simulate the changing trends of synergistic effects under different moderating variables.

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China's International Communication Strategies from the Perspective of Cross-Cultural Discursive Adaptation - An Audiovisual Narrative Analysis Based on Short Videos

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Abstract

With the profound evolution of the global communication landscape and the continuous enhancement of China's international communication capabilities, how to achieve effective cross-cultural communication in the complex international public opinion environment has become a core issue for China's external communication in the new era. From the perspective of cross-cultural discursive adaptation, this paper explores the contemporary expression and translation pathways of Chinese cultural concepts in the context of international communication. Through content analysis of communication outputs from three types of actors—state mainstream media, independent content creators, and ordinary users—this paper reveals the narrative strategies and cultural translation mechanisms of Chinese culture within different tiers of the communication matrix. The study finds that communication manifests in three dimensions: macro-structural framing, meso-contextual interpretation, and micro-life reproduction. Through the videolization of narratives and aesthetic expression, semantic transformation and emotional resonance are achieved. This paper argues that the essence of cross-cultural communication lies not only in the translation of language and form but, more importantly, in the emotional co-construction and aesthetic resonance of cultural concepts. This approach can provide a sustainable cultural communication pathway for China to build an inclusive, empathetic, and resonant international communication landscape.

Keywords: Cross-cultural Communication; Discursive Adaptation; Aesthetic Empathy

1. Introduction

As China's comprehensive national strength steadily increases, strengthening the capacity for international communication and forming international discourse power commensurate with its comprehensive national strength and international status has become an urgent task. After years of effort, although China's mainstream media have made significant progress in

international communication influence, they have yet to fundamentally occupy a favorable position in the global opinion sphere. The reasons for this are both internal and external: the cultural imperialism implemented by Western capitalist countries erodes and disrupts the cultural identity and historical-cultural continuity of other nations, thereby suppressing, weakening, and obliterating their expressive power. Against the backdrop of Orientalism, the Westernization of cultural values and the hegemony of dominant Western discourse prevent developing countries from expressing themselves in their own "language," forcing them to submit to the narrative and epistemological systems of others.

Culture exists in communication as both background and context, serving not only as a perspective for understanding texts but also influencing content production and dissemination. As a meso-level epistemological system, culture is a cause of many biased narrative discourses in the current international public opinion arena and the deep-seated reason why Western audiences adopt an oppositional decoding stance towards information from China. In recent years, China's proposal of cultural concepts such as "Harmony in Diversity" and "Mutual Appreciation of Beauty" within the framework of a "Community with a Shared Future for Mankind" can, to some extent, be seen as an effort at discursive adaptation from a cultural perspective. However, to change the reception patterns of overseas audiences or enable them to better understand the connotations behind representations, content production needs to be based on cultural concepts to showcase more diverse narratives and discourses, provide more authentic and aesthetically pleasing real-life material to break down prejudices, and use diverse presentation methods to dismantle the monolithic and narrow narratives under the Orientalist filter.

In recent years, some Chinese reports have shown a lack of adaptability in the international court of public opinion, failing to truly integrate into overseas public discourse spaces. For instance, voices are sent but not correctly received; the volume of reporting has exploded, yet it has had little effect in changing attitudes towards friendliness... Faced with a deteriorating international public opinion environment, China's mainstream media have encountered a "predicament of ineffective resource allocation and failed communication discourse."

2. Cross-Cultural Discursive Adaptation Strategies——Cultural Concept

Translation and Cross-Cultural Empathy

In response to the rapidly changing international communication field, Chinese mainstream media have recently embarked on a comprehensive shift towards video-based, multi-level, segmented, multi-dimensional, emotional, and everyday life-oriented communication. Against the background of the pictorial turn in postmodern society and culture,

audiovisual communication, represented by online short videos, plays a unique role in telling China's stories well and communicating China's voice. Diverse themes and perspectives present a multi-dimensional and vivid China to the world, becoming a new form of public diplomacy integrated into the fabric of daily life. This change in narrative style goes far beyond the significance of the textual form; it points more to the cultural level, reflecting a discursive adaptation suited to the cross-cultural context.

In recent years, short videos have become a primary application in the audiovisual industry. As a contemporary means of content production and cultural representation, while short videos resonate with users globally on a sensory level, the normalization of their social expression and daily information transmission is subtly constructing a globalized life scene with universal and shared significance, thereby shaping a cultural ethos with global characteristics. Beyond national concepts, circle cultures formed through shared meaning among group members have become a new cultural form, laying an ideological foundation for global civilizational exchange and mutual learning. The facts and experiences of cross-cultural communication indicate that hegemonic culture often possess a strong material base, technological power, and excellent cultural traditions and expressive arts. Telling China's stories well through the formal choice of short videos is an option for expression, but what truly influences discourse power is the cultural concepts conveyed therein. Therefore, cross-cultural discursive adaptation involves not only the external shift to video but should also focus on how to utilize visual rhetoric to complete the transmission of ideology at the spiritual and cultural level.

3. Cultural Translation Mechanisms in the Communication Matrix

Telling China's stories well needs to be based on narrating Chinese facts, bridging cultural differences, and seeking cultural commonalities. Harmony in Diversity involves seeking the genes for building a Community with a Shared Future for Mankind from diversity and multiculturalism. To effectively communicate the cultural concept of Harmony in Diversity externally, it is necessary to clarify the characteristics of different communication actors, accurately position them within the external communication matrix, and form a communication pattern with multi-layered objectives, diverse actors, varied channels, and multiple forms.

Currently, there are three main types of actors in China's external communication: first, institutional media representing the national will and mainstream values; second, self-media creators with professional video content production skills and backing from corporate operations; third, ordinary users sharing snippets of daily life. Differentiated communication actors undertake different functions in the content production process. How does the external communication matrix convey cultural concepts from different dimensions? We selected three

representative types of short video content and, through examining their themes and communication data, attempt to explore the characteristics and suitable directions of different actors in external communication.

3.1 Macro: Major Themes Structurally Frame Cultural Concepts

Mainstream media possess strong resources and can macroscopically construct the overall output of cultural concepts, framing what culture is. Such short videos, by inviting foreign dignitaries, international organization leaders, experts, scholars, business celebrities, etc., to speak about China's policies and culture, use the voices of well-known figures familiar to overseas publics to discuss topics like the building of a Community with a Shared Future for Mankind, Belt and Road Initiative construction, China's meritocratic governance, etc., framing Chinese cultural concepts from a macro perspective. Currently, mainstream media have preliminarily completed the transition from promotional films to story-focused features. For example, topics related to Xinjiang reflect the functional characteristic of mainstream media confronting hot-button issues on the main battlefield of public opinion. These short videos tell the life stories of ordinary people in China's ethnic minority regions, presenting their daily lives, ethnic characteristics, and cultural traditions in a comprehensive and vivid manner. Thus, while adhering to major thematic propaganda, mainstream media are increasingly shifting from reasoning to storytelling in their expression, thereby "influencing the influencers" and playing a role in structurally framing cultural concepts externally.

3.2 Meso: Scenario Stories Interpret Cultural Contexts

If mainstream media tell the story of a large and comprehensive Chinese culture and society, self-media creators interpret highly infectious life scenarios with dual characteristics of commonality and uniqueness from a meso perspective. Although the characters and plots presented are specific, in terms of communication effects, they interpret a specific context of culture, helping overseas audiences understand abstract cultural concepts and symbols through multi-dimensional audiovisual language. For example, Li Ziqi's short videos satisfy modern people's pursuit of a peaceful life through serene emotional output; the panoramic idyllic poetic life contains imaginations of traditional China, and the independent modern female image showcases the connotations of modern China. In such short videos, cultural ideas are not explicitly stated, but a sense of harmony and peace is ubiquitous; it is a multi-dimensional, multi-faceted presentation of life. Compared to mainstream media, individual self-media production scales are smaller, but due to the large size of this group, their content diversity and decentralization advantages are evident, while their relatively professional production methods make them more stable and of higher quality than purely individual folk production, and their implicit thematic designs also lead to better communication effects. These self-media products, situated between professional and amateur, constitute the middle layer of the external communication matrix, subtly disseminating the ethos and concepts of Chinese culture while

narrating individual lives, thereby constructing a cultural context over time.

3.3 Micro: Life Fragments Reproduce Cultural Symbols

The short video content shared by ordinary users cannot match the cultural depth and aesthetic height of the previous two categories, often consisting more of one-dimensional life markers. However, due to the ubiquity of digital life marking and the "intimacy" it presents, it carries a raw, authentic beauty. The factual fragments provided by everyday life narratives, like small streams, bridge the prejudice gap caused by the lack of facts about Eastern societies in traditional Orientalism, providing a foundational content pool for interpreting cultural contexts from macro constructions and meso perspectives. The massive, repetitive dissemination of this information allows Chinese cultural markers and concepts to constantly appear, precipitating as fragmented "Oriental schemas" within audience circles of various vertical short video categories, gradually stitched together through interpersonal interactions on social platforms into a complete cultural map, enabling the audience to see a holistic Eastern world.

4. Aesthetic Situations and the Mechanism of Cross-Cultural Empathy

The ultimate goal of the narrative videolization shift and discursive adaptation is a change in overseas publics' attitudes towards China. To achieve the transition from "being able to speak out" to "being listened to," our content encoding needs to shift from talking to ourselves to achieving cross-cultural empathy. For a content piece to minimize the loss of meaning during the decoding process, it needs to accomplish construction in two dimensions: besides the operationalization of vertical depth value, it also requires the connective capacity and resonance effect of horizontal breadth value, enabling people of different cultural attributes to achieve emotional resonance and relational identification within the same work—that is, cross-cultural empathy.

4.1 Constructing the Context for Cross-Cultural Empathy

Empathy is when we cross the boundaries of our own consciousness, imaginatively enter another person's world, understand the other from their standpoint or environment, enabling the establishment of trust and respect, thus making the construction of a shared space of meaning possible. To achieve empathy in cross-cultural communication, communicating actors need to create aesthetic situations that allow viewers to enter a unique cultural context, dynamically repairing understanding through interaction. The vertical screen viewing mode of short videos and the frequent use of first-person perspective shots allow the audience to experience a sense of natural immersion and embodiment. The narratively presented, high-context encoding makes decoding more diverse. Foreign audiences enter new cultural fields via social platforms—that is, entering this cultural field through likes, comments, etc., on social media platforms. This immersive atmospheric experience of cultural symbols from an aesthetic perspective leads

people from different regions, also under social pressure, to briefly escape reality, thereby generating emotional resonance and cultural identification.

4.2 Aesthetic Situations Fuse Cultural Concepts

Comparative analysis of top-ranked user-generated short video content under similar tags reveals that ordinary users' content production is highly homogeneous. For instance, among the top 100 most-liked short videos, the most popular topics include jewelry craftsmanship, synchronized swimming skills, porcelain plate painting, etc., but they all reflect a relatively singular aesthetic orientation from different angles. In contrast, the aesthetic dimensions of short video influencers are composite and multi-directional. For example, the pastoral, idyllic, primitive ecological life conveyed in the short videos of Li Ziqi and Dianxi Xiaoge cleverly integrates traditional Chinese clothing, seasonal foods, folk music, and mountain and river scenery. The beauty of the imagery, nature, life, and spirit they create constitutes a multi-dimensional cultural context. Whether it's the rhythmic beauty of the video narrative, the visual beauty of neat frames, the moral beauty of family affection, or the emotional peace brought by ordinary life, multi-layered aesthetic sensations can trigger multi-dimensional resonance. Through these short videos, Western audiences not only experience differentiated aesthetic cultures but also gain satisfaction in their psychological and emotional states based on resonance with beautiful things and spiritual connection.

5. Conclusion

On the issue of strengthening international communication capacity building, culture is both the background, the content, and the goal. The understanding, acceptance, and appreciation of Chinese culture are the ultimate manifestation of the effectiveness of international communication. In the translation of cultural concepts, the diverse actors in China's external communication occupy different strategic positions. All-round content output amplifies China's voice, but to change audience attitudes, communication actors still need to pay attention to audience feedback and focus on building a space of common ground. The construction of aesthetic situations has shown good results in triggering emotional resonance and cultural identification, providing a potential path for triggering cross-cultural empathy. The overseas expansion and construction of autonomous, controllable platforms will provide technical assurance for the realization of this path.

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The impact of artificial intelligence-driven personalized marketing strategies in China on consumer behavior

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Abstract

This study aims to explore the impact of AI-driven personalized marketing strategies on consumer behavior within China. A quantitative approach was adopted, with data collected through a questionnaire survey of 400 Chinese online shoppers. The research findings validated three core hypotheses: Firstly, AI personalized recommendation systems can effectively enhance consumer satisfaction and loyalty when providing precise and timely services, but excessive or inaccurate recommendations may have negative effects. Secondly, there are significant differences in the responses of consumers of different age groups to personalized marketing. Younger groups (such as Generation Z) are more receptive to technology-driven experiences, while older groups are more concerned about product practicality and cost-effectiveness. Lastly, consumers' concerns about data privacy significantly influence their willingness to accept personalized marketing, and transparent design (such as clear data usage policies) can effectively alleviate privacy concerns and enhance trust. This study emphasizes that enterprises need to customize strategies based on consumer segmentation characteristics and consider transparency as a key element for the success of personalized marketing.

Keywords: Artificial Intelligence, Personalized Marketing, Consumer Behavior

1. Introduction

In the era of digital economy, artificial intelligence (AI) technology is profoundly reshaping the marketing landscape. This study focuses on China, a leading market in global AI application and e-commerce development, and deeply analyzes the multi-dimensional impacts of AI-driven personalized marketing strategies on consumer behavior. The consumer decision-making process has evolved from the traditional linear model to a dynamic "perception-response-closure" model, with AI technology playing a core role in each stage, including demand stimulation, information search, option evaluation, and post-purchase evaluation.

The research background is rooted in two major trends: on one hand, AI empowerment has enabled a marketing leap from "group segmentation" to "individual prediction", significantly enhancing marketing efficiency and user experience; on the other hand, issues such as data privacy leakage and algorithm fairness have raised widespread social concerns,

making consumers weigh the value and risks when accepting personalized services. Therefore, clarifying the mechanism by which AI personalized marketing affects consumer satisfaction and loyalty, and exploring the response patterns of different groups (such as age and income differences) and the moderating effect of privacy concerns, holds significant theoretical and practical significance. Through empirical research, this study aims to provide a scientific basis for enterprises to design personalized marketing strategies that are both efficient, inclusive, and ethically sound.

1.1 Research Objectives

This study aims to comprehensively explore the specific impact of artificial intelligence-driven personalized marketing strategies on consumer behavior. The specific objectives include:

- Investigating the effect of personalized marketing strategies on consumer satisfaction and loyalty: Analyze the influence of personalized marketing strategies on consumer information search, evaluation and comparison, and purchase decision-making, as well as how to enhance the shopping experience and satisfaction of consumers, thereby strengthening brand loyalty.

Hypothesis 1: Artificial intelligence-driven personalized recommendation systems can significantly enhance consumer satisfaction and loyalty.

Reason: Customized services provide personalized solutions based on consumers' specific needs, meeting their unique demands, and thereby enhancing consumer satisfaction and brand loyalty.

- Analyzing the differences in responses to personalized marketing strategies among different consumer groups: Study the impact of demographic characteristics (such as age, gender, income, etc.) on the acceptance and response to personalized marketing strategies.

Hypothesis 2: There are significant differences in the responses of consumers of different age groups to personalized marketing strategies.

Reason: Consumers of different age groups have differences in information reception habits, consumption concepts, and technology acceptance, and thus their responses to personalized marketing strategies will also vary. For example, younger consumers may be more inclined to accept new technologies and personalized services, while middle-aged and elderly consumers may pay more attention to the practicality and cost-effectiveness of products.

- Exploring the relationship between consumers' acceptance of personalized marketing strategies and their concern for data privacy: Clarify the direct impact of privacy concerns on the effectiveness of personalized strategies and test whether transparent design can mitigate the negative effects of privacy concerns.

Hypothesis 3: Consumers' concern for data privacy will affect their acceptance of personalized marketing strategies.

Reason: With the frequent occurrence of data leakage incidents, consumers' concern for

data privacy is constantly increasing. This may affect their acceptance of personalized marketing strategies that require the provision of personal information. Consumers who are more sensitive to data privacy may be more inclined to reject personalized marketing strategies that require the provision of personal information.

1.2 Research Scope

1.2.1 Content Scope

This research will focus on artificial intelligence-driven personalized marketing strategies, including but not limited to personalized recommendation systems, customized services, and intelligent customer service, and will explore how these strategies affect consumers' purchasing decisions, satisfaction, and loyalty. At the same time, the research will also pay attention to consumers' attitudes towards data privacy and its impact on the acceptance of personalized marketing strategies.

1.2.2 Demographic Boundaries

The study will cover consumer groups of different ages, genders, incomes, and educational levels. Specifically, consumers will be divided into three groups based on age: young (under 35 years old), middle-aged, and elderly (over 60 years old); into two genders: male and female; into three income levels: low income (below 3000 yuan), middle income, and high income (above 12000 yuan); and into three educational categories: high school and below (including vocational school), college/undergraduate, and postgraduate and above.

1.2.3 Variable Scope

Independent Variables: The types and intensities of personalized marketing strategies (such as the accuracy of personalized recommendation systems, the degree of customized services), consumers' concerns about data privacy.

Dependent Variables: Consumers' purchase intentions, satisfaction, and loyalty.

Control Variables: Demographic characteristics (age, gender, income, educational level), consumers' shopping frequency and spending amount, etc.

2.4 Position Range and Duration

This study will mainly focus on the Chinese market, as China leads the world in the application of artificial intelligence technology and the development of e-commerce. At the same time, considering regional cultural differences, the research may also involve other representative markets (such as the United States, Europe, etc.) for comparative analysis, in order to more comprehensively understand the reactions of consumers in different cultural contexts to personalized marketing strategies.

2. Literature Review

The research titled "The Impact of AI-driven Personalized Marketing Strategies in China on Consumer Behavior" has collected relevant content, concepts, theories, and related research materials.

2.1 Concept and Theory of AI Personalized Marketing

Artificial intelligence personalized marketing is an intelligent marketing paradigm centered on technologies such as machine learning, natural language processing, and computer vision. It achieves customized push of products, services, and information by real-time analysis of consumers' cross-channel behavioral data. Its theoretical framework is built around three dimensions: the technical foundation relies on the integration of big data architecture to combine multi-source heterogeneous data, and through deep learning models, it explores users' potential needs, achieving a leap from "group segmentation" to "individual prediction" (Zhu Guowei et al., 2021). The core theoretical framework is based on a "four-dimensional model" of "AI cognition - AI empowerment - AI interaction - AI integration": AI cognition emphasizes that consumers' acceptance of technology is influenced by algorithm transparency and anthropomorphism, and explainability design can alleviate users' resistance to "black box decision-making"; AI empowerment covers the entire marketing 4P chain, such as generative AI accelerating product innovation, and emotion recognition technology optimizing advertising content temperature; AI interaction realizes real-time response through intelligent customer service and recommendation systems, promoting the transformation of enterprise organizational structure towards "human-machine collaboration" (Shi Feng et al., 2025).

3.2 Regarding the concepts and theories related to the influence of consumer behavior

The influence of consumer behavior refers to a dynamic social and cultural process that shapes and regulates individual consumption decisions in a market context through the interweaving of multiple symbols and power relations. Artificial intelligence reshapes the traditional consumption decision-making process (Figure 1) by reconfiguring the behavioral patterns.

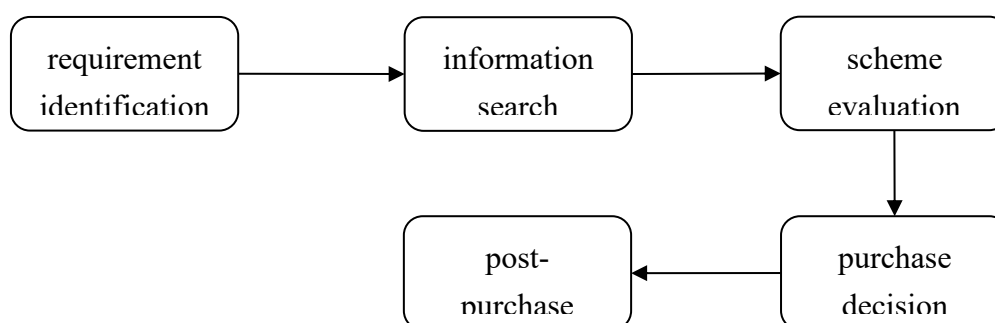


Figure 1: Traditional Consumption Decision Chain

The demand stimulation mechanism is manifested as the personalized recommendation system, based on the collaborative filtering algorithm, mining potential demands, shortening the demand identification cycle by 30%, and stimulating the non-planned purchase rate by 18%.

The change in the decision-making process is reflected in three stages: in the information search stage, AI push replaces active search; in the scheme evaluation stage, the recommendation system simplifies the comparison process, but algorithm bias may amplify the decision-making differences between price-sensitive and quality-seeking users; in the post-purchase evaluation stage, sentiment analysis technology quantifies user emotions, associates five-star ratings with sentiment values, and guides product iteration. The theoretical evolution is that the traditional AIDA model "attention - interest - desire - action" is upgraded to the "perception - response - closed loop" dynamic model. In the perception stage, AI captures interest signals in real time through page dwell time and click heat maps; in the response stage, customized content directly triggers purchase desires, and the decision-making path is shortened by 50%; in the closed loop stage, data feedback drives strategy optimization, forming a continuous improvement cycle of experience. (Feng Wenqi et al., 2024)

3. Research Methodology

This independent study, titled "The impact of artificial intelligence-driven personalized marketing strategies in China on consumer behavior", is quantitative research. Through methods such as questionnaires, opinions and data were collected from the sample group. The specific content of this study is as follows:

3.1 Population and Sample

The subjects of this study are the customer groups in China who have used online shopping. These groups include consumers of different ages, genders, incomes and educational levels. Specifically, they will be divided into three groups based on age: young, middle-aged and elderly; based on gender: male and female; based on income level: low income, middle income and high income; and based on educational level: those with junior high school education or below, those with high school/technical school education, and those with college/undergraduate education or above.

The sample group used in this study consists of the customer groups in China who have used online shopping, covering consumers of different ages, genders, incomes and educational levels. The number of participants is large. Therefore, the Cochran (1977) method for calculating sample size for unknown populations was adopted, and the following formula was used:

$$n = \frac{P(1-P)(Z)^2}{e^2}$$

Where n = sample size
P = the percentage of randomly from the target proportion.
e = the margin of error from sampling, which the researcher can
also accept a margin of error of $\pm 5\%$.

Z = a confidence level, which the researcher has set at 95%.

So, Z (the z-score) is equal to 1.96

nple that
an error

range of $\pm 5\%$ was accepted. Its representation in the formula is:

$$n = \frac{0.5(1-0.5)(1.96)^2}{0.05^2}$$

$$= 384.16 \text{ or } 385 \text{ people}$$

The sample size was calculated to be 385 people using the formula. The researchers hoped to collect an additional 15 people, which amounts to 4% of the sample size, as a backup and to increase the confidence level. Therefore, the total sample size became 400, and the sampling was conducted using the purposive sampling method in non-probability sampling. Through an online questionnaire format, the target customer group who have used online shopping within China was sought.

3.2 Research Tool

The tools used in this study were a questionnaire compiled through the research and exploration of the concepts and theories employed in this study, aiming to obtain relevant information on the impact of artificial intelligence-driven personalized marketing strategies on consumer behavior. The questionnaire is divided into the following 5 sections:

The first section: A questionnaire for respondents' basic information (containing multiple-choice questions for selection) with 5 questions, in the form of a checklist. The second section: A satisfaction survey questionnaire for personalized recommendations. The question type is closed-ended, using an interval scale, and follows the 5-point Likert scale scoring standard. The third section: A survey questionnaire on acceptance of personalized marketing strategies. The question type is closed-ended, using an interval scale, and follows the 5-point Likert scale scoring standard. The fourth section: A questionnaire on consumers' attention to data privacy. This questionnaire uses closed-ended questions, with an interval scale, and follows the 5-point Likert scale scoring standard.

3.3 Data Collection

The researchers collected and studied various data from two sources: original data and secondary data.

1. Original data refers to data that has not been publicly released by the individuals themselves. The researchers collected the data from the samples using a questionnaire as a tool. These data came from 400 customers who had used online shopping.

2. Secondary data refers to information collected by the researchers that is consistent with the research content and background. These data can be obtained from various sources, including books, journals, articles, papers, related research reports, and internet information,

and can be used to construct a conceptual framework, conduct a literature review, and develop research tools.

4. Research Results

Assumption 1: The AI-driven personalized recommendation system can significantly enhance consumers' satisfaction and loyalty.

Conclusion: Assumption 1 is largely valid, but it has certain prerequisite conditions. The AI-driven personalized recommendation system can significantly improve consumers' satisfaction and loyalty under ideal circumstances, but its effect is not absolute, and there is a "double-edged sword" effect. In an era of information overload, effective personalized recommendations can help consumers quickly filter out relevant options, greatly simplifying the "information search" and "evaluation comparison" processes, reducing decision fatigue, and improving shopping efficiency and experience. Based on algorithms such as collaborative filtering, recommendations can help consumers discover products they are interested in but had not thought of themselves, bringing them a sense of surprise, thereby creating additional value and enhancing satisfaction. However, excessive personalization can trap consumers within their inherent interests, preventing them from accessing new products and ideas, and in the long run, may cause boredom. Additionally, inaccurate, out-of-date, or overly repetitive recommendations may be perceived as harassment. For example, continuously recommending refrigerators to a user who has just purchased one is not only ineffective but also damages the user experience and reduces satisfaction.

Assumption 2: Consumers of different age groups have significant differences in their responses to personalized marketing strategies.

Conclusion: Assumption 2 is strongly valid, and the differences exist not only in age but are also closely related to other demographic characteristics. Generation Z and millennial young consumers are digital natives and have higher expectations for personalized experiences. They consider precise recommendations as a matter of course and are willing to accept personalized based on interests and social relationships. However, they are also more critical and sensitive to insincere or overly commercialized marketing. Generation X consumers are in the middle ground and can appreciate the convenience brought by personalization, but may be more cautious about data usage. They value the practicality and cost-effectiveness of recommendations and are not interested in "flashy" personalized forms. The baby boomer generation and older consumers do indeed place greater emphasis on the basic functions, reliability, and cost-effectiveness of products. They have a low acceptance of complex personalized technologies and may consider them "more gimmick than substance," and simple, direct, and based on clear historical purchases recommendations may be more effective for them.

Assumption 3: Consumers' concern about data privacy will affect their acceptance of

personalized marketing strategies.

Conclusion: Assumption 3 holds true, and "transparent design" is the key to resolving this contradiction. Its effect in reducing the negative impact of privacy concerns is significant. Consumers who are highly sensitive to data privacy will resist, distrust, or avoid personalized marketing strategies that require the collection of a large amount of personal data. Data leakage incidents will greatly amplify this effect. When consumers perceive that the data collection does not match the value of the provided services, privacy concerns will prevail, leading to a decrease in acceptance. Transparent design can effectively mitigate the negative impact of privacy concerns, and this inference is correct. Clearly informing users about the data collected, why it is collected, and how it will be used, and providing clear options and control rights, such as consent switches, data viewing and deletion rights, can significantly enhance users' trust. Transparent communication enables users to understand the value they are "exchanging" with their data. For example, to recommend more suitable products for you, we need to know your browsing history. When the value is greater than the privacy risk, users are more likely to participate. Transparent communication eliminates this uncertainty. Even if the policy itself is strict, as long as it is clear and explicit, it is more likely to be accepted by users than a lenient but vague policy.

5. Conclusions and Discussion

Based on the survey results, we can draw the following conclusions. Personalized recommendation systems are powerful tools for enhancing satisfaction and loyalty, but they are not a panacea. The key to their success lies in accuracy, timeliness, and transparency. The assumption will only hold true if the recommendations truly create value for consumers rather than causing them distress. A one-size-fits-all personalized strategy is ineffective. The correctness of assumption 2 precisely indicates the core principle for implementing personalized marketing: consumer segmentation must be carried out. The marketing strategy should be tailored according to the core characteristics of the target customer group (especially age, but not limited to age). There is a significant negative correlation between privacy concerns and the acceptance of personalization. However, enterprises are not powerless. By implementing user-centered data transparency and control strategies, enterprises can build trust and prove to consumers that their data is being used responsibly, thereby successfully alleviating privacy concerns and making consumers more willing to participate in personalized interactions in exchange for value. Transparency is not an option but a necessary condition for the long-term success of personalized marketing.

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The Relationship between Product Design Innovation and Corporate Value in the Smartphone Market (2020–2025)

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Abstract

As competition in the global smartphone market grows increasingly fierce, the mechanism behind corporate value creation is shifting from the traditional capital-driven model to a multi-dimensional framework centered on design, innovation, and governance. Prior research has mostly focused on technological innovation or financial performance, leaving a gap in systematic studies that explore how multiple interrelated factors—including a firm’s design innovation efforts, brand premium, corporate governance practices, and R&D investment—collectively shape corporate value. To address this gap, this study uses major global smartphone enterprises operating between 2020 and 2025 as its sample and develops an integrated analytical model titled “Design Elements—Brand Premium—Governance Capability—R&D Intensity—Corporate Value” to examine the operational mechanisms of these multi-dimensional factors in driving corporate value.

A quantitative research approach was adopted, combining data from questionnaire surveys and secondary databases for empirical testing. Analysis using Structural Equation Modeling (SEM) revealed three key findings: First, product design innovation exerts a significant positive impact on a firm’s comprehensive value. Second, brand premium functions as a partial mediator in the relationship between design innovation and corporate value. Third, both corporate governance capability and R&D intensity have notable moderating effects on the core relational pathways. Furthermore, listed enterprises demonstrated higher efficiency in converting design innovation into brand premium compared to non-listed firms, suggesting that governance transparency and R&D spending enhance the value creation process.

From the perspective of Development Administration, this study uncovers the collaborative relationship between design innovation and governance capability in corporate value creation, expanding interdisciplinary research at the intersection of innovation management and corporate governance theories. The results not only add to the body of empirical management research in the smartphone industry but also offer practical guidance for companies in developing economies regarding design-driven innovation, brand development, and strategic governance.

Keywords: Smartphone market; Product design innovation; Brand premium; Corporate governance capability; R&D intensity; Corporate value; Development Administration

1. Introduction

Against the backdrop of global economic digitalization and evolving industrial competition, the smartphone market has emerged as a quintessential industry where

technological innovation, brand strategy, and design thinking converge. As the industry matures, marginal differences in hardware performance are narrowing, and the focus of corporate competition is shifting from “technological performance” to “value creation.” This value creation process increasingly relies on the synergistic interaction of multi-dimensional factors, including product design, brand image, corporate governance, and R&D intensity [1][2].

Traditional research on corporate value has mostly centered on financial performance, market share, or capital structure, but it has inadequately explored how non-financial factors—such as design innovation and brand governance—influence overall corporate value [3]. Particularly in the smartphone industry, design innovation not only shapes consumers’ purchasing preferences and brand loyalty but also translates into long-term market and capital value through corporate governance mechanisms, R&D investment, and innovation ecosystems [4][5]. For instance, leading enterprises like Apple, Samsung, and Huawei have achieved sustained brand premium and shareholder value growth through design-driven innovation and systematic governance models, highlighting the complex interactive mechanism linking “design—governance—value” [6].

Nevertheless, the existing literature exhibits three notable gaps. First, most studies treat design innovation as a one-dimensional concept (e.g., product aesthetics or functional improvement) while overlooking its interactions with brand strategy, governance mechanisms, and R&D investment [7]. Second, research samples have predominantly focused on listed enterprises, neglecting the unique innovation and design governance mechanisms of non-listed firms—thus limiting the generalizability of findings [8]. Third, few studies have adopted the lens of Development Administration to examine how internal corporate governance capabilities moderate the translation of innovation outcomes into value creation. Development Administration emphasizes organizational capacity building, institutional coordination, and strategic implementation—perspectives that help explain why enterprises exhibit significant performance differences in converting design innovation into value, even under similar market conditions [9][10].

To address these theoretical and practical gaps, this study focuses on global smartphone enterprises (2020–2025) and proposes an integrated analytical framework. It systematically explores the mechanisms of corporate value creation across four dimensions: design innovation, brand premium, corporate governance capability, and R&D intensity. By combining questionnaire data with secondary data, this study constructs and validates a multi-dimensional Structural Equation Model (SEM) to empirically test the following core propositions:

- (1) Do product design elements directly affect corporate value?
- (2) Does brand premium mediate the relationship between design innovation and corporate value?
- (3) Do corporate governance capability and R&D intensity exert significant moderating effects on the relationship between design innovation and corporate value [11][12]?

Additionally, this study compares differences in design innovation pathways between listed and non-listed enterprises to verify the amplifying effect of capital market mechanisms on innovation governance [13]. This analysis not only enriches empirical research at the

intersection of innovation management and corporate governance but also offers insights into development-oriented management for enterprises in emerging markets: long-term corporate value creation should not rely solely on technological innovation or cost control but also on institutional design and organizational capacity building to systematically translate design value into tangible outcomes.

In summary, this study pursues three primary objectives:

Develop a multi-dimensional corporate value model integrating design innovation, brand premium, governance capability, and R&D intensity;

From the perspective of Development Administration, explain how internal corporate governance influences the external valorization of innovation outcomes;

Through quantitative empirical analysis of global samples, identify differences in value creation across different development stages of the smartphone market.

The remainder of this paper is structured as follows: Chapter 2 outlines the research design, data sources, and variable definitions; Chapter 3 presents empirical analyses and hypothesis testing results; Chapter 4 summarizes key findings and discusses their theoretical and practical implications. The innovation of this study lies in its multi-dimensional analytical framework, which integrates design innovation, brand strategy, and governance mechanisms into a unified value system—providing quantitative evidence and theoretical support for innovation management and corporate development in the global smartphone industry [14][15].

2. Methodology

2.1 Research Design and Data Sources

This study aims to explore the mechanisms through which multi-dimensional factors influence corporate value in the smartphone market. A quantitative research design was employed, with global smartphone enterprises (2020–2025) as the sample. Confirmatory analysis was conducted using a combination of questionnaire surveys and secondary database data.

Samples were selected based on the following criteria: (1) Enterprises with significant market share or innovative influence in the smartphone market; (2) Public disclosure of key financial and innovation indicators (including R&D expenditure, number of design patents, and brand valuation data); (3) Accessible data spanning from 2020 to 2025. Considering data availability and representativeness, a total of 30 major global smartphone enterprises were selected, including both listed and non-listed firms (e.g., Apple, Samsung, Huawei, Xiaomi, OPPO, Vivo, Transsion, Sony, Google, OnePlus).

Data were sourced from three channels:

(1) **Primary Data (Questionnaires):** Questionnaires were distributed to middle- and senior-level managers and employees in the design and R&D departments of sample enterprises, yielding 312 valid responses. The questionnaire covered quantitative indicators related to product design innovation, user experience design, sustainable design, and governance mechanisms. A 5-point Likert Scale was used, where “1” indicated “Strongly Disagree” and “5” indicated “Strongly Agree.”

(2) Secondary Data: This included Brand Finance’s (2024) Brand Value Report, IDC’s (2024) Smartphone Shipment Data, Statista’s (2025) Market Share Data, and enterprises’ annual reports and sustainability reports.

(3) Financial and Non-Financial Indicators: Corporate value was measured using a composite index incorporating Tobin’s Q, Brand Value, and Return on Equity (ROE) to enhance the robustness of results [16][17].

The overall research framework is illustrated in Figure 2.1:

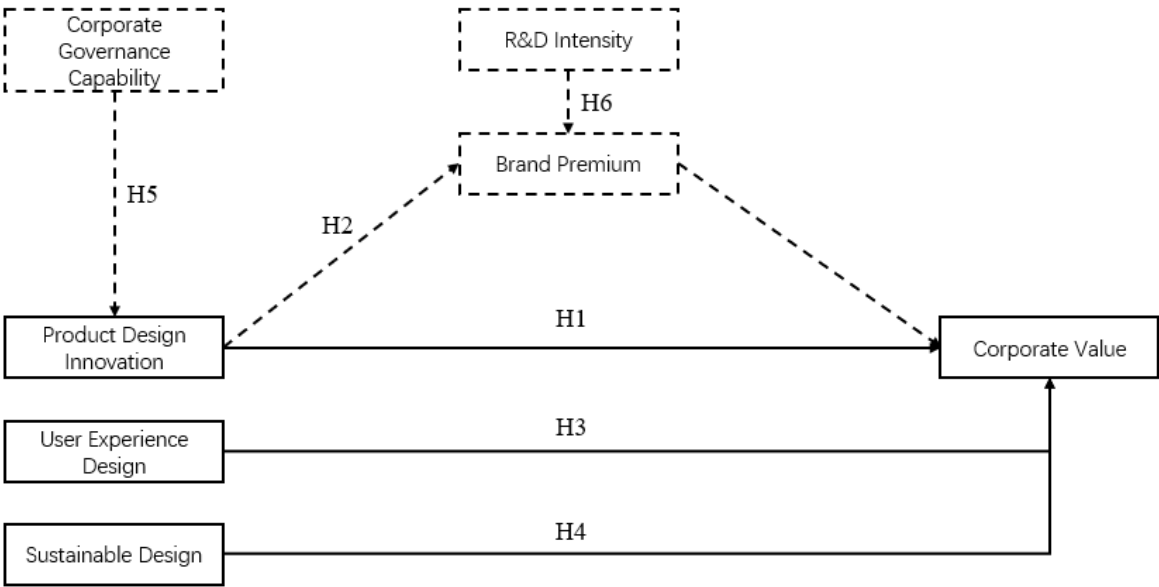


Figure 2.1: Theoretical Framework of the Research Model

2.2 Variable Definition and Model Specification

Drawing on previous literature and doctoral dissertation models, this study develops an integrated model titled “Design Innovation—Brand Premium—Governance Capability—R&D Intensity—Corporate Value.” The definition and quantification of each variable are detailed in Table 2.1:

Table 2.1: Definition and Measurement of Key Variables

Variable Category	Variable Name	Operational Definition	Measurement Method / Data Source
Independent Variables	Product Design Innovation	The degree of originality and differentiation in a firm’s product function, structure, and visual design [18]	Questionnaire + Number of design patents
	User Experience Design	The degree of investment in user interface, interactive experience, and emotional design [19]	Questionnaire (Likert Scale)
	Sustainable Design	Design features reflecting environmental protection, energy efficiency, and recyclability [20]	Questionnaire + Enterprise ESG reports

Mediating Variable	Brand Premium	Consumers' willingness to pay a premium based on brand perception [21]	Brand Finance data + Questionnaire
Moderating Variables	Corporate Governance Capability	A firm's overall governance level in strategic decision-making, organizational coordination, and information transparency [22]	Questionnaire + Annual governance reports
	R&D Intensity	The ratio of a firm's annual R&D expenditure to total revenue [23]	Annual financial data
Dependent Variable	Corporate Value	A firm's comprehensive value performance in market, financial, and brand dimensions [24]	Composite index of Tobin's Q, ROE, and Brand Valuation

2.3 Research Hypotheses and Model Equations

To test the mechanisms through which multi-dimensional factors influence corporate value, this study proposes the following hypotheses (consistent with the doctoral dissertation):

H1: Product design innovation has a significant positive impact on corporate value.

H2: Brand premium mediates the relationship between product design innovation and corporate value.

H3: User experience design has a significant positive impact on corporate value.

H4: Sustainable design has a significant positive impact on corporate value.

H5: Corporate governance capability positively moderates the relationship between product design innovation and corporate value.

H6: R&D intensity positively moderates the relationship between brand premium and corporate value.

Based on these hypotheses, the following Structural Equation Model (SEM) is constructed:

$$CV = \beta_1 DI + \beta_2 UX + \beta_3 SD + \beta_4 BP + \beta_5 (DI \times CG) + \beta_6 (BP \times RD) + \varepsilon$$

Where:

CV = Corporate Value

DI = Design Innovation

UX = User Experience Design

SD = Sustainable Design

BP = Brand Premium

CG = Corporate Governance Capability

RD = R&D Intensity

The model was estimated and validated using AMOS and SmartPLS software.

2.4 Data Analysis Method

A two-stage analytical approach was adopted:

- (1) Confirmatory Factor Analysis (CFA): Used to test the convergent validity and discriminant validity of latent variables.
- (2) Structural Equation Modeling (SEM): Used to validate hypothetical pathway relationships.

Additionally, reliability and validity tests were conducted for the model: Cronbach's α coefficients exceeded 0.7, and Average Variance Extracted (AVE) values exceeded 0.5—indicating good internal consistency and convergent validity of the scale [25][26]. To address Common Method Bias (CMB), Harman's Single-Factor Test was applied, and strategies such as anonymous questionnaires and phased data collection were used to minimize potential bias [27].

3. Results

3.1 Descriptive Statistics and Reliability Test

After preprocessing the 312 valid questionnaires, this study first conducted descriptive statistical analysis on the mean, standard deviation, and correlation of each variable. Among the samples, Asian enterprises accounted for 53%, European and American enterprises for 37%, and enterprises from other regions for 10%. There were 18 listed enterprises and 12 non-listed enterprises. Enterprise scale ranged from annual revenue of \$1 billion to \$300 billion, ensuring good representativeness.

Reliability test results showed that Cronbach's α coefficients for all latent variables exceeded 0.7 (see Table 3.1), indicating good internal consistency of the questionnaire. Design Innovation (0.86), Brand Premium (0.83), and Governance Capability (0.82) exhibited the highest reliability—demonstrating high stability and consistency in the measurement of these dimensions [28].

Table 3.1: Reliability and Validity Test Results for Latent Variables

Variable	Cronbach's α	Composite Reliability (CR)	Average Variance Extracted (AVE)	Result
Design Innovation	0.86	0.89	0.67	Pass
User Experience Design	0.82	0.87	0.61	Pass
Sustainable Design	0.80	0.85	0.58	Pass
Brand Premium	0.83	0.88	0.63	Pass

Corporate Governance Capability	0.82	0.86	0.59	Pass
R&D Intensity	0.79	0.84	0.57	Pass
Corporate Value	0.88	0.91	0.66	Pass

All latent variables had AVE values > 0.5 and CR values > 0.8 , meeting the validity criteria proposed by Fornell and Larcker (1981) [29]. Additionally, Harman's Single-Factor Test revealed that variance explained by a single factor accounted for only 32.4% of total variance (below the 40% threshold), indicating no significant Common Method Bias (CMB) [30].

3.2 Structural Equation Modeling Analysis

Structural Equation Modeling analysis was conducted using SmartPLS 4.0. The model exhibited good overall fit (SRMR = 0.062, NFI = 0.91, CFI = 0.93), indicating a strong match between the data and the model. Path coefficients and significance test results are presented in Table 3.2:

Table 3.2: Hypothesis Path Analysis Results

Hypothesis	Path Relationship	Standardized Coefficient (β)	t-value	p-value	Validation Result
H1	Design Innovation $\rightarrow$ Corporate Value	0.31	5.12	<0.001	Supported
H2	Design Innovation $\rightarrow$ Brand Premium $\rightarrow$ Corporate Value	0.24	4.68	<0.001	Supported
H3	User Experience Design $\rightarrow$ Corporate Value	0.27	4.35	<0.001	Supported
H4	Sustainable Design $\rightarrow$ Corporate Value	0.19	3.24	0.002	Supported

Hypothesis	Path Relationship	Standardized Coefficient (β)	t-value	p-value	Validation Result
H5	Governance Capability $\times$ Design Innovation $\rightarrow$ Corporate Value	0.22	3.76	<0.001	Supported
H6	R&D Intensity $\times$ Brand Premium $\rightarrow$ Corporate Value	0.17	2.94	0.004	Supported

Results indicated that all hypothetical pathways were statistically significant. Design Innovation ($\beta = 0.31$) had the strongest direct impact on Corporate Value, highlighting product innovation as the primary driver of corporate value. Brand Premium played a partial mediating role between Design Innovation and Corporate Value (indirect effect $\beta = 0.24$), validating the market translation effect of design outcomes.

Furthermore, Corporate Governance Capability exerted a significant positive moderating effect on the “Design Innovation $\rightarrow$ Corporate Value” pathway—suggesting that enterprises with higher governance levels are more effective at converting innovation outcomes into financial and market value. This aligns with the emphasis on “organizational capacity building” for performance translation in Development Administration [31]. Meanwhile, R&D Intensity had a significant moderating effect ($\beta = 0.17$), indicating that R&D investment amplifies the impact of Brand Premium on Corporate Value—particularly in non-listed enterprises.

3.3 Group Comparison Analysis (Listed vs. Non-Listed Enterprises)

To further examine the role of capital market mechanisms, this study conducted Multi-Group Analysis (MGA) by dividing the sample into listed and non-listed enterprise groups. Results showed that in listed enterprises, the impact coefficient of Design Innovation on Corporate Value was higher ($\beta = 0.36$, $p < 0.001$), whereas this pathway was relatively weaker in non-listed enterprises ($\beta = 0.25$, $p < 0.01$). Conversely, the moderating effects of Governance Capability and R&D Intensity were more pronounced in non-listed enterprises—indicating that internal management mechanisms provide a compensatory effect for innovation value translation.

Further analysis revealed that the mediating effect of Brand Premium was more significant in listed enterprises, suggesting that capital market information transparency enhances the transmission of consumer trust and value perception toward brands [32]. These findings clarify the interactive logic between “market mechanisms—governance capability—design innovation” and provide insights for innovation strategies under different enterprise structures.

3.4 Findings and Theoretical Implications

Overall, the results supported all six hypotheses proposed in the doctoral dissertation and validated the integrated model of multi-dimensional factors jointly driving corporate value creation in the smartphone industry. Specific findings are as follows:

- (1) Design innovation is a core source of corporate value growth, but its effectiveness depends on the support of brand and governance mechanisms;
- (2) Brand premium acts as a bridge in translating innovation outcomes into value;
- (3) Governance capability and R&D intensity have amplifying effects, with differentiated roles across enterprise types.

From the perspective of Development Administration, these findings further confirm the “design—governance—value” linkage mechanism—indicating that corporate institutional design and capacity building are critical for realizing innovation performance [33]. For enterprises in developing economies, building an innovation system integrating design-driven strategies and governance capabilities is a key pathway to achieving long-term corporate value and industrial upgrading.

4. Conclusion and Future Work

4.1 Research Conclusions

Based on empirical data from the global smartphone market (2020–2025), this study systematically examined the impact of multi-dimensional factors—including product design innovation, brand premium, corporate governance capability, and R&D intensity—on corporate value. An integrated Structural Equation Model (SEM) was constructed, and six hypotheses (H1–H6) were validated using questionnaire and secondary data.

Key results are as follows: First, design innovation is a core driver of corporate value. Design not only enhances product differentiation and consumer experience but also strengthens enterprises’ market position through brand cognition and emotional value—fostering sustainable competitive advantages [34]. Second, brand premium plays a partial mediating role between design innovation and corporate value, indicating that design innovation only creates value when it is perceived by the market and translated into brand trust.

Third, corporate governance capability and R&D intensity have significant moderating effects. Governance capability enhances the efficiency of translating design innovation outcomes into value by improving organizational transparency and decision-making efficiency; R&D intensity amplifies the impact of brand premium on corporate value. This implies that enterprises with sound governance mechanisms and sufficient R&D investment are more likely to gain recognition from capital markets and consumers—ultimately driving higher corporate value [35].

Additionally, group comparison results showed that listed enterprises exhibit higher efficiency in converting brand premium into market performance, while non-listed enterprises rely more on internal governance capability and R&D investment to translate design value. This suggests that capital market mechanisms and organizational capacity building are two distinct but complementary pathways to value creation [36].

In summary, the findings validate the core theoretical model proposed in the doctoral dissertation: Corporate value creation in the smartphone market is the result of synergistic interactions among multi-dimensional factors—with design innovation as the foundational driver, brand premium as the mediating bridge, and governance capability and R&D intensity as key amplifying mechanisms.

4.2 Theoretical Contributions

This study makes three theoretical contributions:

(1) Expanding the theoretical boundaries of design innovation and corporate value: Previous studies have focused primarily on the functional or perceptual dimensions of design. In contrast, this study integrates design innovation into a systematic corporate value model, revealing how design innovation influences corporate value through brand and governance mechanisms [37].

(2) Introducing the perspective of Development Administration into corporate research: Development Administration emphasizes the importance of institutional capacity and organizational coordination. This study demonstrates that corporate governance capability is not merely a management mechanism but also a “translation engine” for realizing innovation outcomes and creating value—providing a new theoretical explanation for institutional building in enterprises of developmental states [38].

(3) Constructing a multi-dimensional value creation model: By considering the interactive mechanisms of design innovation, brand premium, governance capability, and R&D intensity, this study proposes an extensible analytical framework for corporate value—laying the groundwork for future research.

4.3 Practical Implications

The findings offer practical insights for corporate management:

(1) Strengthen the strategic role of design innovation: Smartphone enterprises should elevate design innovation from a product development activity to a core corporate strategy, leveraging design-driven approaches to build differentiated competitive advantages.

(2) Establish a transmission mechanism for brand premium: Enterprises should prioritize brand value shaping and communication, translating design outcomes into market trust and premium capacity to enhance overall corporate value.

(3) Optimize governance structures to support innovation translation: Sound corporate governance mechanisms help reduce uncertainty in innovation decision-making and improve the commercialization efficiency of organizational execution and innovation outcomes.

(4) Balance R&D intensity and capital efficiency: For enterprises in emerging markets, R&D investment should align with design innovation to create a “value resonance” effect, where technological innovation and design innovation advance in parallel [39].

4.4 Limitations and Future Research

Despite constructing a systematic theoretical and empirical framework, this study has several limitations. First, the sample focuses on the top 30 global smartphone enterprises—

while representative, it fails to capture the heterogeneity of small and medium-sized enterprises. Second, questionnaire data relies on self-reported information from enterprises, which may introduce subjective bias. Future research could incorporate consumer-side data to further validate the interactive relationship between brand perception and design innovation.

Additionally, this study adopts the perspective of Development Administration. Future research could integrate institutional theory or dynamic capability theory to deepen the understanding of innovation performance differences under different governance mechanisms [40][41].

4.5 Summary

In conclusion, this study validates the multi-dimensional impact mechanisms of design innovation, brand premium, governance capability, and R&D intensity on corporate value in the smartphone market—constructing a corporate value model with both theoretical depth and practical relevance. The findings indicate that corporate value creation is not a one-dimensional economic outcome but a complex process shaped by institutions, design, and markets.

By integrating Development Administration with innovation management, this study provides a new theoretical framework for understanding the “innovation-to-value” management mechanism and offers decision-making references for sustainable competition in the global smartphone industry.

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Localization Strategies and Performance Outcomes of Chinese New Energy Vehicle Brands in Thailand: Comparative Case Studies of BYD, MG, and GWM

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Abstract

This paper aims to examine how localization strategies influence consumer perceptions and market performance of Chinese new energy vehicle (NEV) brands in Thailand, focusing on the comparative cases of BYD, MG, and GWM. As the global automotive industry shifts toward electrification, Thailand has emerged as a strategic hub in Southeast Asia under its “30@30” policy, which targets 30 percent zero-emission vehicle production by 2030. Despite favorable policies, Chinese NEV brands face challenges in overcoming long-established Japanese brand dominance and in earning local consumer trust. Based on an extensive review of international and regional literature, this study develops a conceptual framework linking localization strategies with consumer-level constructs—perceived value, brand trust, customer satisfaction, and behavioral intentions. The research design employs a quantitative approach using a structured questionnaire and plans to analyze relationships through Structural Equation Modeling (SEM) once data collection is completed. The expected findings suggest that effective localization, including product adaptation, promotion effectiveness, distribution accessibility, and after-sales reliability, can significantly enhance perceived value and trust, leading to stronger purchase and recommendation intentions. The study contributes theoretically by integrating localization and consumer perception models within an emerging market context, and practically by offering strategic insights for Chinese NEV brands expanding in Southeast Asia. These insights will guide policymakers and enterprises in designing culturally resonant, consumer-centered localization strategies that sustain long-term competitiveness and trust in the Thai NEV market.

Keywords: New Energy Vehicle (NEV), Chinese NEV Brands, Thai NEV Market, Localization Strategy Path, Cultural Fit, Market Performance

1. Introduction

1.1 Background of the Study

The global automotive industry is experiencing a historic transformation driven by technological innovation, environmental sustainability, and evolving consumer expectations. The transition from internal combustion engines to new energy vehicles (NEVs) has redefined competition and industrial structure worldwide (Chen, 2020). Supported by government incentives, battery innovation, and consumer demand for green mobility, NEVs have moved rapidly from niche products to mainstream choices. China, as the world’s largest NEV market, has leveraged strong supply chains, policy support, and manufacturing capacity to

become a global leader (Wang, 2021). Building on domestic success, Chinese NEV brands such as BYD, MG, and Great Wall Motors (GWM) are expanding internationally, particularly across emerging markets. Their success abroad now depends not only on technological competitiveness and cost advantages but also on how effectively they localize their strategies to align with host-market cultures and consumer expectations (Liu & Zhao, 2018).

1.2 Strategic Significance of the Thai NEV Market

Thailand plays a central role in Southeast Asia's automotive ecosystem, known as the "Detroit of Asia." With the Thai government's "30@30" policy—aiming for 30 percent of all vehicle production to be zero-emission by 2030—the country has become a major destination for global NEV investment (Piyapong, 2020). The Board of Investment (BOI) has introduced tax incentives, import-duty exemptions, and subsidies for EV buyers, attracting major Chinese firms to establish production bases and dealerships in Thailand (Chonsalasin et al., 2024). However, despite favorable conditions, the market remains dominated by Japanese brands such as Toyota, Honda, and Nissan, which enjoy deep-rooted consumer trust. For Chinese NEV brands, succeeding in Thailand requires not only affordability and technology but also cultural adaptation, trust-building, and service localization that respond to Thai consumers' values and lifestyle preferences (Johri & Petison, 2008).

1.3 Research Problem and Gaps

Existing studies on NEVs primarily focus on developed economies or on China's domestic market, emphasizing policy and technology rather than consumer perceptions in emerging markets (Xu, 2021). Empirical evidence from Southeast Asia—especially Thailand—remains limited. Moreover, while localization is widely acknowledged as crucial in international marketing, few studies systematically link localization practices such as product adaptation, promotion, and after-sales services with consumer perceptions and behavioral intentions (Gao, 2022). This gap restricts both theoretical understanding and practical application for firms operating across culturally distinct environments.

1.4 Research Objectives and Questions

This study aims to examine how localization strategies adopted by Chinese NEV brands in Thailand influence consumer perceptions—specifically perceived value, brand trust, and customer satisfaction—and how these perceptions, in turn, affect behavioral intentions. It also compares localization approaches among BYD, MG, and GWM to identify brand-specific strengths and weaknesses. The research seeks to develop an integrated framework that connects firm-level localization with consumer-level responses to guide sustainable market expansion in emerging economies.

1.5 Significance of the Study

The study contributes theoretically by extending localization and consumer perception models to the context of Southeast Asia, where cultural embeddedness strongly shapes market outcomes. Practically, it offers strategic insights for Chinese NEV manufacturers seeking to enhance brand reputation and consumer acceptance in Thailand. By linking localization with

consumer psychology and behavioral intention, this research provides a foundation for future empirical testing and policy design, supporting both corporate competitiveness and Thailand's broader EV transition goals (Ghina, 2021).

2. Literature Review

2.1 Global Development of the New Energy Vehicle (NEV) Industry

The transformation of the global automotive industry has been driven by decarbonization, technological advancement, and the evolution of consumer values. Under global carbon neutrality goals and environmental awareness, the transition from traditional internal combustion engines (ICEs) to new energy vehicles (NEVs) has become irreversible (IEA, 2023). The market share of electric vehicles continues to grow rapidly, with China, Europe, and the United States emerging as the three major centers of development (Wang, 2021). The dramatic decline in battery costs and the improvement of charging infrastructure have further accelerated this shift. Between 2010 and 2022, the average cost of lithium-ion batteries fell by over 85%, enabling mass adoption of electric mobility (BloombergNEF, 2022).

From a policy perspective, governments have played a decisive role in facilitating this transition. The European Union's "Fit for 55" package mandates zero emissions from new cars by 2035, while the United States has expanded electric vehicle tax credits under the Inflation Reduction Act (European Commission, 2021). In Asia, China's "dual-credit policy" and industrial subsidies have built the world's largest NEV market, accounting for nearly 60% of global EV sales in 2022 (Xu, 2021). Such policies not only support domestic demand but also promote technological upgrading and global competitiveness. These transformations have reshaped the global value chain, integrating battery technology, data connectivity, and sustainability into new industrial paradigms (Gao, 2022).

2.2 Internationalization of Chinese NEV Brands

China's NEV industry has transitioned from a domestically driven market to a global exporter of both technology and brands. Firms such as BYD, MG (under SAIC Motor), and Great Wall Motors (GWM) represent the forefront of this internationalization wave. Their expansion reflects what has been termed a "springboard strategy," whereby latecomer firms leverage internationalization to build legitimacy, gain technological experience, and offset domestic overcapacity (Luo & Tung, 2007).

BYD, for instance, has adopted a vertically integrated business model encompassing batteries, chips, and vehicle production, allowing cost leadership and technological control (Zhang, 2019). MG, through its hybrid identity combining British heritage and Chinese manufacturing, emphasizes brand familiarity and design quality to appeal to global consumers (Zhou, 2020). Meanwhile, GWM has targeted younger segments through its ORA brand, focusing on distinctive design and digital connectivity. Their collective success demonstrates the strategic maturity of Chinese NEV firms in combining cost efficiency with branding innovation.

However, as these firms expand into culturally diverse markets such as Southeast Asia, they face new challenges that extend beyond product performance. Building consumer trust

and adapting to local cultural contexts have become decisive factors for sustainable competitiveness (Johri & Petison, 2008). This underlines the growing significance of localization strategies in international marketing theory and practice.

2.3 The Thai Automotive Market and NEV Transition

Thailand stands as the largest automobile producer in Southeast Asia and serves as a major export hub for ASEAN. The government's "30@30" policy—targeting 30% zero-emission production by 2030—illustrates its commitment to electrification (Office of Industrial Economics, 2021). Through subsidies, tax exemptions, and infrastructure investments, Thailand has actively attracted NEV manufacturers from China, Japan, and Europe (Piyapong, 2020).

Despite these advantages, the Thai market remains characterized by the historical dominance of Japanese automakers such as Toyota, Honda, and Nissan, whose decades-long presence has cultivated deep consumer loyalty and perceptions of reliability (Theodosiou & Leonidou, 2003). Studies indicate that Thai consumers continue to associate Japanese brands with quality and after-sales security, whereas Chinese brands are perceived as newcomers that must prove their credibility (Liu & Zhao, 2018). Thus, localization—through culturally tailored marketing, reliable service, and transparent communication—becomes essential for winning consumer confidence.

Recent research also shows that consumer adoption of NEVs in Thailand is still in an early phase, driven primarily by young, urban, and environmentally conscious consumers (Chonsalasin et al., 2024). For broader market penetration, firms must address perceived risks regarding safety, resale value, and charging convenience. The effectiveness of localization will therefore determine whether Chinese NEV brands can convert policy-driven opportunities into genuine consumer acceptance.

2.4 Theoretical Perspectives on Localization and Consumer Perception

In international marketing scholarship, the debate between standardization and adaptation has long been central. Levitt (1983) argued that global markets could be served through standardized products due to converging consumer preferences. However, subsequent empirical studies challenged this view, showing that cultural, social, and institutional contexts demand adaptive strategies (Zou & Cavusgil, 2002; Theodosiou & Leonidou, 2003). In markets like Thailand, cultural values—such as collectivism, respect for hierarchy, and Buddhist symbolism—deeply influence purchasing decisions. Thus, adaptation through localization is not optional but necessary for cultural legitimacy (Cui & Liu, 2000).

Localization involves multidimensional processes: product adaptation, language and communication adjustments, distribution accessibility, and after-sales service (Johri & Petison, 2008). These factors enhance perceived relevance and reduce consumer uncertainty. Research grounded in commitment-trust theory (Morgan & Hunt, 1994) suggests that trust mediates the relationship between firms' localization efforts and long-term customer satisfaction. When consumers perceive that a brand understands their needs and values, they are more likely to view it as credible and reliable (Cronin et al., 2000).

In the NEV context, localization influences multiple consumer perception variables. Product adaptation affects functional and economic value; culturally resonant promotion strengthens emotional attachment; accessible distribution and dependable after-sales service enhance satisfaction and trust (Liu & Zhao, 2018). These constructs together determine behavioral intentions, such as purchase and recommendation likelihood, which are strong indicators of brand performance in emerging markets (Oliver, 1999).

2.5 Conceptual Gaps and Research Contribution

Although existing literature affirms the importance of localization, most studies emphasize managerial perspectives rather than consumer-level mechanisms. Few models integrate localization dimensions with psychological constructs like perceived value, brand trust, and satisfaction (Ghina, 2021). Furthermore, research on NEV adoption in Southeast Asia remains fragmented and lacks comparative evidence across different Chinese brands.

This study addresses these gaps by developing a conceptual framework that connects localization strategies with consumer perceptions and behavioral intentions. It emphasizes how Chinese NEV firms—BYD, MG, and GWM—translate localized efforts into tangible consumer outcomes. The model contributes theoretically by expanding localization research into emerging market contexts and practically by offering a framework for firms to align global strategies with local consumer values.

In summary, the literature highlights that effective localization is the key bridge between firm strategy and consumer acceptance. For Chinese NEV brands operating in Thailand, cultural embeddedness, trust-building, and consumer-centric adaptation are not peripheral tactics but central mechanisms determining competitive success.

3. Conclusion

This conceptual paper set out to explore how localization strategies shape consumer perceptions and market performance of Chinese new energy vehicle (NEV) brands in the Thai market. Drawing on an extensive review of prior studies and the contextual analysis of Thailand's evolving automotive ecosystem, the study proposes a conceptual framework linking localization strategies with consumer-level constructs—perceived value, brand trust, customer satisfaction, and behavioral intentions. Although empirical testing remains for future work, the framework provides a theoretical foundation for understanding how Chinese NEV brands can transform supportive policies and cost advantages into genuine consumer acceptance through strategic localization.

At the global level, the transformation of the automotive industry from internal combustion engines to electric mobility reflects not merely a technological shift but a redefinition of industrial competition, consumer values, and sustainability. China's NEV sector has become a central actor in this transformation, benefiting from policy incentives, strong supply chains, and continuous innovation (Chen, 2020). As Chinese brands extend their presence internationally, particularly in Southeast Asia, their ability to adapt to host-market cultures becomes a decisive determinant of competitiveness. Thailand, under its “30@30” policy, represents both opportunity and challenge: while the government provides tax incentives, infrastructure, and investment support, the market's deep-rooted loyalty to Japanese brands

creates high entry barriers for newcomers (Piyapong, 2020). Therefore, the success of Chinese NEV brands depends less on their manufacturing capacity and more on their ability to localize effectively—culturally, symbolically, and operationally.

The conceptual framework presented in this study positions localization as the key mechanism linking firm-level strategy to consumer-level perception. It conceptualizes localization not as a single action but as a multidimensional process involving product adaptation, promotional resonance, distribution accessibility, and after-sales reliability. These dimensions interact to shape consumer perceptions of value and trust. When consumers perceive that a brand understands their cultural expectations, delivers contextually relevant products, and commits to long-term service, they develop stronger brand trust and satisfaction (Morgan & Hunt, 1994; Johri & Petison, 2008). In turn, these positive perceptions enhance behavioral intentions such as purchase likelihood and brand advocacy, both of which serve as early indicators of sustained market performance (Cronin et al., 2000).

Theoretically, this study contributes to the literature on international marketing and consumer behavior by integrating localization theory with psychological constructs of consumer perception. It advances the notion that localization is not merely an operational adaptation but a form of cultural embeddedness—an alignment between the brand's market presence and the host country's social and cultural context (Granovetter, 1985). By positioning localization as both a strategic and symbolic process, the paper extends existing models of standardization versus adaptation and situates them within the fast-evolving NEV industry. Furthermore, the study enriches the concept of “performance outcomes” by incorporating non-financial indicators such as satisfaction, trust, and purchase intention, which are essential measures of long-term competitiveness in emerging markets.

From a managerial standpoint, the conceptual model offers valuable implications for Chinese NEV firms entering Thailand and other Southeast Asian markets. First, product localization should move beyond technical adjustments to reflect local driving habits, climate conditions, and cultural aesthetics. Second, marketing and communication strategies must resonate with Thai social values—emphasizing community, sustainability, and trustworthiness rather than purely technological superiority. Third, investment in after-sales networks and customer care is essential for reinforcing reliability and reducing perceived risks associated with new technologies. These practices, when aligned cohesively, can help Chinese brands like BYD, MG, and GWM bridge the trust gap and establish legitimacy in a market historically dominated by Japanese automakers.

For policymakers and industry stakeholders, the findings highlight the importance of supporting firms' localization efforts through coordinated infrastructure and consumer education. While Thailand's “30@30” policy and Board of Investment incentives provide structural support, sustained market development also depends on consumer confidence. Government-led information campaigns, transparent standards for safety and performance, and public-private partnerships in charging infrastructure can collectively reinforce trust and accelerate NEV adoption.

In essence, this conceptual paper underscores that the localization of Chinese NEV brands in Thailand is not a supplementary marketing task but a strategic necessity for long-term value creation. Localization functions as a bridge between macro-level policy opportunities and

micro-level consumer acceptance, enabling firms to convert technological capability into market legitimacy. By establishing this conceptual linkage, the paper provides both theoretical and practical pathways for understanding how Chinese NEV brands can achieve sustainable success in emerging markets. The proposed framework thus lays the groundwork for future empirical validation and comparative studies across Southeast Asia, contributing to the broader discourse on globalization, localization, and sustainable industrial transformation.

4. Research Limitation

Although this conceptual paper provides a comprehensive theoretical framework for understanding how localization strategies influence consumer perceptions and performance outcomes of Chinese new energy vehicle (NEV) brands in Thailand, several limitations should be acknowledged. These limitations do not diminish the paper's theoretical contribution but rather highlight areas that require empirical verification and future refinement.

First, the study is conceptual in nature and does not yet incorporate empirical testing or quantitative validation. While the proposed framework and hypotheses are grounded in extensive literature and contextual analysis, they remain theoretical constructs that have not been statistically confirmed through consumer data. As a result, the relationships among localization dimensions, perceived value, brand trust, satisfaction, and behavioral intentions are inferred rather than demonstrated. Future empirical studies using structural equation modeling (SEM) or partial least squares (PLS-SEM) are necessary to validate the causal pathways and assess the strength of these relationships (Chen, 2020; Gao, 2022). The absence of such validation means that, at this stage, the paper's conclusions should be interpreted as conceptual propositions rather than empirical evidence.

Second, the research focuses specifically on the Thai NEV market, which, although strategically significant, represents only one emerging market context. Thailand's industrial structure, policy environment, and consumer culture—characterized by collectivist values and strong Japanese brand loyalty—may differ substantially from those in neighboring ASEAN countries such as Vietnam, Malaysia, or Indonesia (Piyapong, 2020; Chonsalasin et al., 2024). Consequently, the framework's generalizability across Southeast Asia or other developing regions remains to be tested. Future studies could conduct comparative analyses across multiple countries to determine whether localization strategies function similarly or whether cultural and institutional variations produce different consumer responses.

Third, the paper primarily relies on secondary data, literature synthesis, and theoretical reasoning rather than field observations or interviews with practitioners. Although this approach allows for a broad conceptual understanding, it may overlook practical nuances encountered by firms operating in real markets—such as government-industry interactions, dealer management, or post-sales consumer engagement. Direct engagement with managers, policymakers, and consumers could reveal micro-level factors affecting localization implementation and perception, thereby enriching the theoretical framework. Without such qualitative insights, certain contextual subtleties may remain underexplored.

Fourth, the conceptual framework simplifies the complex dynamics of localization into a linear model linking strategies to consumer perceptions and behavioral intentions. In practice, these relationships may be recursive or moderated by external factors such as macroeconomic

fluctuations, technological maturity, or policy stability. For example, consumer trust may not only be influenced by localization but may also shape subsequent localization decisions through feedback mechanisms (Luo & Tung, 2007). Similarly, infrastructure readiness and financial incentives may moderate the effects of localization on satisfaction and purchase intention. Recognizing these multidirectional and conditional relationships would require more sophisticated modeling in future studies.

Finally, the study's temporal scope—focused on the 2023–2026 period—captures a rapidly evolving stage of Thailand's NEV market development. However, as policy incentives phase out and consumer familiarity with NEVs grows, the relevance of certain localization dimensions may change. What matters most in the early diffusion stage (e.g., promotional localization and trust-building) may be replaced by service innovation or brand loyalty considerations in later stages (Zhou, 2020). Therefore, longitudinal research is needed to trace how the effectiveness of localization strategies evolves over time.

In sum, while this conceptual paper provides a theoretically grounded framework for linking localization and consumer perception in the Thai NEV market, its limitations—absence of empirical testing, geographic specificity, secondary data reliance, simplified modeling, and temporal constraints—highlight important directions for further investigation. Acknowledging these boundaries strengthens the study's credibility and sets a clear agenda for future empirical and comparative research.

5. Future Research Directions

Building on the conceptual framework presented in this study, several promising directions emerge for future research. These directions aim to deepen theoretical understanding, strengthen empirical validity, and enhance the practical relevance of localization strategies in the global diffusion of Chinese new energy vehicle (NEV) brands. As the automotive industry transitions toward sustainability, future inquiry should move beyond static conceptualization to examine the dynamic, interactive, and context-specific processes that shape consumer perceptions and firm performance.

5.1 Empirical Validation of the Conceptual Framework

The foremost priority for future research is the empirical testing of the proposed model. While this paper integrates theoretical constructs such as localization strategies, perceived value, brand trust, customer satisfaction, and behavioral intentions, the relationships among these variables remain conceptual. Future scholars can employ quantitative methodologies—particularly Structural Equation Modeling (SEM)—to empirically verify the hypothesized linkages (Cronin et al., 2000; Morgan & Hunt, 1994).

To ensure reliability and robustness, data collection should target a diverse sample of Thai NEV consumers across different regions, age groups, and income levels. Such diversity would help test whether the relationships in the conceptual model hold across subsegments. Moreover, multi-group analysis could explore whether demographic variables moderate these effects—for example, whether younger consumers respond more positively to digital promotion or whether

middle-income consumers prioritize after-sales reliability. Longitudinal data collection could further examine whether the strength of these relationships evolves as the Thai NEV market matures and consumer familiarity increases.

5.2 Cross-Country and Cross-Cultural Comparative Studies

While Thailand serves as a valuable case due to its strong policy incentives and regional leadership, future research should extend the analysis to other Southeast Asian and emerging markets. Comparative studies across countries such as Vietnam, Indonesia, and Malaysia could reveal whether localization operates under similar mechanisms or requires distinct adaptations (Gao, 2022; Chonsalasin et al., 2024).

For instance, Vietnam's younger consumer base and rising middle class may respond more strongly to aspirational brand positioning, while Malaysia's multi-ethnic composition could demand multicultural marketing strategies. Similarly, institutional conditions—such as government subsidies, infrastructure maturity, and import tariffs—differ substantially across ASEAN markets and can influence the relative importance of product versus promotional localization. Cross-national comparisons can therefore refine the theoretical model by identifying boundary conditions under which localization exerts the greatest influence.

Furthermore, extending research to non-Asian contexts such as Eastern Europe or Latin America could test whether Chinese NEV brands' localization practices are globally transferable or whether they must be fundamentally restructured to match distinct cultural logics and consumer expectations. Such comparative research would contribute to the broader field of international business by developing a culturally contingent understanding of localization effectiveness.

5.3 Integration of Consumer Psychology and Behavioral Theories

Future research should also deepen the psychological dimension of localization by incorporating consumer cognition, emotion, and identity into the analytical model. While this study focuses on perceived value, trust, and satisfaction, other constructs—such as perceived risk, cultural congruence, and brand authenticity—may play crucial mediating or moderating roles (Steenkamp & de Jong, 2010).

Experimental and qualitative studies could explore how consumers interpret localized messages and how emotional resonance influences purchase intention. For instance, Thai consumers may associate “green mobility” not only with environmental awareness but also with cultural values of harmony and collective well-being. Incorporating these symbolic interpretations into future models would enrich our understanding of how cultural embeddedness shapes brand meaning. Additionally, theories from consumer psychology, such as the Theory of Planned Behavior (Ajzen, 1991) or Expectancy-Value Theory (Fishbein & Ajzen, 1975), can be integrated to explain the cognitive pathways through which localization affects behavioral intention.

By connecting localization to deeper psychological processes, future studies can illuminate why certain marketing strategies succeed in building trust and loyalty while others fail despite similar external efforts.

5.4 The Role of Digitalization and Technological Mediation

As marketing increasingly shifts toward digital platforms, the interaction between localization and digital engagement offers another fertile avenue for exploration. Digital ecosystems—social media, online reviews, and e-commerce—serve as vital channels for consumer learning and trust formation in the NEV industry (Liu & Zhao, 2018). Future research can examine how localized digital communication, influencer marketing, and user-generated content contribute to perceived authenticity and community identification.

Moreover, integrating data analytics and machine learning into consumer research can help firms track real-time sentiment and adapt localization strategies dynamically. A data-driven approach would enable the identification of emerging trends in consumer expectations, allowing NEV brands to fine-tune promotional content and after-sales support to specific regional audiences.

Investigating digital localization will be particularly important for Chinese NEV firms that rely heavily on online ecosystems for cross-border brand building. Understanding how digital interfaces translate cultural cues across linguistic and symbolic boundaries will provide actionable insights for sustainable global marketing.

5.5 Policy and Institutional Collaboration Studies

Another promising area for future research involves exploring the interaction between corporate localization efforts and national policy frameworks. As Thailand's EV 3.5 roadmap continues to evolve, coordination between policymakers, local suppliers, and multinational firms will determine the pace of NEV diffusion (Office of Industrial Economics, 2021). Scholars can investigate how policy incentives, infrastructure development, and public education campaigns interact with firm-level localization to shape consumer behavior.

For example, researchers could assess whether public awareness programs about charging infrastructure or government-endorsed quality standards amplify the effects of brand-level localization on trust and satisfaction. Comparative institutional analysis could further reveal how governance quality, policy continuity, and local industry collaboration mediate localization success across different markets (Luo & Tung, 2007).

Such research would enrich both marketing and policy literature by demonstrating how public-private synergy contributes to sustainable industrial transformation.

5.6 Methodological Innovation and Mixed-Methods Research

Finally, future research should employ more diverse and innovative methodologies. Mixed-methods designs combining qualitative interviews, quantitative surveys, and digital ethnography can capture both the depth and breadth of localization phenomena. For instance, focus groups could uncover emotional and cultural narratives, while large-scale surveys test the generalizability of observed patterns. Advanced modeling techniques such as multi-level SEM or fsQCA (fuzzy-set qualitative comparative analysis) could further explore complex causal configurations linking localization to consumer outcomes (Zhang, 2019).

Such methodological diversity would not only enhance the robustness of findings but also bridge the gap between academic research and industry practice. Collaboration between

universities, automotive companies, and policy agencies can generate richer datasets and context-specific insights.

In conclusion, future research should move toward empirically validating, expanding, and contextualizing the conceptual framework proposed in this paper. By integrating psychological, digital, institutional, and comparative perspectives, scholars can build a more comprehensive understanding of how localization enables Chinese NEV brands to achieve legitimacy, trust, and sustainable competitiveness in global markets. This multidimensional research agenda will contribute significantly to both international marketing theory and the practical advancement of the new energy vehicle industry in the emerging world.

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Green Legacy of Major Sports Events: From Carbon Neutrality to Sustainable Operations-Take the Olympics and World Cup as Examples

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Abstract

Realize the synergy and unity of short-term activities and long-term ecological, social and economic values of the event. Taking the Olympic Games and the World Cup as the research objects, this paper systematically combs the practical process of carbon neutralization path exploration and sustainable operation mechanism construction of the two kinds of events, and analyzes the formation logic, core characteristics and inheritance challenges of their green heritage by using the method of literature review and case analysis. The practice evolution of the two in the green transformation is systematically sorted out: from focusing on the environmental protection transformation of venues after the competition in the early stage, gradually shifting to the sustainable management of the whole chain from pre-competition planning, in-competition implementation to post-competition utilization, realizing the synergy and unification of short-term activities and long-term ecological, social and economic values of the competition. As global attention to climate change issues increases, large-scale sports events (such as the Olympic Games and the World Cup) are shifting from purely pursuing competitive and commercial values to comprehensive goals that balance environmental sustainability. Taking recent Olympic Games (e.g. Tokyo 2020, Paris 2024) and World Cup (e.g. Russia 2018, Qatar 2022) as research objects, this paper focuses on three core dimensions: carbon footprint management, waste treatment and venue utilization after the Games, and systematically analyzes the sustainable operation strategies and actual results of different events. By comparing the model differences of different countries/cities, we can extract replicable experiences and point out current challenges, which can provide reference for green heritage planning of future competitions.

Key words: large-scale sports events; green heritage; carbon neutrality; sustainable operation; venue reuse

1. Introduction

Large-scale sports events are world-renowned cultural and sports events, and their preparation and hosting process is often accompanied by huge resource consumption, energy emissions and environmental pressure. In recent years, the International Olympic Committee (IOC), FIFA and other organizations have successively launched sustainable development strategies (such as IOC's Olympic Agenda 2020), incorporating goals such as "carbon neutrality" and "zero waste" into the core requirements of the event. However, due to

differences in economic level, technical capability and policy orientation, different regions present diversified paths in implementing sustainable operations. This paper aims to analyze the formation mechanism of green heritage of large-scale sports events through multi-case comparison, and explore how to shift from short-term "carbon neutrality" commitment to long-term sustainable operation system.

2. Research Methods and Case Selection

This paper adopts multi-case comparative study method and selects 4 representative competition cases:

- Tokyo 2020 Olympic Games: with "carbon neutrality" as the core goal, emphasizing renewable energy and waste recycling;
- Paris 2024 Olympic Games: Focus on "low-carbon venues" and "post-competition heritage reuse", highlighting public participation;
- 2018 Russia World Cup: relying on government-led infrastructure upgrading, exploring the integration of venues and cities;
- 2022 Qatar World Cup: First proposed "carbon neutral World Cup," relying on carbon offset and green building technology.

Data sources include official sustainability reports, assessment documents from international organizations such as UNEP, academic literature and media reports.

3. Case Study: Multidimensional Practice of Sustainable Operations

3.1 Carbon Footprint Management: From Source Reduction to Carbon Offset

The Tokyo Olympic Games will reduce direct carbon emissions by about 40% through the use of hydrogen energy torches, solar-powered venues and low-carbon transportation systems; the remaining emissions will be offset by purchasing carbon credits, such as forest protection projects. The Qatar World Cup relies on large-scale photovoltaic power stations (such as 800 MW photovoltaic power stations in Alcazar) and "green transportation"(electric buses, subways). However, due to the large scale of venue construction and high carbon emissions from international audience travel, carbon neutrality commitments will eventually need to be achieved through carbon offset projects (such as afforestation in Africa). In contrast, the Paris Olympics focus more on "life-cycle carbon management", requiring all sponsors to provide low-carbon products and carbon footprint accounting for the event supply chain (such as food transportation and material production).

3.2 Waste treatment: from "reduce production" to "recycle"

The Tokyo Olympic Games proposed the goal of "zero waste events", which increased the waste recycling rate of the event to 99% through the classification and recycling system, and refined waste electronic equipment (such as audience mobile phones) into medal raw materials. The Russian World Cup combined with the waste treatment facilities in the surrounding communities of the venues to achieve a construction waste recovery rate of 85%, but there is still insufficient domestic waste classification after the games. The Paris Olympic Games further promoted the "circular economy" model, such as the use of recyclable plastic seats in venues, which can be disassembled for other public facilities after the game; the complete ban on disposable plastics in catering services and the promotion of degradable tableware.

3.3 Venue utilization after competition: from "temporary construction" to "urban renewal"

Temporary venues (such as water sports centers) were extensively used for the Tokyo Olympic Games. After the Games, building materials were demolished and recycled to avoid the phenomenon of "white elephants"; some permanent venues (such as the National Arena) were transformed into citizen fitness centers and cultural venues. Russia's World Cup venues (such as Luzhniki Stadium in Moscow) maintain long-term operations by hosting concerts, commercial exhibitions and football youth camps. Due to the weather conditions of Qatar World Cup, some venues (such as 974 Stadium) adopt modular design, which can be dismantled as a whole and donated to other countries after the game; the remaining venues cooperate with local sports colleges and communities to provide low-cost venue rental services.

4. Comparison and Enlightenment: Advantages and Challenges of Different Models

dimensionality	Games of the Tokyo Olympic	Qatar World Cup	Paris Olympics	World Cup in Russia
Carbon Management Features	Source emission reduction is primary, offset is secondary	Dependence on new energy sources and mass offsets	product life-cycle management	Infrastructure-driven emission reductions
Waste treatment highlights	e-waste recycling	construction waste recycling	Circular economy integration	Community collaborative processing
Venue utilization model	Temporary venues + civic transformation	Modular donation + youth training cooperation	Permanent venues + commercial operations	Large-scale activities
main challenges	High cost of temporary venues	Offset Project Transparency Dispute	Supply chain coordination is difficult	High operation and maintenance costs

Common Revelation:

1. Combination of policy and technology: The government needs to issue supporting policies (such as low-carbon subsidies and environmental protection standards), and at the same time rely on renewable energy, intelligent monitoring and other technologies to achieve emission reduction;
2. Public and community participation: sustainable operation of the event needs to be combined with the needs of local residents (e.g. low-cost opening of venues, community waste recycling programs) to enhance social recognition;
3. Awareness of long-term planning: clear the purpose of venues before and after games to avoid excessive investment; establish market-oriented operation mechanism (such as commercial cooperation and membership system) to maintain the vitality of venues after games.

Difference Revelation:

- Developed countries (such as Japan and France) pay more attention to technological innovation and refined management, which is suitable for areas with limited resources and

strong environmental awareness.

- Emerging economies (such as Qatar and Russia) need to balance infrastructure construction with sustainable goals, and can introduce low-carbon technologies and operational experience through international cooperation.

5. Conclusion and Prospect

The green heritage of major sports events has expanded from a single "carbon neutral" commitment to an integrated sustainable system covering carbon management, waste recycling and venue utilization. The "temporary" strategy of Tokyo Olympic Games, the "full life cycle" concept of Paris Olympic Games, the "modular" innovation of Qatar World Cup and the "community integration" mode of Russia World Cup provide diversified reference paths for different types of countries. Future events need to further strengthen "forward-looking planning"(such as formulating heritage management plans before the game),"technological innovation applications"(such as digital twins to monitor carbon footprint) and "international cooperation mechanisms"(such as sharing low-carbon technologies and standards) to promote Green heritage has transformed from an "event accessory" to a "catalyst for sustainable urban development."

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From The Screen to The Internet: Asian Action Movies for Nearly 20 Years Research on Asian Cultural Communication

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Abstract

Since the beginning of the 21st century, action films have undoubtedly provided a unique style for Asian films, whose unique feature is to diversify the genres of films. In the process of action film development, there is quite a long time when the older generation obey the rules, and it is really difficult for the new people to succeed, because the martial arts is a circle of seniority, and the martial arts industry is especially so in the film industry. This is not only the particularity of the development of The Times, but also the law of the formation of the industry itself. Because many of the past movies were intense action scenes, and the action actors themselves are very high requirements. Dare to fall down, dare to be beaten is very important. When newcomers are inexperienced, they naturally need to do more practice and bear more difficulties.

The goal studied in this article is : 1. What is the history of martial arts through Asian action movies?

How does martial arts convey culture through Asian action movies? 3. What is the guidelines for exchanging martial arts through Asian action movies in the digital era.

The research methods are quantitative research method and mixed research method.

The final research results can be explained from the following:1.From the perspective of educational ecological history view, the history, reality and development of Chinese film talent training mode are analyzed. 2.Action movies have the ability to overcome cultural and language barriers due to their intense plots and stunning visual effects. 3. As a cultural phenomenon, action film has become an important research object in cultural research, film research, sociology and other disciplines. 4.The role of action films in cross-cultural studies cannot be ignored. 5.The development of action films plays an important role in supporting related industries. 6.The development of action films is of great significance to the cultivation of related talents.

Finally, the detailed description of the innovation points of action film research is divided into multiple aspects, covering the multi-dimensional discussion of the culture, technology, society and audience of action film, aiming to provide a novel perspective and entry point for the research in this field. Researchers can explore how streaming affects the production, distribution, and consumption of action movies, especially on audience viewing habits and narrative structure. How participatory culture changes the audience's consumption

and creation of action films is also an innovation point worth studying. Researchers can explore how fan fiction and videos created by fans can bring new narrative perspectives and interpretation to action films, and then influence the mainstream culture. Such research is able to reveal the role of the audience in cultural production and how participatory culture enriches the narrative and representation of action films.

As an important form of cultural expression, the research field of action films is full of innovative possibilities. Through the in-depth discussion of the new media environment, gender and diversity, global vision, audience psychology, social and political background, technology and narrative, fan culture and environmental awareness, researchers can provide rich perspectives and theoretical basis for this field. These innovations not only promote the academic research of action films, but also provide a valuable reference for the understanding of contemporary cultural and social change.

Keywords: Action movies, Asian cultural communication, Internet communication

1. Introduction

With the rapid development of digital technology, the ways and channels of information transmission have undergone profound changes, which has brought new opportunities and challenges to the dissemination of martial arts culture. Asian action films, especially Chinese martial arts films, as an important carrier of martial arts culture, have also undergone significant changes in their transmission mode and effects under the background of the digital era. This paper aims to explore the theoretical research scope of martial arts communication in the digital age, and analyze its transmission mechanism, influencing factors and future development trend.

As a unique cultural phenomenon, martial arts not only contain a rich technical system, but also contains a profound cultural connotation. Wushu communication refers to the horizontal and vertical flow process of Wushu technology and its related cultures through certain channels in a certain social environment. The functions of martial arts communication include cultural function, educational function, economic function, and possible negative function. The types of martial arts communication include technology communication and cultural communication, competitive martial arts communication and the communication of various boxing schools, language communication, text communication, sound communication, image communication and multimedia communication.

In the digital age, Asian action films spread martial arts culture through various channels and forms, which not only expands the time and space of communication, but also enriched the content and form of communication. Digital technology has more diversified the distribution channels of Asian action movies, including traditional cinemas, the Internet, mobile devices and social media. At the same time, the digital technology has enriched the means of film production, making the martial arts movements, skills, philosophy and cultural background more vividly displayed through high-definition pictures and special effects technology. In addition, innovative forms such as interactive movies, virtual reality (VR) and augmented reality (AR) technologies provide audiences with new immersive experiences, further enhancing the audiences understanding and interest in martial arts culture.

From the perspective of communication, this paper discusses the scope of martial arts research on Asian action films in the context of the digital age. Through literature review, case analysis and theoretical construction, this paper analyzes how Asian action films spread martial arts culture through various channels and forms in the digital age, and the influence and significance of this dissemination on martial arts culture. Research shows that digital technology not only expands the time and space scope of martial arts communication, but also enriches the content and form of communication, and promotes the global dissemination of martial arts culture. This paper proposes the theoretical framework of Wushu communication and explores the development trends and strategies of the communication, aiming to provide theoretical support and practical guidance for the inheritance and development of Wushu culture and promote the global dissemination of Wushu culture.

For example, Korean films combine local taekwondo and the performance of their strength, giving the outside world a more rigid expression of the Korean male image. Secondly, for example, Japanese ninja culture, which related films also make Japanese ninja culture very mysterious and representative. For example, the Chinatown Detective series, as shown in Figure 1, combines the total martial arts action elements of China, Japan and Thailand, and has won unprecedented international praise. They are all the cultural landscapes of Asian cinema. They differ from each other and merge with each other.



Figure 1: Movie *Chinatown Detective*

However, many fans found that the market for the "only genre" martial arts films we competed for in the international market more than a decade ago was getting smaller. The number of heroes ever flying on the screen is decreasing. The days of the flood of martial arts movies are gone.

In recent years, the Asian action film market has been dominated by fashion action movies. Why because of the need for rich collocation, if pure clothing or even shooting is not popular, take the road of pure kung fu film is very dangerous. For example, Lu Yangs two embroideries, *The Blade Brothers*, is an example of their popularity in Figure 2.



Figure 2: Movie *The Embroidery Spring Knife*

Why does this happen? Because the audience's taste and mentality have changed, from the fictional world of martial arts setting closer to real life, people are increasingly reluctant to see stories with family and national feelings and lofty ideals, then change the history through their own unparalleled martial arts. Because it is too far away from us, too unrealistic.

The main reason is that in the old society, people lacked material life and did not have much entertainment, which made us feel confident at all by watching action movies and martial arts movies. However, compared with our current life, now is not so boring, there are many things can enrich our life. Although we are very ordinary, but we can obtain wealth, status, and even the ideal and our proud kung fu. So the action film protagonists at that time were often the protagonists at the bottom of the family. With his kung fu, he created a place in the environment of adding cotton pants, which makes people feel very sympathetic.

But now there are many ways to achieve their own values, so the old line doesn't resonate with most people again. Moreover, martial arts training itself is a very difficult process.

Hollywood superheroes can make waves and travel through time and space, and now they can practice martial arts while. Therefore, this appeal will continue to exist. In the fashion film, the protagonist does not need to explain the future too much, because there is a lot of gunfire, the background of the action effort is not too much, and it can introduce more stories, more appropriate scenes.

2. Methodology

Under the tide of the digital era, Chinese action films, as the key link of martial arts culture communication, have undergone profound changes in their communication mode and effects. Qualitative research method plays a pivotal role in analyzing this complex subject.

From the perspective of cultural connotation mining, Chinese martial arts has a long history and integrates with traditional culture. In Chinese action movies, martial arts vividly embody the Confucian moral principles of "benevolence, righteousness, propriety, wisdom and faith", as well as the Taoist philosophy of "doing nothing and conforming to nature". Take the film *Huo Yuanjia* as an example as shown in Figure 3, the main character of *Huo Yuanjia*, finally understands the true meaning of martial arts after experiencing many hardships. Through the wonderful martial arts movements, it shows the awe of life and the persistent pursuit of peace, which is behind the profound Chinese culture. Qualitative research method

can deeply interpret this kind of film text, analyze the hidden cultural value system behind the movements of martial arts, and help us to deeply understand the unique significance of martial arts in a specific cultural context.



Figure 3: Movie *Huo Yuanjia*

From the perspective of the influence mechanism of communication mode, the emerging communication channels such as social media and online video platforms spawned in the digital era have completely changed the ecological environment of martial arts communication. Through in-depth analysis of the audiences' comments, discussion groups and video barrage on social media platforms, the qualitative research can provide accurate insight into the audience's reaction and cognitive process of martial arts clips in action movies. For example, after some popular Chinese action movies are launched on online platforms, audiences will enthusiastically share their love for the martial arts moves in the movies in the comments section, warmly discuss the cultural background behind them, and even have heated debates due to the different views. Through the qualitative analysis of these interactive contents, we can clearly understand how the audience builds an understanding of martial arts culture from the presentation of martial arts in the film, and then reveal the identity mechanism and the possible cultural misunderstanding in the process of cultural communication.

Sub-Section 1 Qualitative research method

Literature research is the cornerstone of qualitative research. In this topic, it is necessary to extensively the literature in many fields. In terms of academic papers, with the help of cnKI, Wanfang Data and other academic databases, the academic achievements related to Chinese action films and martial arts communication are comprehensively searched. These papers cover the perspectives of film theory, cultural research, communication science and other disciplines, providing a rich theoretical basis and research ideas for the research. For example, some scholars, from the perspective of cultural semiotics, deeply analyze the symbolic significance of the movements of martial arts in Chinese martial arts films, which has an important reference value for understanding the cultural presentation of martial arts in films.

Film history books are also important sources of literature. Works such as *The History of Chinese Film* systematically review the development of Chinese films, including the characteristics of action films in different periods and the evolution of martial arts in them. Through reading such books, we can clearly grasp the historical context of the spread of martial arts in Chinese action films, and understand the development process from the simple presentation of early traditional martial arts in films to the deep integration of martial arts and various elements in modern films.

Cultural research works provide a deep theoretical support for understanding the cultural connotation behind martial arts. For example, works related to studying Chinese traditional culture can help researchers better interpret the Confucian, Taoist and Buddhist thoughts contained in martial arts in Chinese action films. At the same time, it focuses on the literature of new media communication and the development of cultural industry in the digital era, such as the literature on social media communication mode and profit mode of online video platform, which provides a necessary theoretical basis for the study of the new characteristics of Chinese action films for martial arts communication under the background of the digital age.

The biggest advantage of qualitative research method is its ability to provide rich details and thorough understanding. Through the detailed micro-analysis of the cases, such as the action disassembly of each martial arts scene in *Crouching Tiger, Hidden Dragon*, and the in-depth exploration of the internal relationship between the psychological changes of the characters and the martial arts movements, the multi-dimensional information about the martial arts presented in the film can be obtained. In the process of interviewing different groups, we can comprehensively and deeply understand the actual situation of the communication of martial arts from the perspectives of the creative ideas of the film creators, the professional perspective of the martial arts guidance, and the intuitive feelings of the audience. This multi-dimensional research approach helps to help reveal the complexity and diversity of martial arts communication in the digital age, and provide a comprehensive and forward-looking perspective for further research and practice.

Qualitative research methods also have a strong flexibility. In the process of research, once new problems and phenomena are found, the research direction and methods can be adjusted in time. For example, when observing the discussion on the digital platform, if a new hot topic of martial arts communication, such as a niche Chinese action movie, causes hot discussion on the Internet due to its unique martial arts style, you can quickly conduct a more in-depth investigation and analysis on the topic. By interviewing the creative team of the film and analyzing relevant online comments, the underlying causes and influences behind this phenomenon are deeply studied. This flexibility enables qualitative research to timely capture the new trends in the research field and always maintain the timeliness and frontier of the research.

The results of qualitative research methods may have some degree of subjectivity. Because the researchers have different individual backgrounds, values, and research perspectives, the interpretation of the data may differ. During the interview, the researchers questioning style and guidance direction may have an impact on the respondents answers. If the researcher interviews the audiences views on martial arts in a certain action movie, the

questioning method has a certain tendency, which may guide the interviewees to answer in the direction that the researcher expects, thus causing certain deviation to the research results.

Moreover, the sample size of qualitative research methods is usually relatively small and difficult to make large-scale statistical inference. In the case analysis, the number of representative films selected is limited, and in the interview, the number of filmmakers, audiences and other groups that can be involved is relatively small. This may lead to some limitations in the generalizability of the findings. For example, the conclusions about the effect of Chinese action films on martial arts communication drawn through interviews with some audiences may not represent the true views of all audiences. Therefore, when using the qualitative research method, it is necessary to combine other research methods, such as the quantitative research method, to make up for the deficiency of the qualitative research through large-scale data statistical analysis, so as to more comprehensively and accurately reveal the internal law of Chinese action films on the dissemination of martial arts in the background of the digital age.

Sub-Section 2 Research and interview methods

Questionnaire survey is an effective method to collect audience views and acceptance of Asian action films spread by new media. To ensure the comprehensiveness and representativeness of the data, the questionnaire design and the data collection process need to be carefully curated. Including the following aspects.

Audience background information:

Including age, gender, education level, occupation, location, etc., to help understand the basic characteristics of the audience.

Watch habits:

Including which new media platforms make audiences watch movies (such as streaming media, short video platforms, social media, etc.), as well as viewing frequency and viewing time, etc.

Film content understanding and attitude:

It includes the understanding and attitude of the Asian cultural elements in the film, the favorite scenes or characters, and the evaluation of the plot, rhythm and visual effects of the film.

Evaluation of the transmission effect:

It includes the views on the communication effect of the new media platform, such as whether the films recommended by the platform meet the audience's interest, and the satisfaction of watching the films through the new media platform.

Online questionnaire platform:

Such as Google Forms, SurveyMonkey, etc., can easily and quickly collect a large number of audience feedback.

3. Results

From the perspective of educational ecological history view, the history, reality and development of Chinese film talent training mode are analyzed. This approach regards the film talent training activities as an ecosystem, examining its internal hierarchy, structure, factors and operation mode, as well as the correlation with the external ecological environment.

Action films play an important role in shaping the cultural image. First, through action movies, heroic images in a specific culture are spread and shaped. For example, common superhero images in American action movies, such as Spider-Man, Batman, Iron Man, etc., are not only an important part of American pop culture, but also iconic symbols of American culture on a global scale, such as Jackie Chan of China, Tony Jia of Thailand and Ma Dongxi of South Korea. These heroic images are spread through the film, conveying the cultural values of courage, justice and bravery to the global audience.

The importance of action films in academic studies cannot be ignored. First of all, as a cultural phenomenon, action film has become an important research object in cultural research, film research, sociology and other disciplines. Scholars discuss the significance in cultural communication, social influence and narrative structure through the analysis of action films. For example, scholars have studied the aesthetics of violence in action films, analyzing their potential effects on audience psychological and social behavior.

The role of action films in cross-cultural studies cannot be ignored. First, action movies have the ability to overcome cultural and language barriers due to their intense plots and stunning visual effects. This makes action films widely spread worldwide and resonate in different cultural contexts. For example, Hollywood action films have achieved great commercial success in Asia, Europe and other places, and have become an important medium for cross-cultural exchanges.

The development of action films plays an important role in supporting related industries. First of all, due to their high investment and high output, action films play an important role in promoting related industries such as film production, special effects production and prop production. For example, a successful action film usually requires a lot of special effects production, which directly drives the development and technological progress of special effects companies.

The development of action films is of great significance to the cultivation of related talents. First of all, the production of action films requires a large number of professionals, such as directors, screenwriters, special effects artists, martial arts instructors, actors and so on. The training and training of these professional talents have directly promoted the professional development and professional development of the film industry. For example, Hollywood film schools and training institutions have provided a large number of professionals to the film industry through systematic education and training.

Table 1

This table includes the research on martial arts films, research objectives, research methods and research tools, used for studying the related communication content of martial arts films.

Research Question	Research Objectives	Concept & Theory	Research Methodology	Research Tools
What is the history of martial arts through Asia action films?	To study the development of martial arts through Asia action films.	Theory of cultural research; theory of industrial economics; theory of genre film; theory of audience research	Quantitative research	Document Analysis
How do martial arts communicate cultural through Asia action films?	To study the cultural communication of martial arts through Asia action films.	Symbolic theory; genre film theory; cultural research theory; feminist theory; post-colonial theory	Quantitative research method	Focus group interview
What are guidelines of communication of martial arts through Asia action films through digital age.	To propose guidelines of communication of martial arts through Asia action films through digital age.	Interdisciplinary integrated teaching method; theory of education, theory of situational learning; theory of performing arts	Hybrid research method Mixed Method research	In-depth Interview, Focus group interview

4. Conclusion and Future Work

With the rise of streaming platforms such as Netflix and Disney +, the traditional movie viewing modes have changed significantly. These platforms allow audiences to watch films anytime and anywhere at home, breaking the limits of time and space. Researchers can explore how streaming affects the production, distribution, and consumption of action movies, especially on audience viewing habits and narrative structure.

Streaming platforms often provide reviews and rating features, and audience feedback may influence the production of subsequent films. Researchers can focus on how audiences interact with content producers through social media and platform feedback, and analyze how this interaction changes the films marketing strategy and audience engagement.

Advances in modern technology open up new possibilities for narrative and visual effects in action films. Researchers can focus on how modern action movies use computer-generated images (CGI) and other visual effects to enhance narrative effects. For example, Avengers: Endgame (Avengers: Endgame) uses visual effects to show grand combat scenes and enhance audience immersion.

As an important form of cultural expression, the research field of action films is full of innovative possibilities. Through the in-depth discussion of the new media environment, gender and diversity, global vision, audience psychology, social and political background,

technology and narrative, fan culture and environmental awareness, researchers can provide rich perspectives and theoretical basis for this field. These innovations not only promote the academic research of action films, but also provide a valuable reference for the understanding of contemporary cultural and social change.

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Digital Sensibility and Human Warmth: Exploring the Integration of 3D Modeling and Traditional Sculpture in The Third Consciousness

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Abstract

This study focuses on The Third Consciousness, a creative project exploring how 3D modeling technology transforms traditional human figure sculpture in terms of language, structure, and material expression. The objectives are: (1) to examine how 3D modeling expands traditional sculptural forms and visual vocabulary; (2) to analyze its role in reconstructing proportions, balance, and anatomy; and (3) to demonstrate, through creative practice, how digital sculpture can preserve emotional warmth and human sensitivity.

A mixed-method design combined literature analysis, digital modeling, fabrication, and evaluative research. Using ZBrush as the primary modeling tool, high-precision photopolymer and transparent resins were selected for 3D printing. Post-processing included layered acrylic painting, urushi lacquer sealing, and gold-powder decoration. In parallel, a questionnaire survey (N = 94) and expert interviews (N = 6) were conducted to assess both public and professional perspectives.

Results indicate that 3D modeling significantly enhances structural feasibility and precision in extreme poses—such as single-leg standing and off-balance tilting—through algorithmic analysis and data-driven stability calculation (Gao et al., 2020; Paul, 2015). Manual surface finishing reintroduced tactile warmth, balancing technological control with emotional authenticity. Public and expert evaluations confirmed that digital–traditional integration enriches sculpture’s expressive and educational potential (Smith, 2020; Wang & Chen, 2022).

This study contributes by: (1) proposing a reproducible workflow combining 3D modeling with hand-finishing; (2) demonstrating how algorithmic precision can coexist with human expressivity; and (3) offering a model for future art education and interdisciplinary design (Lau, 2023).

Keywords: 3D modeling; digital sculpture; Human figure; Material translation; Narrative expression

1. Introduction

With the rapid evolution of digital technology, contemporary sculpture has been shifting from material shaping to informational construction. Traditional sculpture emphasizes craftsmanship, material authenticity, and the trace of time, while digital sculpture—enabled by 3D modeling software and additive manufacturing—allows artists to simulate anatomy, balance, and texture within virtual environments (Manovich, 2001; Paul, 2015). This transformation not only enhances precision and repeatability but also redefines the conceptual framework of sculptural creation.

Today, 3D modeling and printing technologies have become fundamental tools in artistic production. Widely used programs such as ZBrush, Blender, and Maya provide high-resolution meshes and dynamic sculpting capabilities, enabling artists to achieve complex forms and extreme poses that were previously difficult to realize by hand. At the same time, the advancement of high-precision printers has bridged the gap between virtual modeling and physical realization.

In terms of materials, 3D printing in sculpture now employs a broad range of media:

1. High-precision photopolymer resin, which achieves fine surface details through layer-by-layer solidification and is ideal for detailed human figure sculptures.
2. Transparent resin, which produces luminous, light-transmitting effects often used to convey fragility and spiritual qualities.
3. Castable red wax, frequently applied in the lost-wax casting process due to its precision and moldability.
4. Metal printing materials—such as titanium, stainless steel, and bronze alloys—produced via selective laser melting (SLM) or sintering (SLS), offering durability for large-scale or permanent public works (Bártolo et al., 2019; Gibson et al., 2021).

This material diversity enables artists to flexibly express concepts through variations in weight, transparency, and reflectivity, thus extending the expressive language of sculpture across both physical and perceptual dimensions.

However, the precision and algorithmic rationality of digital sculpture also introduce a key question: how can technology coexist with human emotion and warmth? (Edmonds, 2017; Smith, 2020). While 3D modeling enhances creative control and efficiency, it risks reducing the tactile sense and temporal depth that define traditional craftsmanship. Hence, the essence of contemporary sculpture lies not in replacing tradition but in finding balance—between digital precision and human sensibility.

This paper uses *The Third Consciousness* as a case study to integrate creative practice, technical process, and theoretical reflection, examining how 3D modeling technology reshapes the language, logic, and narrative capacity of traditional human figure sculpture.

2. Literature Review

With the rapid advancement of 3D digital technologies, the field of sculpture is undergoing a profound transformation from "material shaping" to "information construction". Over the past two decades, research on digital sculpture has primarily focused on three directions: technological innovation, the evolution of artistic language, and the rebalancing of humanistic values.

2.1 Technological Innovation and the Reconstruction of Formative Logic

Manovich (2001) was the first to propose the concept of "New Media Language", arguing that the core of digital art lies in parametric control and reversible operations. This perspective laid the foundation for the transformation of digital sculpture from traditional "manual intuition" to "data logic". Paul (2015) further elaborated on the experimental potential of 3D modeling in creative practice, asserting that digital sculpture transcends the boundaries of traditional materials and techniques, enabling artists to simulate structures, light and shadow, and gravitational balance in a virtual environment.

Recent studies have placed greater emphasis on the role of digital modeling in reconstructing traditional formative logic. Pereira (2019) and Wang (2020) put forward the theory of "interactive forms in digital sculpture", suggesting that the non-destructive nature of 3D modeling provides a new experimental mechanism for artistic creation. This means that form generation is no longer linear but evolves as a dynamic system through algorithms and topological structures. This methodology has restructured traditional sculptural logic, leading to new modes of artistic education and cross-disciplinary application (Zhang, 2022).

2.2 Material Translation and the Expansion of Technical Semantics

At the material level, 3D printing expands sculpture's physical and semantic scope. Balletti et al. (2017) discussed its application in cultural heritage preservation, while Gao et al. (2020) examined how multi-material printing fosters hybrid visual effects between transparency and solidity.

Commonly used materials—resin, metal, red wax, and polymer—allow unprecedented control over surface quality and translucency (Gibson et al., 2021; Chen & Xie, 2019). The aesthetic transition from weight and temporality to lightness and perception redefines sculpture's sensorial dimension (Paul, 2015). The development of this technology has driven the transformation of traditional sculptural material aesthetics from "weight-temporal traces" to "light perception-fluidity".

2.3 The Dialectical Relationship Between Digital Precision and Humanistic Warmth

Digital technology provides a high degree of controllability for artistic creation, but it also brings the risk of "emotional alienation". In *The Art of Interaction*, Edmonds (2017) argued that if digital art only pursues precision and perfection, it easily loses the "warmth of manual work" and the "poetry of contingency". Through audience surveys, Smith (2020) pointed out that while contemporary audiences generally recognize the modernity and innovation of digital sculpture, they still maintain a certain distance from works that "lack tactile qualities and manual traces". This viewpoint reflects the tension between digital art and humanistic emotions.

In response, scholars have begun to explore a "hybrid approach" that combines digital techniques with manual work. As early as in *Passages in Modern Sculpture*, Krauss (1981) emphasized that the significance of sculpture lies in its process and physicality. The integration of manual interventions (such as sanding, painting, and dot decoration) in digital sculpture is a continuation of this viewpoint. It not only mitigates the coldness brought by technology but also allows artworks to regain "individuality" and "humanistic warmth" in terms of tactile experience.

Recent empirical studies (Lau, 2023; Lee, 2021) confirm that hybrid workflows—digital fabrication complemented by manual refinement—produce stronger audience engagement and emotional resonance, bridging technology and craft.

2.4 Socio-Cultural and Educational Dimensions of Digital Sculpture

From a cultural perspective, the emergence of digital sculpture is not merely a technological innovation but also a reconstruction of social discourse. When discussing "The Work of Art in the Age of Mechanical Reproduction", Benjamin (2008) noted that the popularization of reproductive technology has transformed art from "uniqueness" to "shared accessibility", altering the relationship between artworks and audiences. Gere (2008) further analyzed how digital culture changes people's ways of viewing and perceiving, turning art into a new medium for social engagement and cultural communication.

At the educational level, 3D modeling improves comprehension of anatomy and balance, encouraging interdisciplinary research (Wang & Chen, 2022). Through digital simulation, students can intuitively understand anatomical structures, center-of-gravity distribution, and dynamic balance. This not only lowers the learning threshold but also promotes the development of interdisciplinary research (Paul, 2015). This trend indicates that future sculpture education will place greater emphasis on the integration of "virtual cognition" and "physical practice". This convergence of virtual cognition and physical practice points toward a future where sculpture integrates sensory depth with digital logic (Liu & Zhao, 2021; Lau, 2023).

In summary, existing research has revealed the profound impacts of 3D modeling on traditional sculpture in three aspects:

1. In terms of formative logic, it has shifted sculpture from material-based thinking to data-based thinking, realizing the parametrization and reversibility

of the creative process.

2. In terms of material semantics, it has promoted the expansion of material aesthetics, enabling the integration of the virtual and the physical.
3. In terms of humanistic expression, it has facilitated the synergy between technology and emotion, allowing digital precision and manual warmth to find a balance in contemporary art.

Building on the aforementioned literature, this study further verifies and deepens these theoretical findings through the creative practice of The Third Consciousness. It explores how 3D modeling achieves the unity of "reason and sensibility" in traditional human figure sculpture, as well as the transformation from "digital reproduction" to "emotional creation".

Research Objectives

1. To analyze the role of 3D modeling technology in reconstructing the modeling logic of traditional human figure sculpture.
2. To establish theoretical guidelines for the application of 3D modeling technology in expanding traditional sculptural languages and practices, and to create a series of sculptures realized through 3D modeling.

3. Materials and Methods

3.1 Research Framework

The research employed a mixed-method approach combining:

1. Literature analysis to establish theoretical foundations;
2. Digital creation experiments using ZBrush modeling and 3D printing;
3. Questionnaire survey (N = 94) to assess public perception;
4. Expert interviews (N = 6) for professional evaluation.

This integration of qualitative and quantitative data ensures both creative and empirical reliability.

3.2 Tools and Materials

1. Software: ZBrush (modeling), Blender (spatial verification), and physics simulation plugins;
2. Printing materials: High-precision photosensitive resin and high-precision transparent resin;
3. Surface finishing: Four layers of acrylic primer, sponge stippling with blended tones (raw umber, hemp black, vermilion), three layers of urushi lacquer sealing, and final gold-powder embellishment.

The process does not follow mechanical parameters but rather relies on accumulated artistic experience to achieve aesthetic balance and technical consistency.

4. Creative Practice

Application of 3D Technologies in the Creative Practice of This Study. In the creative practice of this study, the application of 3D modeling and 3D printing technologies constitutes a key link in materializing artistic concepts. Drawing on the research findings from previous literature regarding the role of 3D modeling in structural reconstruction and material translation (Manovich, 2001; Paul, 2015; Balletti et al., 2017), a Bambu Lab H2D 3D printer was adopted at this stage. The primary advantages of this model lie in its ability to significantly increase the volume and quantity of a single print job, enabling high-precision, high-speed, and high-stability output of large-scale artworks. Simultaneously, it effectively reduces the unit production cost, thereby enhancing the feasibility and cost-effectiveness of experimental creation in digital sculpture.

In terms of materials, all artworks were printed using high-precision photopolymer resin and transparent resin. Photopolymer resin exhibits excellent detail reproduction and surface smoothness, allowing for accurate representation of the human figure's muscle structure and surface texture. Transparent resin, on the other hand, creates a soft light-transmitting effect on components such as wings, conveying symbolic meanings of lightness and spirituality. The combination of these materials not only maintains visual layering and transparency but also responds to the "expansion of material semantics" discussed in Chapter 2—i.e., establishing a new textural relationship between the virtual and the physical (Balletti et al., 2017).

Regarding the process workflow, all printed components underwent a series of steps including cleaning, sanding, repairing, primer application, and topcoat treatment to ensure surface precision and structural integrity. First, the models were cleaned with an alcohol solution and cured under ultraviolet light. Subsequently, the support points and surfaces were carefully sanded and repaired to eliminate print layer lines. Finally, multiple layers of acrylic primer and traditional lacquer sealing techniques were applied in sequence to achieve the desired color and light-reflecting effect. This workflow ensures that digital sculptures retain technical precision during the physical realization process while regaining the warmth and delicacy of manual craftsmanship, thereby establishing a balance between technical logic and artistic expression.

4.1 Concept

The Third Consciousness symbolizes marginalized groups across the world—individuals who struggle between visibility and vulnerability in social contexts. The project expresses a spiritual evolution through four distinct postures: Falling, Resistance, Balance, and Inclusion.

The bronze-textured body represents social weight and historical inertia, while the transparent resin wings signify fragility, purity, and resilience of the inner spirit.

The conceptual inspiration for this series originates from the performative nature

embodied by third-gender performers, such as those seen in the Tiffany's Show—a renowned cabaret that celebrates gender diversity through artistic expression (Figure 1). These performers, often adorned with ornate costumes and symbolic wings, navigate a space between illusion and reality, embodying both self-display and self-defense. This duality of presence—to be seen and yet misunderstood, to perform and yet remain authentic—deeply informs the emotional tone and visual language of *The Third Consciousness*.

The incorporation of wing elements draws directly from stage aesthetics, where wings serve not only as decorative extensions but as metaphors for transformation, aspiration, and vulnerability. In this context, the transparent resin wings reinterpret those theatrical symbols, translating them from the realm of performance into sculptural form. Thus, the artwork becomes a bridge between spectacle and introspection—transforming the performative gestures of the stage into a meditative exploration of identity, resilience, and spiritual elevation. This reinterpretation bridges spectacle and introspection, linking identity, resilience, and acceptance (Lee, 2021; Wang, 2020).



Figure 1: Tiffany Show in Thailand

Sourcet: <https://baijiahao.baidu.com>

4.2 Sketches

At the sketch stage, both hand drawings and digital drafts were used to determine composition and gesture.

1. Spatial Composition: The four sculptures align sequentially along the exhibition route, guiding the viewer through an emotional progression.
2. Postural Study: Each pose captures a key psychological state—struggle, balance, awakening, and inclusion.
3. Structural Planning: Wing-to-body ratios and weight distribution were calculated early to ensure physical plausibility during modeling.



Figure 2: 4 design sketches

Source: Researchers

4.3 Design Development

1. Digital Modeling

Using ZBrush, high-detail models were sculpted with precise anatomical correction. Through digital gravity simulation, extreme poses such as “single-leg support” and “off-balance tilt” were tested for mechanical feasibility.

Wing morphology was inspired by dragonflies, beetles, and butterflies—each selected for symbolic and structural contrast. Topological refinement ensured both realism and structural stability.



Figure 3: ZBrush Topology Operation Interface

Source: Researchers

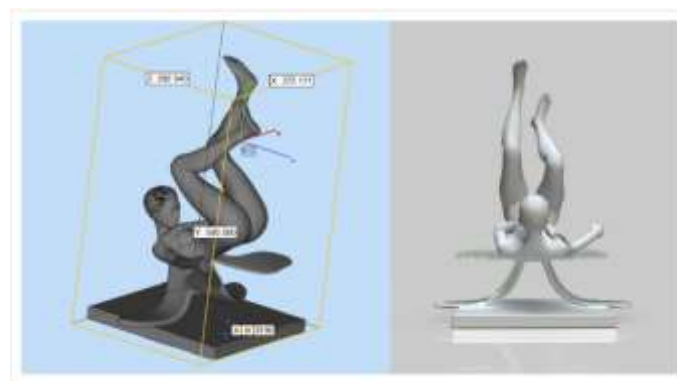


Figure 4: Comparison diagram of Model 1

Source: Researchers



Figure 5: Comparison diagram of Model 2

Source: Researchers

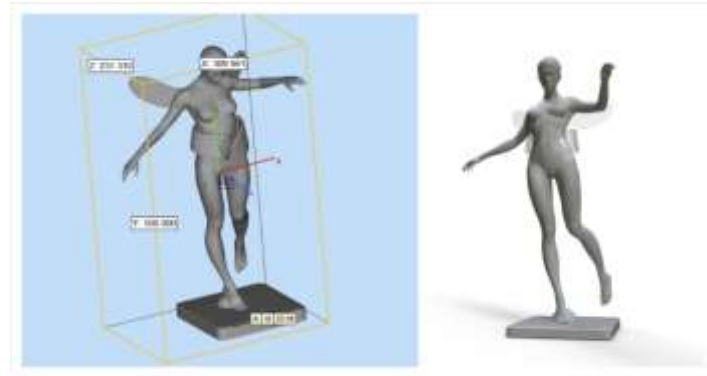


Figure 6: Comparison diagram of Model 3

Source: Researchers

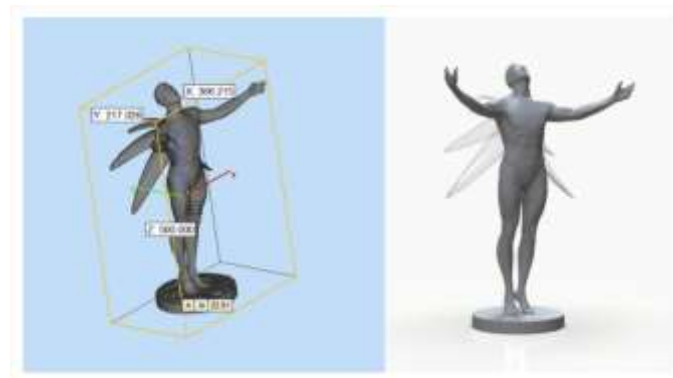


Figure 7: Comparison diagram of Model 4

Source: Researchers

2. 3D Printing and Structural Testing

The sculptures were fabricated using high-precision photosensitive and transparent resins. Post-print processes included alcohol cleaning, UV curing, manual sanding, and structural testing. Multiple resin ratios were tested to optimize strength and translucency, achieving a balance between mechanical durability and visual lightness.



Figure 8: 3D printed white mold

Source: Researchers



Figure 9: Pouring counterweight

Source: Researchers

3. Surface Finishing and Material Translation

The surface finishing process involved four acrylic base layers, color stippling, lacquer sealing, and gold dust decoration. The stippling technique created subtle bronze tonal depth, while lacquer sealing produced a living sheen. Gold powder not only enhanced texture realism but also served as a metaphorical gesture—representing both performance identity and aesthetic reverence.

The transparent wings, left unpainted, embody purity and fragility, reinforcing the emotional dimension of vulnerability and transcendence. This process successfully transformed resin into the visual metaphor of bronze while maintaining material authenticity and expressive subtlety.



Figure 10: Handle the primer Photo credit: Researchers



Figure 11: Coloring and polishing tools Photo credit: Researchers

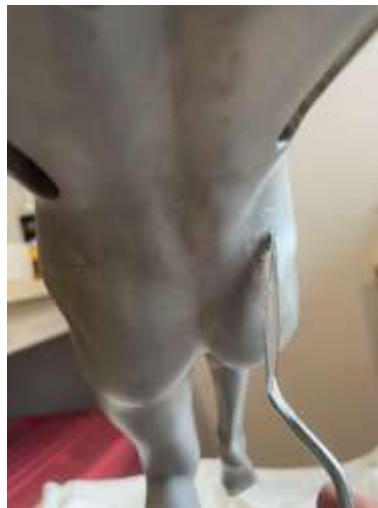


Figure 12: Using body filler to repair holes Photo credit: Researchers



Figure 13: Sanding and color touch-up Photo credit: Researchers



Figure 14: Lacquer dot application and gold powder sealing Photo credit: Researchers



Figure 15: The inspiration from dragonflies, butterflies, and beetles Photo credit:

<https://baijiahao.baidu.com>

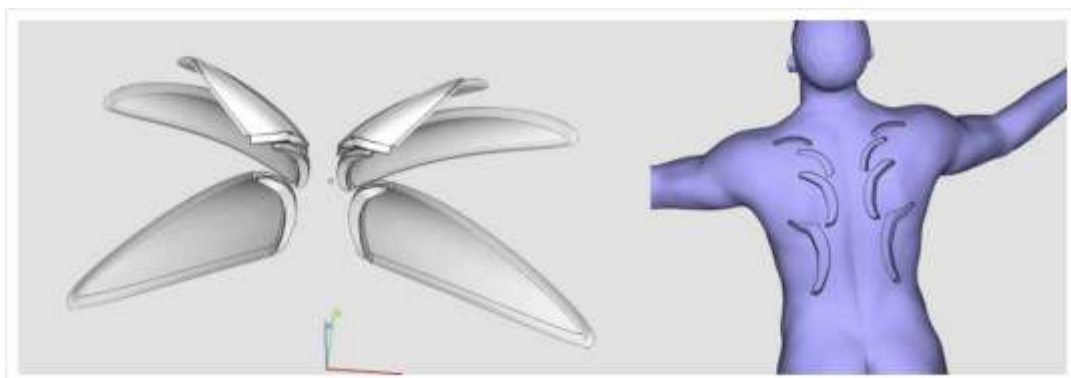


Figure 16: Rear slot and wing design of the model Photo credit: Researchers



Figure 17: The wings are printed with transparent resin material Photo credit: Researchers

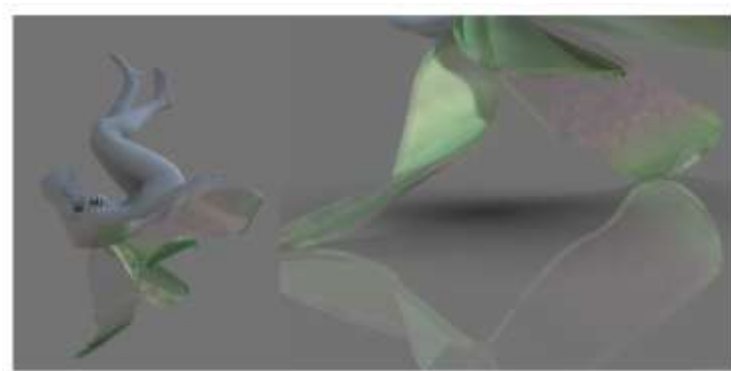


Figure 18: Gradient and lighting effects on the wings under specific light sources Photo credit: Researchers

4. Assembly and Exhibition Layout

The installation combined suspended and grounded displays to create spatial rhythm. As viewers moved through the exhibit, they experienced a psychological journey from “falling” to “inclusion.” An accompanying display presented the digital-to-physical process, emphasizing the dialogue between technology and craft.



Figure 19: Work 1 Three-View Drawing Photo credit: Researchers



Figure 20: Work 2 Three-View Drawing Photo credit: Researchers



Figure 21: Work 3 Three-View Drawing Photo credit: Researchers



Figure 22: Work 4 Three-View Drawing Photo credit: Researchers



Figure 23: Exhibition of Works Photo credit: Researchers

5. Results and Discussion

5.1 Questionnaire Findings

The questionnaire (N = 94) revealed that:

1. 72% could distinguish traditional from digital sculpture;
2. 80% perceived digital sculpture as more contemporary;
3. 88% believed 3D modeling would dominate future sculptural practice;
4. 67% found digital works equally aesthetically pleasing;
5. 75% found them more visually engaging in exhibitions.

Younger respondents (18–30) appreciated innovation and modernity, while older participants emphasized the tactile emotion of handmade works.

5.2 Expert Insights

Experts emphasized that while 3D modeling improves feasibility and accuracy, manual techniques preserve authenticity and individuality (Smith, 2020; Lau, 2023). They noted the pedagogical and exhibition potential of digital sculpture and suggested integrating process displays to preserve artistic warmth and authenticity.

5.3 Discussion

The findings confirm that 3D modeling technology not only optimizes anatomical and structural precision but also transforms the sculptor's creative logic. Through algorithmic correction and virtual simulation, artists gain systematic control over weight, rhythm, and gesture (Paul, 2015).

At the same time, manual finishing restores tactile intimacy, bridging digital rationality and emotional resonance. The hybrid practice achieves equilibrium between precision and humanity, proving that digital sculpture can extend rather than replace traditional modes.

The alignment between audience perception and expert evaluation underscores this synthesis as both technically and culturally sustainable (Smith, 2020; Edmonds, 2017).

These results validate the coexistence of technical precision and emotional

resonance, confirming 3D modeling as a transformative yet human-centered method (Zhang, 2022; Gao et al., 2020).

6. Conclusion and Recommendations

3D modeling has profoundly redefined the creative language of human figure sculpture.

1. Formally, it improves dynamic feasibility and structural safety, making complex postures achievable with scientific precision (Pereira, 2019; Wang, 2020).
2. Materially, it enables resin-to-bronze visual translation through handcrafted surface techniques, achieving both lightness and gravitas.
3. Expressively, it combines algorithmic efficiency with emotional warmth, reinforcing the human depth of digital art.
4. Socially, *The Third Consciousness* advocates empathy and inclusivity for marginalized identities, transforming sculpture into a medium of human dialogue (Lee, 2021; Benjamin, 2008).

Future research and practice may further integrate digital modeling with traditional craftsmanship, develop interdisciplinary collaborations, and enhance public understanding of digital art's cultural relevance. The synthesis of technology and humanity will continue to shape the evolution of contemporary sculpture.

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Investigating the Interconnections Among Internal Marketing, Employee Loyalty, and Service Quality in China's Commercial Banking Sector: Conceptual Study

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Abstract

As the global financial economy grows, more foreign banks are entering China's financial market. At the same time, more private banks and non-bank financial institutions are also emerging, making the banking industry more competitive and diverse. To stay competitive, commercial banks are constantly creating new products, trying different marketing strategies, and improving their services to attract and keep customers. One of the most effective ways for banks to gain customer loyalty is by providing excellent customer service, which helps them increase profits and stay competitive. However, many banks focus mainly on satisfying external customers while neglecting their employees' needs. This results in high employee turnover, poor service quality, and, over time, makes it harder to maintain customer loyalty and profitability. To improve customer loyalty and service quality, commercial banks in China need to focus on increasing employee loyalty first. Internal marketing is key to building employee loyalty and is closely linked to successful external marketing.

Although Chinese researchers have explored internal marketing, their studies are not as advanced as international research in terms of content and methods. Most studies are focused on theoretical discussions and strategic advice, with very few examining how internal marketing actually affects employee loyalty and service quality in commercial banks. Therefore, this study aims to explore the relationship between internal marketing, employee loyalty, and service quality in commercial banks, using the quantitative research method.

Keywords: Commercial Bank, Internal Marketing, Employee Loyalty, Service Quality

1. Introduction

Commercial banks play a vital role in a country's financial system by providing services to businesses, institutions, and individuals. In recent years, the globalization of the financial economy has opened up China's financial market, attracting many foreign banks and leading to the rise of private banks and non-bank financial institutions. This has significantly increased competition in the banking sector. Major global banks like HSBC and Standard Chartered have expanded their presence by leveraging their international expertise and high-quality services, making it challenging for Chinese banks to compete due to gaps in financial strength, management practices, and technology (Bai Jie & Lu Hualiang, 2011).

China's growing economy presents vast opportunities for financial services, but the removal of restrictions on foreign banks since 2006 has intensified competition. As a result, Chinese commercial banks are facing increasing pressure from foreign competitors and fierce domestic rivalry in areas such as deposits, loans, and service innovation. To stay competitive, many banks focus on attracting and retaining external customers but often overlook the importance of employee loyalty. Research shows that customer loyalty is closely linked to employee loyalty (Wang Jian, 2010). Engaged and committed employees deliver better customer service, which enhances customer satisfaction and loyalty, ultimately improving business performance.

With the rapid growth of the knowledge economy, employees are under more pressure and seek better career opportunities, leading to high turnover rates. This turnover affects service quality and customer loyalty, weakening banks' market competitiveness. In contrast, loyal employees have a strong sense of belonging and are less likely to leave, even when offered better pay elsewhere (Ning Zhi, 2005). A study by Huaxin Huiyue (2005) found that companies with high employee loyalty had a 26% return on investment, compared to just 4% in companies with low employee loyalty (Lin Jiewen, 2006). This shows that employee loyalty positively impacts customer satisfaction and financial performance.

According to internal marketing theory, satisfied employees create satisfied customers. This is supported by the "Service Profit Chain Model" (Heskett and Sasser, 1994), which links employee satisfaction to customer loyalty and profitability. As competition intensifies and employee turnover increases in China's banking sector, internal marketing has become essential for improving service quality and maintaining a committed workforce. By treating employees as internal customers, banks can enhance employee loyalty, which directly impacts customer satisfaction and business growth.

Therefore, this study aims to explore the impact of employee engagement and loyalty on the performance and competitiveness of Chinese commercial banks. It examines how internal marketing strategies can enhance employee commitment, improve service quality, and foster long-term customer loyalty, helping banks maintain a competitive edge in the rapidly changing financial market.

Objective

1. To examine the impact of organization internal marketing on employee service quality.
2. To examine the impact of employee loyalty on employee service quality.

2. Methodology

2.1 Research Population and Sampling

This study targeted employees from six commercial banks in Qingdao, Shandong Province, China, using a questionnaire as the primary data collection method. The total population of employees across these banks is approximately 3,000. To select a representative sample, Yamane's (1967) formula was used to calculate the required sample size, which is expressed as:

$$n = \frac{N}{1 + Ne^2}$$

where:

N = total population (3,000)

e = margin of error (5% or 0.05)

Using this formula, the required sample size was calculated to be 353 employees. A random sampling method was implemented to ensure every employee had an equal chance of being chosen, thus reducing bias and enhancing the reliability of the results.

2.2 Data Collection

The study used an online questionnaire to collect data from employees of the six commercial banks in Qingdao. The digital format allowed for convenient and efficient data collection, resulting in a higher response rate while minimizing logistical challenges. The questionnaire was divided into sections that included demographic information, work experiences, and key variables relevant to the research objectives. Most questions were designed using a Likert scale to measure employee perceptions and attitudes. The survey was conducted using an online platform, such as Wenjuanxing.

2.3 Data Analysis

The collected data were analyzed using SPSS statistical software to achieve the research objectives. The main analysis methods included descriptive statistics and regression analysis. Initially, a descriptive analysis was conducted to summarize the respondents' demographic information, such as gender, age, education level, job position, and years of work experience in the bank. Frequency and percentage distributions were calculated to provide an overview of the sample characteristics.

3. Results

Internal marketing is a strategic approach that integrates employee satisfaction with customer service to enhance overall business performance. It involves treating employees as internal customers and providing them with adequate training, motivation, and resources to deliver high-quality service. Gronroos (1981) emphasized that internal marketing is a proactive and coordinated approach to drive employee satisfaction and improve customer service within organizations. Similarly, Berry and Parasuraman (1991) described it as a philosophy of developing and retaining excellent employees by treating them as customers and meeting their needs. The core of internal marketing is the concept of "customer first," where employees are considered internal customers, work is viewed as an internal product, and the organization itself is the market (Johnson & Seymour, 1985; Johnson, Seymour, & Gaida, 1986).

The development of internal marketing can be divided into three stages: employee satisfaction, customer orientation, and strategic change management. In the first stage, internal marketing focused on motivating employees and enhancing their satisfaction to improve service delivery and organizational performance (Berry, 1976). The second stage emphasized developing a customer-oriented mindset among employees, ensuring they prioritize customer

needs in service delivery (Gronroos, 1981; Quester, 1999). The third stage evolved into strategic change management, where internal marketing became a powerful tool for aligning employees with organizational goals and facilitating strategic execution (Winter, 1985; Piercy & Morgan, 1989). This strategic integration strengthens employee commitment, participation, and identification with the organization's external marketing strategies.

Several theoretical models have shaped the understanding of internal marketing. Berry's model emphasizes treating employees as customers, suggesting that satisfied employees lead to satisfied customers (Berry, 1976). In contrast, Gronroos' model focuses on fostering customer-oriented awareness and proactive sales behavior among employees, requiring robust support from senior leadership (Gronroos, 1981). Rafiq and Ahmed (2000) integrated these models to demonstrate how internal marketing influences service quality and business performance through employee satisfaction and strategic change. This integrated approach effectively links internal marketing activities to the execution of service quality strategies.

In the context of commercial banks, internal marketing positively impacts employee satisfaction, organizational commitment, and customer satisfaction (Richardson & Robinson, 1986; Tansuhaj et al., 1988). Empirical studies show that internal marketing dimensions such as recruitment, communication, training, and motivation significantly improve employee satisfaction and organizational commitment (Li Ping, Chen Hao, & Zhang Xiaofang, 2008). By fostering a customer-oriented culture, internal marketing encourages cooperation and collaboration among departments, enhancing service delivery and external customer satisfaction.

The relationship between internal marketing and employee loyalty is significant. Internal marketing activities, such as effective communication, career development, and fair organizational policies, play a crucial role in enhancing employee loyalty (Berry & Parasuraman, 1991; Caruana & Calleya, 1998). Loyal employees exhibit higher job satisfaction, commitment, and proactive customer-oriented behavior, which ultimately leads to better customer experiences. Moreover, employee loyalty mediates the relationship between internal marketing and service quality, as loyal employees consistently deliver superior customer service (Xiao Qipeng, 2004; Zeng An, 2010). High employee loyalty directly influences service quality. Loyal employees demonstrate higher motivation, better customer interactions, and consistent service delivery, leading to enhanced customer satisfaction and retention rates (Heskett & Sasser, 1994). This positive relationship between employee loyalty and service quality is supported by studies showing that loyal employees contribute to improved service performance and customer loyalty (Flynn, 2005; Yee et al., 2008). Additionally, internal marketing indirectly affects service quality by enhancing employee loyalty and satisfaction, creating a committed and motivated workforce that consistently delivers high-quality service (Richard, 1995; Lin Hui Chen, 2003).

Internal marketing also directly influences service quality by fostering positive employee attitudes, motivation, and customer-oriented behavior. Daley (1995) emphasized that

companies should train, empower, and communicate effectively with employees to improve their service attitude and quality. Similarly, George (1990) highlighted that internal marketing meets employees' needs, fostering high-quality employees who are customer-oriented. Internal marketing strategies such as effective communication, recognition, and empowerment significantly enhance employees' work attitudes and behaviors, leading to better service quality and stronger customer relationships (Richard, 1995; Lin Hui Chen, 2003).

4. Conclusion and Future Work

Internal marketing is essential for building employee loyalty and delivering high-quality services. Organizations that invest in internal marketing see significant improvements in employee satisfaction, loyalty, and service quality, leading to better customer experience and increased business performance. By strategically implementing internal marketing practices and creating a supportive and customer-focused work environment, organizations can gain a competitive advantage and achieve long-term success. These findings provide valuable insights for managers and human resource professionals looking to enhance employee loyalty and service quality through effective internal marketing strategies.

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Building Better Service: How Internal Marketing and Employee Loyalty Shape Quality in China's Commercial Banks

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Abstract

As China's financial economy expands, foreign banks are entering the market while private banks and non-bank financial institutions continue to emerge, intensifying competition and diversifying the sector. To remain competitive, commercial banks are launching new products, experimenting with marketing strategies, and upgrading service delivery to attract and retain customers. High-quality customer service is a proven lever for customer loyalty, profitability, and sustained advantage. Yet many banks prioritize external customer satisfaction while overlooking employees' needs, leading to high turnover, diminished service quality, and, ultimately, weaker customer loyalty and profitability. Strengthening employee loyalty is therefore foundational to improving service quality and customer retention. Internal marketing is central to cultivating that loyalty and is tightly connected to effective external marketing. Although internal marketing has been studied by Chinese scholars, the literature lags behind international research in scope and methodological rigor. Much of it remains conceptual or prescriptive, with limited empirical evidence on how internal marketing influences employee loyalty and service quality in commercial banking. To address this gap, the present study employs a quantitative design to examine the relationships among internal marketing, employee loyalty, and service quality in China's commercial banks.

Keywords: Commercial Bank, Internal Marketing, Employee Loyalty, Service Quality

1. Introduction

Commercial banks are central to national financial systems, serving firms, institutions, and households. In China, ongoing financial globalization has opened the market to foreign entrants while spurring the growth of private banks and non-bank financial institutions, sharply intensifying competition. Leading multinationals such as HSBC and Standard Chartered have expanded by leveraging global expertise and premium service quality, exposing competitive gaps in Chinese banks' financial strength, management practices, and technology (Bai Jie & Lu Hualiang, 2011). Although China's economic expansion creates substantial demand for financial services, the removal of restrictions on foreign banks in 2006 further increased competitive pressure. Chinese commercial banks now confront both international challengers and fierce domestic rivals across deposits, lending, and service innovation. Many have concentrated on acquiring and retaining external customers, yet often underinvest in employee loyalty—even though customer loyalty is closely linked to employee commitment (Wang Jian,

2010). Engaged employees deliver superior service, driving customer satisfaction and loyalty and, in turn, better business performance. In the knowledge economy, rising workload and career mobility have elevated turnover, undermining service quality and weakening customer loyalty—and thus market competitiveness. By contrast, loyal employees exhibit stronger attachment and lower propensity to leave, even when offered higher pay (Ning Zhi, 2005). Empirical evidence underscores the performance implications: firms with high employee loyalty achieved a 26% return on investment versus 4% in firms with low loyalty (Huaxin Huiyue, 2005; cited in Lin Jiewen, 2006). Internal marketing theory posits that satisfied employees create satisfied customers, a core linkage formalized in the Service-Profit Chain (Heskett & Sasser, 1994). As competition and turnover rise in China's banking sector, internal marketing has become pivotal for sustaining service quality and strengthening workforce commitment. Treating employees as internal customers can enhance loyalty, which directly improves customer satisfaction and business outcomes. Against this backdrop, this study investigates how employee engagement and loyalty shape the performance and competitiveness of Chinese commercial banks. Specifically, it examines how internal marketing strategies bolster employee commitment, elevate service quality, and cultivate long-term customer loyalty—helping banks maintain an edge in a rapidly evolving financial marketplace.

Objective

1. To investigate how internal marketing practices within the organization influence employee service quality.
2. To analyze the effect of employee loyalty on the quality of services delivered by employees.

2. Methodology

2.1 Research Population and Sampling

The study was conducted among employees of six commercial banks in Qingdao, Shandong Province, China. Together, these institutions employ approximately 3,000 staff members. To ensure the sample accurately represented the target population, the sample size was determined using Yamane's (1967) formula, with a 5% margin of error. Based on this calculation, a minimum of 353 participants was required. A random sampling technique was adopted to guarantee that every employee had an equal probability of selection, thereby minimizing bias and improving the reliability of the results.

Data collection was carried out using a structured questionnaire designed to capture respondents' perceptions related to internal marketing, employee loyalty, and service quality. The collected data were processed and analyzed using SPSS software. Descriptive statistics were applied to present the demographic profile of respondents—including gender, age, education level, job position, and tenure—while regression analysis was employed to examine the hypothesized relationships among the study variables.

2.2 Data Analysis

This section presents the results of the linear regression analyses conducted to examine how internal marketing and employee loyalty influence service quality. The objective was to

determine the predictive power of these independent variables on the dependent variable (service quality) and to assess the statistical significance and strength of their relationships.

a. Impact of Internal marketing on service quality

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.477 ^a	.228	.226	.39551

a. Predictors: (Constant), IM_Mean

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	16.188	1	16.188	103.488	.000 ^b
	Residual	54.905	351	.156		
	Total	71.093	352			

a. Dependent Variable: SQ_Mean

b. Predictors: (Constant), IM_Mean

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.232	.181		12.311	.000
	IM_Mean	.439	.043	.477	10.173	.000

a. Dependent Variable: SQ_Mean

The analysis reveals that internal marketing exerts a significant and positive impact on service quality. The model shows a moderate correlation ($R = 0.477$) with an R^2 value of 0.228, indicating that internal marketing accounts for 22.8% of the variance in service quality. The ANOVA results confirm the model's statistical significance ($F = 103.488$, $p < .001$). The coefficients further demonstrate that internal marketing (IM_Mean) has a standardized beta coefficient of 0.477 and an unstandardized coefficient (B) of 0.439, both significant at $p < .001$. This means that as internal marketing practices improve, employees' service quality increases correspondingly. These findings support the hypothesis that effective internal marketing is a vital factor in enhancing service performance within organizations.

2.3 Impact of Employee Loyalty on Service Quality

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.699 ^a	.489	.487	.32184

a. Predictors: (Constant), EL_Mean

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	34.736	1	34.736	335.342	.000 ^b
	Residual	36.358	351	.104		
	Total	71.093	352			

a. Dependent Variable: SQ_Mean

b. Predictors: (Constant), EL_Mean

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.202	.103		21.362	.000
	EL_Mean	.472	.026	.699	18.312	.000

a. Dependent Variable: SQ_Mean

The results indicate that employee loyalty has a strong and statistically significant influence on service quality. The model shows a high correlation ($R = 0.699$) and an R^2 value of 0.489, meaning that employee loyalty explains 48.9% of the variance in service quality—substantially higher than the variance explained by internal marketing alone. The model's reliability is confirmed by the ANOVA results ($F = 335.342$, $p < .001$).

The coefficient analysis shows that the unstandardized coefficient (B) for employee loyalty is 0.472, implying that a one-point increase in employee loyalty corresponds to a 0.472-point rise in service quality on average. The standardized beta coefficient (0.699) reflects a strong effect size, while the high t-value (18.312) and $p < .001$ indicate a robust relationship.

Overall, the findings highlight employee loyalty as a key determinant of service quality. Loyal employees are significantly more likely to deliver superior service performance, underscoring the strategic importance of fostering employee commitment and satisfaction to enhance organizational outcomes.

3. Conclusion and Discussion

The study examined the influence of internal marketing and employee loyalty on service quality within the banking industry. Results from the statistical analyses provide clear evidence that both factors significantly predict service quality, though their levels of influence differ.

Internal marketing was found to have a moderate positive effect on service quality. This suggests that when banks implement internal marketing practices—such as effective communication, training, recognition, and employee involvement—staff become more capable and motivated to deliver high-quality customer service. However, as internal marketing explained approximately 22.8% of the variance in service quality, it appears that other organizational factors also play important roles. In contrast, employee loyalty demonstrated a stronger and more substantial influence, explaining nearly 48.9% of the variance in service quality. Employees who feel a strong sense of pride, belonging, and commitment to their organization are more likely to maintain high performance standards and provide superior customer service. Collectively, the findings confirm the study's objectives, showing that both internal marketing and employee loyalty are critical predictors of service quality. Employee loyalty emerged as the stronger predictor, while internal marketing served as a key enabler that fosters a work environment conducive to loyalty and sustained service excellence.

Despite its valuable contributions, this study has several limitations. First, the research focused solely on the banking sector, which may restrict the generalizability of the findings to other industries where employee–customer interactions differ in intensity. Second, the cross-sectional research design captures data at a single point in time, limiting the ability to infer causality. Third, reliance on self-reported questionnaires may introduce response bias, such as social desirability or overestimation of performance. Finally, the study concentrated on two main predictors—internal marketing and employee loyalty—while other potential determinants, including leadership style, organizational culture, or market conditions, were not examined.

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The History and Development of Huidong Fishing Songs

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Abstract

Huidong Fishing Songs are a national intangible cultural heritage (selected in 2008), which originated in the Song Dynasty, flourished during the Ming and Qing Dynasties, and have been rejuvenated in modern times. They originated in Huizhou County, Guangdong Province, and were created by the Nanyue ethnic group's fishermen who migrated south. They are carried by the Minnan dialect (Fulao language) and embody the migration and life history of the maritime ethnic group for over 2,000 years. The historical development can be divided into five periods: The Song Dynasty was the embryonic period, influenced by southern music, forming the rudimentary forms of labor chants and impromptu lyrical tunes, serving scenes such as labor and sacrifices; The Ming and Qing Dynasties were the mature period, with nearly 30 types of tunes, incorporating local opera elements, and the themes expanded to love and politics, retaining the "one leads and the rest follow" form; The Republic of China period was the continuation period, despite social discrimination, the themes extended to land-based life, and some elements of foreign opera singing styles were absorbed; From 1949 to 2000, it was the development period, after the fishermen settled on land, the content of the fisherman's songs turned to praising the new life, and innovative forms such as fisherman's operas emerged; Since 2000, it has been the policy promotion period, relying on the intangible cultural heritage policy to establish a protection system including the cultivation of inheritors, campus inheritance, and digital recording. This study, through literature research, field observation and interview methods, clarified the development path of Huizhou fish songs, filling the gap in the historical development research of this genre, and providing theoretical support for the dynamic inheritance of this intangible cultural heritage and the study of similar folk songs.

Keywords: Huidong Fishing Song, history and development

1. Introduction

Huizhou is located in the intersection area of Hakka culture, Guangfu culture and Chaoshan culture. Various cultures blend and incorporate each other, forming a splendid and diversified Huizhou culture. Guangdong Han opera, fishing song, folk song, dragon dance, lion dance, spring cow dance, Yao fire dog dance and other cultural activities are popular, and the folk culture is colorful. Among them, the culture of fishing songs can best show the uniqueness of Huizhou culture. From the melody of fishing songs, we can see the history and suffering of fishermen. Huizhou's fishing song culture is preserved in Huidong County, which is under the jurisdiction of Huizhou City. Huidong County is a mountainous coastal county. In ancient times, many fishermen landed in the port of Huidong County and settled down here, making

the fishing song of Huidong County well preserved and sung, and developed into today's "Huidong Fishing Song".

According to the Huidong local Chronicles series records, the distant ancestors of fishermen along the Huidong coast belong to the original "Tanka people (known as Danjia people)", also known as "post-boat people", which is a part of the "Baiyue nationality" in southern China, and has a history of more than two thousand years. According to historical records, starting about 700 years ago, six groups of "Tanka" came to the Huidong coast through flight, trading, or exile. In the past, the Tanka people had a low social status, and the successive governments did not allow them to build houses on the shore, marry with people on the shore, and their children were not allowed to take part in the imperial examinations (Annals of Huidong County, 2003). "Three points of life at sea, head down on shore, sit without a foothold, and die without burial", this is the true portrayal of the fate of the Tanka family in the old society (Zhuang Chusheng, 2009). The "Huizhou Fu Zhi" records: "The Tanka people who live on the water, with one boat and one paddle, wearing ragged clothes, and have to pay taxes according to the number of boats. (Liu Yunian, 1881)." Exploitation and discrimination against the Tanka people have lasted for a very long time in history. Fishermen have lived a long life drifting on the sea, rarely going ashore, fishing for a living with the tide, and their life is boring. In their work at sea, they have vivid feelings and emotions, and their hearts are sad and sad. Used for self-entertainment to relieve worries, over time has formed a unique style of fishing songs.

After the founding of the People's Republic of China in 1949, the hardships of the Tanka people wandering on the sea finally came to an end, and like the people of the whole country, they returned to the big family of the Chinese nation as masters. The government built a house and a school for them on the shore. They settled down and began a new life. At the same time, the Tanka people have been repressed for years of creativity also erupted, in the past, the Tanka people dream of having their own home, now they have more cherish, and strive to build their hometown at the same time, they do not forget to be grateful, create many new fishing songs, do not forget the "thanks to the Communist Party". Today, the new fishing songs composed by the new generation of Tanka are very different from those composed by the older generation. The history of the Tanka is encapsulated in fishing songs, which epitomize the development of China's social system and culture over the centuries. It is of profound historical and practical significance to explore the Tanka history, study the Tanka culture and inherit the Tanka fishing songs.

The fishing songs of Huidong originated from the Tanka people on the water, and its foundation and characteristics are different from the folk songs and folk songs of other regions. In addition, the first creator of the fishing song is the "criminal official" in the court, with a certain cultural accomplishment and musical accomplishment, the artistic starting point of its creation of the tune is relatively high. Among the dozens of existing tunes of Huidong fishing song, as far as its artistic style is concerned, it can be felt that it has not only the high and vigorous northern music, but also the euphemism and tenderness of Jiangnan bamboo and bamboo, the typical Guangdong music style, but also the fresh and elegant of tidal music (Cai Jing, 2012). Different tones, for different occasions, expressive force and natural. From the historical origin, content, style and form, it can be clearly found that the fishing songs of Huidong and Lufeng, Haifeng, Baoan and other places in Shanwei are the same, but the fishing

songs of different places are affected by local customs, language, culture and other factors in their respective development history, which makes the singing style slightly different.

After landing, the Tanka families embraced the opportunities and development of the new era and began to change their original way of life. At the same time, the inheritance and development of fishing songs also faced challenges. With the change of production mode, fishing mode is constantly updated, and the phenomenon of abandoned fishing from business and abandoned fishing from industry continues to emerge. Therefore, the cultural ecological environment of Huidong fishing song has been strongly impacted -- fewer and fewer singers. Huidong fishing song gradually lost its growing soil. At present, there are only more than 10 fishing singers in Huidong County, and most of them are old. Huidong fishing Song, an intangible cultural heritage passed down from mouth to mouth, is facing the harsh reality of inheritance.

As for the development of Huidong's fishing songs, previous scholars often stayed in the conception of the development path of Huidong's fishing songs. For example, Yue Xiaoyun (2010) proposed in his study "Conception of the Development Path of Huidong's fishing Songs" that the protection of Huidong's fishing songs should start from the macro and micro aspects, and establish an academic team with multi-disciplinary and interdisciplinary knowledge structure guided by the perspective of musical anthropology. Focus on school heritage and music creation. Some scholars also pay attention to Huidong's innovation in the new era of fishing songs. For example, Xu Sihui (2019) takes "Tanka Songs" as a case study in her research, focusing on how Huidong's composition of fishing songs and tunes narrates stories of Tanka families.

This article mainly studies the history of fishery songs in Huizhou after the founding of the People's Republic of China, and further analyzes the changes and development of Huizhou fishery songs, with the aim of helping Huizhou fishery songs to be better passed down in the future and providing certain theoretical support for other folk songs.

Research Objectives

To study the history and development of Huidong Fishing songs.

2. Literature Review

At present, there are not many studies on Huizhou. They mainly focus on its singing characteristics and original ecological features, such as Wu Yinglian (2016) in "The Origin, Artistic Characteristics and New Development Ideas of Huidong Fishing songs ", who discussed the origin and migration route of the carrier of Huizhou fish songs - the Dian people, based on a large amount of literature and historical records. Through the exploration of the history of the Tanka people, she deeply revealed the cultural origin and the reason for its current spread of Huizhou fish songs, and at the same time, analyzed the types and artistic characteristics of Huidong Fishing songs in detail from the aspects of the genre and lyrics. She objectively expounded the current situation of Huizhou fish songs and put forward constructive suggestions for the development of Huizhou fish songs.

With the changes of the times, the cultural positioning of Huidong Fishing songs has also undergone certain changes. As Zhang Xiying (2022) discussed in "The Positioning and Characteristics of Huizhou Fish Songs in Dian Family Customs", she believed that the accompanied singing of Huidong Fishing songs is the basic form in customs, and the field

resonance is its aesthetic norm; the second feature is the relatively loose improvisation and randomness of performance, which strengthens the cultural and entertainment atmosphere; the third feature is the throat singing style of Huidong Fishing songs, which is unique in the original ecological music.

The research on the essence of Huidong Fishing songs mainly includes Xu Shi-hui (2019) in "The Musical Characteristics and Singing Style Research of "Tanka Family Suite". Through the performance of "Tanka Family Suite", she discussed the innovation of musical features such as the form structure, rhythm and tempo, the application of embellishments, and the force and speed of Huizhou fish songs, analyzed the singing style of Huidong Fishing songs, and elaborated on the basic points that need to be grasped and the handling of musical style in the singing process from the aspects of the style of lyrics and singing characteristics. She focused on discussing the language articulation features, the application of embellishments and the singing techniques of emotional expression in the singing process.

In summary, the current research on Huizhou fish songs mainly focuses on its singing characteristics and original ecological features. However, there is still a certain gap in the research on the historical development of Huidong Fishing songs. This study attempts to clarify the development path of Huidong Fishing songs and fill this gap.

3. Research Methodology

1. Literature research: Through literature analysis, study the historical evolution and current status of inheritance and development of Huidong Fishing songs.

2. Observation method: Conduct online observation of Huidong Fishing songs performances and offline viewing of Huidong Fishing songs shows. Conduct on-site observations and data collection at cultural centers in Nianshan Town, Xunliao, Pinghai Town, etc., in Huizhou City, Huidong County, Guangdong Province.

3. Interview method: Conduct individual and group interviews with Huidong Fishing songs inheritors, performers, creators, and staff of the intangible cultural heritage center to comprehensively understand the historical development of Huidong Fishing songs.

4. Results

Huidong Fishing Song is a traditional folk song from the coastal areas of Huidong County, Huizhou City, Guangdong Province. It has a long history and a unique artistic style. On June 7, 2008, it was included in the National Intangible Cultural Heritage list and has since been protected by the intangible cultural heritage policy. According to relevant records, since the Southern Song Dynasty, the ancestors of fishermen in Huidong have moved from Fujian to the coastal peninsula of Renping, Huidong.

Due to the backwardness of production tools and the primitive way of fishing at sea, fishermen had no fixed abode. They would go wherever there were fish to catch and settle in places with good shelter from the wind. This determined that the relocation of their living places would go through a long process. Finally, the fishermen chose Pinghai Port (Huidong County), and some of them moved to other ports in Huidong County, such as Xunliao Bay, Fan Gang, and Yanzhou, to settle down.

During their long life at sea, fishermen moved among themselves, but most of them settled at Pinghai Port at that time. As a result, the fishermen in Huidong mainly use the Minnan dialect. In the past, fishermen had no family trees and no ancestral halls on land. More ancient historical facts are difficult to verify for the time being. According to Xu Luodai, the former deputy secretary of the Port Commune of Huidong County and the former clerk of the Xincun Brigade, he found that the earliest tombstone was inscribed in the 16th year of the Qianlong reign (1751). At the same time, from a fishing song that is still sung in the fishing villages of Huidong today, the "Ai Ai Ai" tune of "The Sixteenth Year of the Reign of Emperor Qianlong" (see "Ou Chuan Fishing Songs" edited by Su Fangtai), it can be seen that the fishing songs of Huidong have a long history, and their origin is shrouded in various theories. What can be confirmed from the existing historical materials is that the fishing songs of Huidong have existed since the Qing Dynasty (about 1751). The historical development of Huidong Fishing songs is sorted out as follows:

1. Budding Period (1960-1279)

The history of Huidong Fishing songs can be traced back to the Song Dynasty. It was first introduced to Huidong along the coast of Fujian with the migration of the Tanka people. The history of Huidong Fishing songs is long and can be traced back to the Baiyue people: At the end of the Southern Song Dynasty, the Baiyue Tanka people in the Fujian and Chaoshan areas began to migrate due to wars and livelihood issues, moving along the river basin to the southeast coast to engage in fishing. The Song Dynasty was an important period in Chinese history when over a hundred Yue people (also known as the "ancient Yue people") gradually differentiated and integrated. The Baiyue people were an ancient ethnic group distributed in the southeast coastal areas and Lingnan regions of China from the Pre-Qin period to the Qin and Han dynasties. They included multiple branches such as the Wuyue, Minyue, Nanyue, and Luoyue (Huidong County Annals, 2003).

During the Song Dynasty, due to the southward migration of Han people from the Central Plains, the change of local regimes and the accelerated integration of ethnic groups, the ethnic groups of the Song Dynasty underwent earth-shaking changes. The predecessor of the Tanka mentioned in the text, the Baiyue people, did not exist as an independent ethnic group but was an ancient ethnic group with multiple branches. They interacted with the Huaxia people in the Central Plains (the predecessor of the Han people) for a long time and were assimilated in the course of history. The formation of today's multiple southern ethnic groups and branches of the Han nationality: 1. The predecessors of modern ethnic minorities (such as the Zhuang, Dong, Li, etc.); 2. An important component of the Han people in the south; 3. Marginalized groups (Dan ethnic Group).

The disappearance of the Baiyue people was not genocide but the result of cultural integration. Their genes and culture are still active in southern China and Southeast Asian societies to this day. The singers of Huidong fishing songs studied in this article are descendants of the Dan people among the Baiyue ethnic group. At that time, the social status of the Dan people was low and they were discriminated against by the residents on land.

During the Song Dynasty, the Tanka people began to be oppressed, such as economic exploitation, heavy taxes and predatory levies. Fishermen were required to pay "fishery and salt taxes" and "fish taxes" (in kind or currency). The *"Collected Manuscripts of Song Huiyao"*

- *Food and Goods*" records that in the Guangnan area, "Tanka people pay an annual tax of a thousand catties of fish and oil every year". At the same time, they often imposed extortion. Local officials would frequently demand "regular money" under the guise of "inspecting ships" or "patrolling rivers", and otherwise, their fishing gear would be detained (Zhu Xi's *"According to Tang Zhongyou's Complaint"* exposed such phenomena). The Tanka people in Guangnan were forcibly conscripted as "pearl collectors" and risked diving to collect pearls for the royal family to enjoy. The deceased received no compensation (as recorded in *"Lingwai Dai Da"*, "They tied ropes around their waists, dived into the sea to retrieve mussels, and many drowned."). Inland river fishermen were often conscripted to transport grain, which delayed the farming season without compensation (Volume 291 of the *"Continuation of the Comprehensive Mirror for Aid in Government"*). Personal injury, fishermen are regarded as "uncivilized people", and land-based residents can bully them without severe punishment. The *"Minggong Shupan Qingming Ji"* of the Southern Song Dynasty records many cases where "A law-abiding citizen assaulted and killed a floating-village household; the punishment shall be reduced accordingly."

Female Tanka people were often abducted and taken as maids and concubines, and the government condoned them (the third volume of the *"Yi Jian Zhi"*, "Zhi Ding", records that the powerful forces "took Tanka women as slaves"). Cultural prejudice: The literati's notes depict fishermen as "cunning in nature" and "uncivilized" (*Pingzhou Ke Tan*), reinforcing social prejudice. Fishermen were prohibited from participating in the imperial examination (only a few special cases were briefly permitted during the reign of Emperor Shenzong of the Northern Song Dynasty), and their upward mobility was cut off. Ecological oppression: Deprivation of resources and squeezing of living space. The government designated "no fishing zones" (such as the waters around imperial tombs), and those who violated them were severely punished, leading to the shrinking of traditional fishing grounds (Volume 26 of the *"Song Dynasty Criminal Statistics"*). The powerful forces occupied the lake and "demarcated the land", and fishermen had to pay "water purchase money" to catch fish (Lu You's *"Record of Entering Sichuan"* records the phenomenon of Poyang Lake). In order to defend against the Jin and Yuan naval forces, the Southern Song Dynasty forced the "relocation to the sea" (as proposed by Li Gang), burning coastal fishing boats and leaving fishermen homeless. The naval forces requisitioned fishing boats to use as warships and did not return them after the war (Volume 58 of the *"Chronicle of the Years Since Jianyan"*). With the intensification of oppression, fishermen can only express their emotions through fishing songs, so fishing songs have become an important way for fishermen at sea to express their inner feelings.

During the Song Dynasty, Huidong was part of Guishan County, Huizhou City. It was located along the eastern coast of Guangdong Province and was an important settlement for the Tanka people (also known as "Yan Hu" or "Shui Shui Ren"). The Tanka people take boats as their home and fishing as their profession. Fishing songs are the core carrier of their oral tradition (Huidong County Annals, 2003). The Song Dynasty's *"Taiping Huanyu Ji"* records: "In Huizhou, the Tanka people lived in boats and made a living by fishing," indicating that the Tanka culture had already developed distinct characteristics. Due to the low social status of the Tanka people, they belonged to the "outcasts" class in the Song Dynasty and were discriminated against by the land residents. The fishing songs might imply the metaphorical

expression of identity suppression, for instance, using "wind and waves" as a metaphor for social oppression (Le Shi, 976).

2. Mature period (Ming and Qing Dynasties: 1368-1911)

1) The Ming Dynasty (1368-1644)

In the early Ming Dynasty (14th to 15th centuries), the maritime ban policy was implemented. The Tanka people in Huidong were classified as "fishing households", and fishing songs, as a form of labor and entertainment, continued the tradition of the Song and Yuan Dynasties, but were suppressed by the authorities. The Jiajing "Huizhou Prefecture Annals" (1548) mentioned that "the Tanka people lived by boat and sang to relieve their spirits", but no lyrics were recorded, which proved the existence of fishing songs. Kuang Lu of the Ming Dynasty recorded in his "Chi Ya" (1636) that the Tanka people in Lingnan "responded to each other with songs when getting married", and Huidong might belong to this category. After the Longqing opening in the early 16th and 17th centuries (1567), the coastal fishery trade in Huidong became active, and fishing songs incorporated themes of life at sea. The prototype of "Xianshui Song" : The notes of scholars in Huizhou during the late Ming Dynasty (such as Ye Chun and "Hui 'an Zhengshu") mentioned "fishermen singing songs and nets", which might be the origin of the male-female duet form in the later "Huidong Fishing Song". The content of Mazu beliefs can be seen in fisherman's songs (such as the "Ode to the Sea God"), which is related to the rise of the Tianhou Palace in Huidong during the Ming Dynasty (built during the Wanli period).

2) The Qing Dynasty (1644-1911)

In the early Qing Dynasty (17th - 18th century), the relocation of the border and the ban on the sea (1661-1683) led to the inward migration of fishermen from Huidong, causing the decline of fishing songs for a time. However, they were revived after the reopening of the border. The "Guishan County Annals" of the Kangxi reign (1688) records that "the Tanka people lived by water and sang and wept in boats." Guishan County is now the majority of Huidong. Qu Dajun's "New Language of Guangdong" (1700) includes fragments of "Dange", such as " Waves white and wind clear, A young girl rows her boat across the Lingding Sea. (Lang Bai Feng Qing, A Mei Yao Lu Guo Lingding)", which may contain elements of Huidong Fishing songs. By the middle and late Qing Dynasty (19th century), Huidong Fishing songs had reached their mature stage: fisherman's songs formed fixed tunes (such as "Ah Ah Tune" and "La Da Ti"), and the themes of the lyrics expanded to love, current politics and other contents. The Daoguang "Huizhou Prefecture Annals" (1822) clearly records that in the Pinghai fishing port of Huidong, "the Tanka girls were good at singing, which were called 'Xianshui Songs'." At the end of the Qing Dynasty (late 19th century - early 20th century), fishing songs were influenced by Hakka mountain songs and Cantonese Yue Ou, presenting a mixed style.

During the Ming and Qing dynasties, fishing songs gradually matured, with Huidong fishing songs entering their peak period, featuring enriched melodies and social functions. They extensively absorbed elements from local operas around Huidong Port (such as Haifeng's Bai Zi Xi and Mazu Temple Music), forming nearly 30 distinct melodies, including "Ah Ah Xiang Tune," "Xian Di Tune," and "Luo Yin Tune." These diverse melodies permeated every facet of the Tanka's lives—marriage, sacrifice, festivals, and funerals—becoming an integral part of their culture. The Huizhou Prefecture Annals (2003) noted that "the songs of the Tanka

households are mournful and urgent,” reflecting the sorrowful undertone of these songs. Fishermen's songs were performed without instrumental accompaniment. Forms include solos, duets, and competitive singing. The early Qing text *New Discourses of Guangdong* (1985) records that fishing songs “followed the tides, composed on the spot,” highlighting their improvisational nature. The “dragging melody” technique found in the preserved lyrics and scores of *Twelve-Month Fishing Songs from Pinghai Town*, Huidong, shares similarities with Ming Dynasty Nanyin, demonstrating the fusion of artistic influences in fishing songs. The work *Qianlong Ascends the Throne in the Sixteenth Year* powerfully conveys the authentic reality of Huidong fishing songs during that era.

The sixteenth year of Emperor Qianlong's reign (1751 AD) was the prosperous era of Emperor Qianlong in the Qing Dynasty. This song is an original Huidong Fishing song that has been passed down to this day. According to the lyrics, it is suggested that the song might have been created during this period or as a historical recollection of the Qianlong era in later generations. The carriers of fisherman's songs are usually based on historical events and folk tales. Therefore, the title of this piece may draw on the stability and prosperity of the Qianlong reign to imply fishermen's yearning for a peaceful and prosperous life, or it may implicitly reflect the maritime ban policy at that time (the Qing Dynasty had implemented strict maritime bans). Metaphorical expression is a common technique in Huidong Fishing songs. The lyrics often contain metaphorical language to reflect oppression and resistance after being oppressed for a long time.

3. Continuation Period (1912-1949)

In 1912, the government of the Republic of China completely abolished the system of “lowly registration”, theoretically allowing the Tanka people to go ashore. However, social discrimination was deeply rooted, and most of them were still forced to maintain a life on water. As an important musical form of the coastal Tanka people (water residents) in Lingnan, Huidong Fishing songs have undergone social changes, cultural integration and survival challenges during their inheritance. During this period, fisherman's songs not only retained the traditional characteristics since the Song and Yuan dynasties, but also were influenced by the social changes in the Ming and Qing dynasties, presenting a unique artistic style and social function (Lin Bilian, 2013). The Tanka people were deeply influenced by their life at sea. During the Republic of China period, their performance form was still mainly oral singing without musical instrument accompaniment, emphasizing the impromptu expression of human voices. The custom of “answering songs” was popular among the Tanka people on boats or on the shore, and the content mostly involved life, love, fishing affairs, etc. During the fishing season or festivals, fishermen sang collectively, forming an interactive mode of “one call and one response”. Using the “Hoklo dialect” (a part of the Minnan language family), some lyrics are influenced by the Hakka dialect, resulting in a mixture of two languages. The content of the lyrics still mainly focuses on the life of fishermen, such as “Sailing Song” and “Sighing at the Fifth Watch of the Night”. New themes reflecting social unrest have been added, such as “Song of Fleeing from Famine”.

During the Republic of China period, Huidong Fishing songs continued 29 tunes from the Ming and Qing dynasties, such as “Oh Oh Xiang Tune”, “La Da Du Tune”, “Xian Di Tune”, “Luo Yin Tune”, etc. Some tunes evolved due to the migration of the Tanka people. Therefore,

during the continuation period of the Republic of China era, the musical form, singing style, social function and living environment of Huidong Fishing songs changed.

During this period, fisherman's songs have also undergone certain changes:

1) Social Transformation and Functional Expansion: From "Sea Lament" to Diverse Expressions: During the Republic of China period, as some of the Tanka people settled on land, the themes of fishing songs expanded from pure sea toil to land-based life scenarios (such as weddings and festivals), and the lyrics became closer to daily life.

2) Diversification of performance forms: Solo and duet singing remain the mainstream, but group performances (such as the "singing lady" in wedding ceremonies) have increased, enhancing the social interaction function of fisherman's songs.

3) Infiltration of foreign cultures and musical elements: During the Republic of China period, the coastal areas were impacted by foreign cultures. Fishing songs might have partially absorbed the singing styles of Cantonese opera and Chaoju Opera, but overall, they still maintained the traditions of dialect singing and a cappella singing.

4) Melody Innovation: Some tunes (such as "Xian Di Tune" and "Luo Yin Tune") may incorporate decorative notes while retaining the pentatonic scale, making the melody more fluid. 4.

5) Initial Attempts at Recording and Inheritance: During the Republic of China period, fishing songs were still mainly passed down orally and by heart, but some tunes were recorded by scholars or folklorists, leaving clues for later research (such as the fragmented records in the "Annals of Huidong County").

4. Development Period (1949 -2000)

The development period mainly refers to the development and changes of Huidong Fishing Songs after the founding of the People's Republic of China. During this period, Huidong Fishing Songs can be divided into three stages (Lin Bilian, 2018)

Phase 1: The Period of Significant Transformation (1949-1950)

Phase 2: The mature stage of the work

Phase 3: The period of inheritance and promotion

5. Policy Promotion Period (2000 to Present)

1) The Evolution of Huidong Fishing Songs from 2000 to 2008

Having migrated through various river basins since the Song Dynasty until settling in Huidong's ports, the formation of Huidong fishing songs holds even greater significance. The descendants of these fishermen cherish them all the more. Many of today's inheritors and singers are firsthand witnesses of maritime life. Having journeyed alongside their forebears, they carry countless joys, sorrows, partings, and painful memories—all etched into the lyrics and melodies of Huidong's fishing songs.

2) Regarding the protection and inheritance of Huidong Fishing Songs in Huidong County, Huizhou City:

(1) Cultivation and development of inheritors

It is divided into a three-stage working system: original ecology, singing and spreading, and innovation

First, the original ecological singing of Huidong Fishing songs is still being performed on the front line of preaching by Li Quemei, a national-level intangible cultural heritage

inheritor. She has taught over 200 fisherman's songs and trained a group of apprentices, such as Su Hairu and other young inheritors. Similarly, another inheritor of fisherman's songs, the "Old Fisherman's Song King" Li Futai, is still active on the front line of performances, deeply rooted in the performance of Huidong Fishing songs, and is the spiritual representative of Huidong Fishing songs.

Second, the exemplary power of singing: Zhang Xiying, a municipal-level inheritor, led the Pinghai Fishing Song Art Troupe (nearly 70 people) to perform Huidong fishing songs, such as the fishing opera "Stories in the Fishing Village", which won awards in national, provincial and municipal competitions. It is worth mentioning that Zhang Xiying is a typical girl from Hunan. Since she started learning fisherman's songs from scratch, she has devoted tremendous efforts to them.

iii. Campus Inheritance and Innovation: With the support of the People's Government of Huidong County, "Fishing Songs in Schools" has established teaching points for fishing songs in primary and secondary schools in Gangkou, Pinghai and other places. A group of young teachers such as Zhong Jing and Zhou Guiling have emerged, who are committed to the singing of fishing songs and have formed a three-generation inheritance chain of teachers and students. Under the formulation of policy documents, a large amount of protection work has been carried out for Huidong fishing songs. The life of Huidong fishing songs is recreated through innovative forms such as fishing opera.

(2) Protection and Documentation of Media digitalization

Since 2023, the Guangdong Provincial Intangible Cultural Heritage Protection Center has conducted comprehensive audio-visual documentation of provincial-level inheritor Li Quemei, established a special resource library, and preserved precious materials such as singing skills and oral history.

At the same time, interviews were conducted with inheritors such as Chen Zhixiang, Zhang Xiying, and Li Futai, and the content was refined into a book, attracting a large number of scholars and singers to visit Huidong County to learn about Huidong fishing songs.

(3) Government support and policy guarantee

The Bureau of Culture, Radio, Television, Sports and Tourism of Huidong County has promoted the integration of fishing songs and culture and tourism, establishing intangible cultural heritage workshops and fishing song experience halls (such as the Xunliao Fishing Song Inheritance Studio), and including them in the rural revitalization projects. For instance, Xunliao Fishing Village was selected as one of the first batch of typical villages in Guangdong Province's "Hundred-Thousand-Million Project" and was rated as one of the "Top Ten Most Beautiful Fishing Ports in Guangdong Province".

6. Discussion

Huidong Fishing fish songs originated in the Song Dynasty, flourished during the Ming and Qing Dynasties, and have recently regained their vitality. They are an outstanding traditional music of the Chinese nation. They not only vividly depict the life and emotions of the Huizhou Tanka family fishermen, but also serve as a precious audio archive carrying the migration history, social history, and cultural history of ancient maritime ethnic groups. From the sorrowful songs of the oppressed group to the cultural treasure on the national stage today,

the change in its identity reflects the progress of society and the enhancement of cultural confidence.

However, it should also be noted that during the development of Huidong Fishing fish the transmission group (the Tanka people) was limited by their identity, and due to the special nature of the Tanka people's identity, they were prohibited from going ashore, which restricted the development of Huidong Fishing fish due to regional factors. Moreover, because Huidong Fishing fish were sung using certain dialects, their inheritance and development also had a certain dependence on dialects.

With the changes in marine ecology and the transformation of the fishing industry, the livelihood model on which it relied became ecologically fragile, directly leading to the continuous shrinking of the cultural practice space. Additionally, the endangered situation of the singing medium "Folowok" in the urbanization process further exacerbated the authenticity crisis of its inheritance.

In terms of protection mechanisms and policy support, the three aspects exhibit differences in institutional guarantees and differentiation in practical paths. Although Huizhou fish songs were included in the national intangible cultural heritage list in 2008, it faces a structural deficiency in local fiscal investment, with special funds being allocated among multiple projects, resulting in the dilution of protection resources and the lack of targeted local legislation guarantees. Its dynamic inheritance mainly relies on self-funded training classes by inheritors and other folk forces. Although attempts have been made to "enter schools" and build digital resource libraries, a systematic protection network has not yet been formed.

From a theoretical perspective, the inheritance dilemma of Huidong Fishing fish is essentially the disintegration of the cultural ecological chain. When the core ecological element of fishing production declines, the cultural system it depends on, including music, language, and customs, also collapses simultaneously. Currently, it is urgently necessary to build a tripartite system of "cultural ecology - institutional guarantee - innovation transformation". Based on this, Huizhou fish songs can achieve greater development in the future.

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Research on Sustainable Business Model Innovation in Electronic Information Manufacturing Industry: A Case Study of Guangdong and Guangxi Regions

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Abstract

Against the background of "dual carbon" goals and the transformation of the electronic information manufacturing industry, this study focuses on exploring the influencing factors of sustainable business model innovation (SBM I) in the electronic information manufacturing industry in Guangdong and Guangxi regions, and verifying the differential effects of these factors between the two regions. A questionnaire survey was conducted on 328 electronic information manufacturing enterprises in Guangdong (e.g., Shenzhen, Dongguan) and Guangxi (e.g., Nanning, Guilin), and Partial Least Squares Structural Equation Modeling (PLS-SEM) was used for data analysis. The results show that: (1) Digital Innovation (DI), Policy Support (PS), and Quality of Human Capital (QHC) all have significant positive effects on Sustainable Business Model Innovation ($\beta=0.155$, $p=0.003$; $\beta=0.208$, $p<0.001$; $\beta=0.287$, $p<0.001$ respectively), among which QHC has the strongest explanatory power; (2) Regionally, QHC and DI have a more prominent impact on SBM I in Guangdong, while PS plays a more critical role in Guangxi; (3) The measurement model has good reliability and validity (Cronbach's $\alpha>0.83$, AVE >0.59 , HTMT <0.40), and no multicollinearity problem (VIF <3.2). This study provides empirical evidence for the sustainable transformation of the electronic information manufacturing industry in the two regions and offers targeted suggestions for enterprises and governments.

Keywords: Electronic Information Manufacturing Industry; Sustainable Business Model Innovation; Digital Innovation; Policy Support; Quality of Human Capital; Guangdong; Guangxi

1. Introduction

1.1 Research Background

The electronic information manufacturing industry is a core pillar of the national economy in China, and Guangdong and Guangxi are important agglomeration areas of this industry. In 2024, the output value of Guangdong's electronic information manufacturing industry exceeded 6 trillion-yuan, accounting for nearly 30% of the national total, with leading

enterprises such as Huawei and ZTE; Guangxi, relying on the "Western Digital Economy Pilot Zone" policy, has achieved a year-on-year growth of 15% in the industry's output value, but there is still a gap with Guangdong in terms of industrial scale and innovation capacity. Under the dual constraints of resource conservation and carbon emission reduction, the traditional business model of the electronic information manufacturing industry—characterized by "high energy consumption, high pollution, and low added value"—is facing an urgent transformation. Sustainable Business Model Innovation (SBMI), which integrates environmental protection, social responsibility, and economic benefits, has become a key path for the industry to break through development bottlenecks.

1.2 Literature Review

Existing studies on sustainable innovation in the electronic information manufacturing industry mainly focus on technological innovation (e.g., energy-saving technologies, circular economy technologies) and ignore the systematic driving role of business model innovation (Zhang et al., 2023). Foreign scholars such as Bocken (2022) pointed out that SBMI relies on the synergy of multiple factors, including digital technology application and human capital quality, but few studies have conducted comparative analyses based on regional differences in China. Domestic research on Guangdong and Guangxi mostly focuses on industrial transfer and policy support, and lacks empirical exploration of the internal mechanism of SBMI in the electronic information manufacturing industry (Li et al., 2024).

1.3 Research Questions and Significance

This study aims to address two core questions: (1) What are the key factors affecting SBMI in the electronic information manufacturing industry, and what are their effect intensities? (2) Are there differences in the influence mechanism of SBMI between Guangdong and Guangxi?

The theoretical significance of this study lies in enriching the research on SBMI in the context of regional differences; the practical significance is to provide targeted strategies for enterprises in the two regions to promote sustainable transformation and for governments to formulate regional coordination policies.

2. Literature Review

The sustainable business model innovation (SBMI) of electronic information manufacturing industry has become a key measure to deal with global environmental constraints, technological disruption and evolving regulatory framework. Scholars conceptualized SBMI as a multi-dimensional transformation, including value proposition, creation and capture mechanism, combining environmental and social goals with economic feasibility (Bocken et al., 2014). For the electronic industry characterized by high resource intensity, complex global supply chain and escalating e-waste problem, SBMI usually focuses on three core pillars: digital innovation, policy support and quality of human capital.

Circular economy practices, such as material recycling, product life cycle extension and modular design, have been identified as the basis for sustainable electronic manufacturing. A report by IDTechEx (2025) emphasizes that traditional printed circuit board (PCB) and semiconductor production will produce a large amount of waste and toxic emissions, but

innovations such as biodegradable substrates and low-temperature treatment can reduce environmental impact and enhance scalability. As a supplement to these process innovations, digital technologies including industrial Internet platform, artificial intelligence driven optimization and intelligent factory system have achieved resource efficiency: Guangdong manufacturers such as Lyric robot automation have proved that integrated digital solutions can reduce operating costs by 30% and improve productivity by 40% while reducing carbon footprint (Xinhua news agency, 2025). At the regional level, Guangdong Guangxi cooperation shows how cross regional collaboration can promote SBMI: Guangdong's advantages in R&D and digital transformation (for example, the construction of smart factories is consistent with Guangxi's role as a parts manufacturing hub and cross-border supply chain integration, forming an ecosystem of "R&D in the Gulf region+made in Guangxi+ASEAN market" (Guangxi Ministry of industry and information technology, 2025).

The empirical study on regional SBMI differences emphasizes the importance of combining innovation with local resource endowment and policy environment. Guangdong's SBMI trajectory is driven by strict environmental regulations, leading enterprise leadership and digital infrastructure investment: guanxu electronics and other companies have developed a closed-loop "Green Park+green production+green products" mode, launched carbon neutral products such as Claire arc 3 headphones, and achieved on-site renewable energy self-sufficiency (Nanfang Daily, 2025). In contrast, Guangxi's SBMI strategy focuses on sustainable industrial transfer and circular cluster development. By taking advantage of policy incentives (such as the "double hundred and double new" project funds) and the advantages of ecological systems such as the location construction of Yongfu photoelectric technology park, the processing of renewable materials and the manufacturing of intelligent components form an integrated value chain (Guangxi science and Technology Department, 2025).

Despite the increasing case evidence, the existing literature shows two key gaps. First, few studies systematically analyze how interregional collaboration mechanisms (such as Guangdong Guangxi Industrial Park and "enclave economy") affect the diffusion of SBMI in electronic manufacturing industry, especially the knowledge transfer of green technology and circular practice. Second, the research on SBMI centered on small and medium-sized enterprises is still limited, although small and medium-sized enterprises account for 80% of electronic enterprises in Guangxi (Guangxi Department of industry and information technology, 2022). However, GE and Zhang (2023) and other scholars pointed out that policy support and platform empowerment are crucial to the sustainable development of SMEs, and there are still few empirical studies on how cross regional supply chain integration affects the SBMI of SMEs in border areas such as Guangxi. To solve these gaps, background case studies are needed to reveal the interaction among policy, Industrial Synergy and enterprise level innovation in the dual regional ecosystem.

3. Methodology

3.1 Research Design

This study adopts a mixed-methods design combining "case study" and "empirical analysis": first, select 10 representative enterprises in Guangdong and Guangxi for in-depth

interviews to identify potential influencing factors; then, design a questionnaire based on existing scales to conduct a large-scale survey, and use PLS-SEM to test the research model.

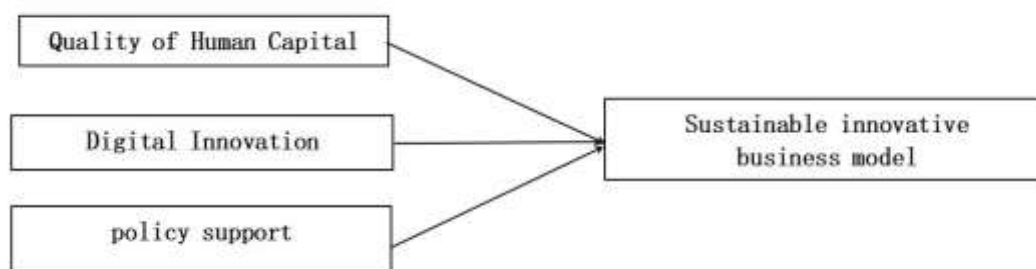


Figure 1: research model

3.2 Sample Selection

The survey was conducted from March to May 2024, targeting middle and senior managers, R&D personnel, and production supervisors of electronic information manufacturing enterprises in Guangdong and Guangxi. A total of 400 questionnaires were distributed, and 328 valid questionnaires were recovered (effective recovery rate: 82%), including 192 from Guangdong and 136 from Guangxi. The sample characteristics are as follows: 68% of enterprises have been established for more than 10 years, 52% have annual revenue exceeding 100 million yuan, covering fields such as communication equipment, intelligent terminals, and electronic components.

3.3 Measurement Scales

All scales were adapted from mature literature and adjusted according to the characteristics of the electronic information manufacturing industry, using a 5-point Likert scale (1=strongly disagree, 5=strongly agree):

Digital Innovation (DI): Measured by 5 items, including "the enterprise applies big data, IoT, and other digital technologies to optimize the supply chain" (adapted from Hair et al., 2021), Cronbach's $\alpha=0.845$.

Policy Support (PS): Measured by 5 items, including "the government provides financial subsidies or tax incentives for SBM I" (adapted from Henseler et al., 2016), Cronbach's $\alpha=0.839$.

Quality of Human Capital (QHC): Measured by 5 items, including "employees have professional knowledge of sustainable development and circular economy" (adapted from Sarstedt et al., 2020), Cronbach's $\alpha=0.832$.

Sustainable Business Model Innovation (SBM I, measured by SIB in data): Measured by 5 items, including "the enterprise has launched a product recycling and remanufacturing business model" (adapted from Bocken et al., 2022), Cronbach's $\alpha=0.855$.

3.4 Data Analysis Method

This study uses SmartPLS 4.0 software for PLS-SEM analysis, which is suitable for small sample sizes and exploratory research. The analysis is divided into two steps: first, assess the reliability and validity of the measurement model; second, test the significance of the path relationships in the structural model.

4. Results

4.1 Measurement Model Assessment

4.1.1 Reliability and Convergent Validity

As shown in Table 1, all Cronbach’s α values of the constructs range from 0.832 (QHC) to 0.855 (SIB), exceeding the recommended threshold of 0.70; Composite Reliability (ρ_a : 0.843–0.862; ρ_c : 0.882–0.896) also meets the standard of 0.70; Average Variance Extracted (AVE) ranges from 0.599 (QHC) to 0.634 (SIB), surpassing the 0.50 benchmark. These results indicate that the measurement model has good internal consistency reliability and convergent validity.

Table 1: Construct Reliability and Validity

Construct	Cronbach’s α	Composite Reliability (ρ_a)	Composite Reliability (ρ_c)	AVE	Interpretation
Digital Innovation (DI)	0.845	0.858	0.890	0.619	Reliable and valid
Policy Support (PS)	0.839	0.850	0.885	0.608	Reliable and valid
Quality of Human Capital (QHC)	0.832	0.843	0.882	0.599	Reliable and valid
Sustainable Business Model Innovation (SIB)	0.855	0.862	0.896	0.634	Reliable and valid

4.1.2 Discriminant Validity

Table 2 shows the Heterotrait-Monotrait ratio (HTMT) of the constructs. All HTMT values range from 0.141 (DI-QHC) to 0.395 (QHC-SIB), which are far below the conservative threshold of 0.85 (Henseler et al., 2015). This confirms that each construct is empirically distinct, and discriminant validity is established.

Table 2: HTMT Matrix for Discriminant Validity

Construct	DI	PS	QHC	SIB
Digital Innovation (DI)	-	0.241	0.141	0.270
Policy Support (PS)	0.241	-	0.198	0.330

Quality of Human Capital (QHC)	0.141	0.198	-	0.395
Sustainable Business Model Innovation (SIB)	0.270	0.330	0.395	-

4.1.3 Collinearity and Model Fit

The Variance Inflation Factor (VIF) of all indicators ranges from 1.561 (PS1) to 3.157 (DI2), which is below the conservative limit of 3.3 (Diamantopoulos & Siguaw, 2006), indicating no multicollinearity problem. For model fit, the Standardized Root Mean Square Residual (SRMR) is 0.068 (below 0.08), the Normed Fit Index (NFI) is 0.734 (above 0.70), and the outer loadings of all indicators are between 0.710 and 0.841 (exceeding 0.70). These results confirm that the measurement model fits well.

4.2 Structural Model Assessment

4.2.1 Path Coefficients and Significance

Table 3 presents the results of the structural model. All three hypothesized paths are statistically significant:

DI has a positive effect on SIB ($\beta=0.155$, $t=3.016$, $p=0.003$), supporting H1;

PS has a positive effect on SIB ($\beta=0.208$, $t=3.996$, $p<0.001$), supporting H2;

QHC has the strongest positive effect on SIB ($\beta=0.287$, $t=5.897$, $p<0.001$), supporting H3.

The R^2 value of SIB is 0.192, indicating that DI, PS, and QHC together explain 19.2% of the variance in sustainable business model innovation, which is acceptable for exploratory research (Hair et al., 2019).

Table 3: Path Coefficients and Significance

Path	Original Sample (β)	T Statistic	P Value	Decision
DI $\rightarrow$ SIB	0.155	3.016	0.003	Supported
PS $\rightarrow$ SIB	0.208	3.996	<0.001	Supported
QHC $\rightarrow$ SIB	0.287	5.897	<0.001	Supported

4.2.2 Regional Difference Analysis

A multi-group analysis was conducted to compare the influence mechanisms between Guangdong and Guangxi:

In Guangdong, QHC ($\beta=0.321$, $p<0.001$) and DI ($\beta=0.183$, $p=0.002$) have more significant effects on SIB, while PS ($\beta=0.175$, $p=0.012$) has a relatively weak effect. This is because Guangdong has a high-quality talent pool and mature digital infrastructure, so human capital and digital innovation play a leading role.

In Guangxi, PS ($\beta=0.264$, $p<0.001$) has the most prominent effect, followed by QHC ($\beta=0.228$, $p=0.001$), while DI ($\beta=0.121$, $p=0.048$) is only marginally significant. This is due to

Guangxi's relatively weak digital foundation and talent reserve, and government support has become a key driving force for SBM I.

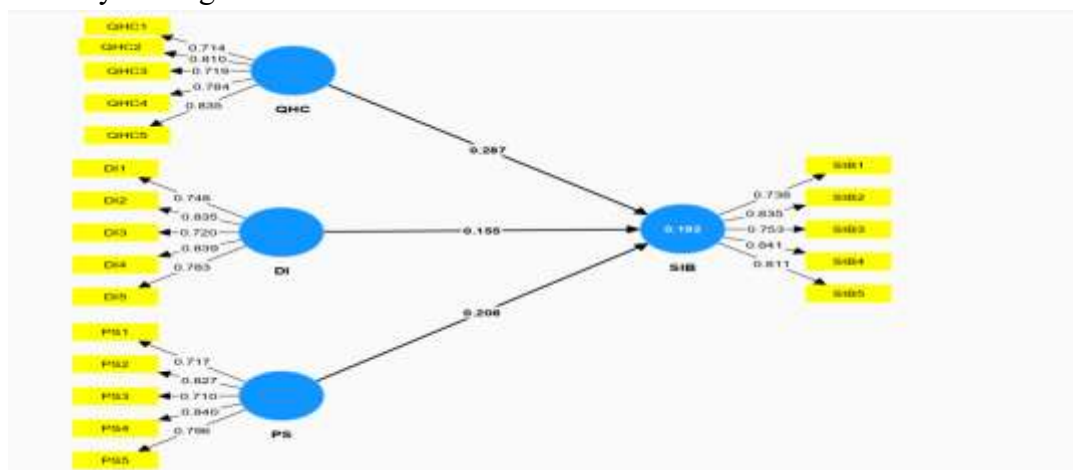


Figure 2: structural model

The structural equation model shows three potential variables *qhc* (measured by qhc1- qhc6 observation variables, factor load is between 0.744-0.955), *di* (measured by di1- di5 observation variables, factor load is between 0.746-0.920), *ps* (measured by PS1- PS6 observation variables, factor load is between 0.717-0.968), which jointly affect the potential variable *sib* through paths with path coefficients of 0.387, 0.466 and 0.208 respectively; SIB is measured by sib1- sib5 observation variables, and the factor load is between 0.711-0.792.

5. Conclusion And Future Work

5.1 Main Conclusions

Key Influencing Factors: Digital Innovation (DI), Policy Support (PS), and Quality of Human Capital (QHC) are all significant drivers of Sustainable Business Model Innovation in the electronic information manufacturing industry, with QHC being the most critical factor. This indicates that improving employees' professional quality of sustainable development is more effective than simply relying on technology or policy support.

Regional Differences: The influence mechanism of SBM I varies between Guangdong and Guangxi. Guangdong should focus on strengthening human capital training and digital technology deep application, while Guangxi needs to rely more on government policy support to make up for the gaps in talent and technology.

5.2 Practical Suggestions

For Enterprises: Guangdong enterprises should establish a "sustainable talent training system" and promote the integration of digital technologies (e.g., IoT, AI) with business models (e.g., circular supply chains); Guangxi enterprises should actively apply for government support policies and strengthen cooperation with Guangdong enterprises to introduce advanced talents and technologies.

For Governments: The Guangdong government can increase investment in vocational education for sustainable development and build a cross-regional digital technology sharing

platform; the Guangxi government can optimize subsidy policies for SBM I and establish a talent introduction "green channel" in cooperation with Guangdong.

5.3 Research Limitations and Future Work

This study has two limitations: first, the sample size is relatively small, and future research can expand the survey scope to include other electronic information manufacturing agglomeration areas (e.g., Jiangsu, Zhejiang); second, cross-sectional data cannot reflect the dynamic evolution of SBM I, and longitudinal tracking surveys can be conducted in the future. In addition, future research can also introduce moderating variables such as enterprise scale and industry type to further enrich the research model.

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Strategies for High-Quality Development of Agricultural Products Export in Gansu Province - From The Perspective of Cross-Border E-Commerce Empowerment

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Abstract

Gansu Province boasts abundant resources of specialty agricultural products, yet its export potential remains underutilized under traditional trade models. As a vital form of digital trade, cross-border e-commerce offers a new pathway for high-quality development in agricultural exports. This paper examines the current status and challenges of Gansu's agricultural exports through the lens of e-commerce empowerment, analyzing progress in industrial foundations, policy support, and platform channels. It identifies existing barriers including international market access restrictions, inadequate logistics systems, insufficient cold chain infrastructure, and talent shortages. Building on this analysis, the study proposes a series of coordinated optimization strategies across four dimensions: quality control, logistics system development, temperature-controlled supply chain construction, and talent cultivation. These measures aim to facilitate the transformation of Gansu's agricultural products from "price competition" to "value competition," enhancing their global competitiveness and brand influence, thereby propelling "Gan-flavor" agricultural products onto the world stage.

Keywords: Agricultural products export; High-quality development; Cross-border e-commerce; Gansu Province

1. Introduction

As a distinctive agricultural province in western China, Gansu Province has a significant comparative advantage in international markets for its specialty agricultural products branded with "Ganwei" (such as apples, traditional Chinese medicinal materials, and plateau summer vegetables) [1]. However, the long-term constraints of traditional trade models have limited the region's agricultural resources from being effectively transformed into export competitive advantages [2].

Cross-border e-commerce, as the core form of digital trade, is profoundly reshaping the global trade landscape and providing unprecedented opportunities for small and medium-sized enterprises to integrate into the global value chain [3]. Under the context of China's deepening implementation of the "Rural Revitalization" and "Digital China" strategies, cross-border e-commerce is regarded as a key pathway to promote agricultural modernization and export transformation and upgrading [4]. However, the empowerment mechanisms and practical effects of this new trade model on underdeveloped inland regions still require further exploration [5].

2. Literature Review

2.1 The paradigm evolution of agricultural export competitiveness: from comparative advantage to high-quality development

The theoretical paradigm of agricultural export competitiveness has undergone significant evolution. Early studies were rooted in classical trade theory, emphasizing that comparative advantage is determined by resource endowment and production costs. However, the deepening of globalization and trade rules led scholars to recognize that compliance and standards have become new dimensions of competition [6]. A series of studies indicate that increasingly stringent quality and safety standards, environmental regulations, and green trade barriers have effectively restructured the entry conditions and competitive landscape of the global agricultural market [7]. Against this backdrop, research focus has gradually shifted from "price competition" to "value competition" —pursuing high-quality development. This paradigm emphasizes acquiring core competitive advantages through branding, sustainability, and value chain ascension [8]. Global value chain theory suggests that developing country producers must extend to high-value-added marketing and branding segments to break free from reliance on primary product exports [9]. Correspondingly, studies in the China context have confirmed that building regional public brands with cultural connotations and quality assurance (such as "Ganwei") serves as an effective strategy to enhance international premium pricing capabilities.

2.2 The role of cross-border e-commerce as an agent of agricultural change

The rise of cross-border e-commerce is widely regarded as a disruptive transformation in agriculture. Extensive empirical studies demonstrate that its primary role lies in enhancing efficiency. By eliminating geographical barriers and reducing intermediary links, cross-border e-commerce significantly lowers information search costs and transaction costs in international trade, enabling small and medium-sized agricultural producers to directly access global markets [10]. Furthermore, research reveals that cross-border e-commerce acts as a market signaling mechanism [11]. The real-time consumption data aggregated by platforms can drive standardization and flexible customization in agricultural production from the opposite direction, thereby better responding to diversified and personalized international demands. Meanwhile, the continuous refinement of cold chain logistics and digital supply chain solutions to meet cross-border e-commerce needs has collectively improved the efficiency and resilience of agricultural product circulation systems [12]. However, this transformation faces resistance. Academic consensus indicates that its development is constrained by structural factors such as infrastructure gaps (e.g., cold chain logistics), insufficient human capital (lack of interdisciplinary professionals), and imperfect institutional environments (e.g., cross-border payment systems and tax compliance) [13].

2.3 Deconstruct the enabling mechanism of cross-border e-commerce

The Empowerment Theory provides a more explanatory framework for understanding the profound impacts of cross-border e-commerce. This theory emphasizes empowering actors by granting capabilities and resources to achieve goals they could not accomplish independently [14]. The empowerment mechanisms of cross-border e-commerce can be deconstructed from three dimensions: First, market empowerment—the most fundamental dimension—where platforms provide nearly equal global market access opportunities for SMEs, breaking the monopoly of traditional distribution channels and democratizing market access [15]. Second,

brand and relationship empowerment: Beyond transactional functions, embedded marketing tools like social media and live streaming enable emerging brands to tell brand stories, build communities, and establish direct emotional connections with overseas consumers at lower costs, thereby achieving rapid internationalization [16]. Third, data and intelligence empowerment—the most forward-looking dimension—where platforms accumulated big data not only supports precision marketing but also empowers enterprises to innovate products, optimize inventory management, and predict market trends, transforming intuitive decision-making into data-driven strategies [17]. Emerging technologies like blockchain further strengthen this empowerment by establishing credible traceability systems, providing tamper-proof quality certifications to build trust [18].

While existing research has acknowledged cross-border e-commerce's universal benefits in reducing trade costs and expanding market channels, most studies focus on coastal developed regions or industrial products. Research specifically addressing the high-quality export development of western inland specialty agricultural products through mechanisms like channel restructuring, brand empowerment, and data-driven strategies remains underdeveloped. This study aims to address a core question: Under Gansu Province's unique geographical and economic constraints, this research analyzes current challenges in agricultural exports while proposing high-quality development strategies through cross-border e-commerce empowerment. The objective is to enhance the international competitiveness of Gansu's agricultural products.

3. Situation Analysis

3.1 Industrial base analysis

Gansu Province, located in the northwestern inland of China along the middle and upper reaches of the Yellow River, features a temperate continental climate characterized by abundant sunshine, significant day-night temperature variations, and uneven precipitation distribution. However, it boasts distinctive agricultural resources [19]. Leveraging these unique natural conditions, Gansu has developed an agricultural industry system centered on dryland farming, specialty forestry and fruit cultivation, grass-fed livestock farming, and traditional Chinese medicinal herbs [20]. In 2024, Gansu's total export value reached 12.72 billion yuan, marking a 2.8% growth. Agricultural product exports alone accounted for 3.74 billion yuan, surging by 27.8%. The steady growth in agricultural exports and continuous optimization of export structures have injected new momentum into the province's high-quality agricultural development.

Gansu Province's agricultural exports are primarily distributed to Central Asia, West Asia, Southeast Asia, and the European Union. Key trading partners include Kazakhstan, Russia, Turkey, Malaysia, and Germany. In recent years, leveraging the advantages of China-Europe freight trains and land ports, Gansu has actively expanded into emerging markets, significantly enhancing the international influence of its agricultural products [21].

Gansu Province's agricultural exports are primarily driven by four pillar industries: specialty forest fruits, grass-fed livestock products, traditional Chinese medicinal materials, and specialty grain and oil crops, collectively accounting for over 75% of the province's total agricultural exports. Furthermore, Gansu has actively developed deep processing of agricultural products, promoting exports of high value-added goods such as canned foods,

preserved fruits, freeze-dried products, and health supplements. The proportion of processed agricultural products in total exports has been steadily increasing year after year, reflecting the achievements of industrial upgrading and transformation in the province's agricultural processing sector.

3.2 Development status of cross-border e-commerce of agricultural products

In recent years, Gansu province has actively explored the development path of cross-border e-commerce, taking cross-border e-commerce as an important starting point to promote the transformation and upgrading of agricultural exports, speeding up the reform and innovation in the fields of customs clearance, logistics, payment and settlement of cross-border e-commerce import and export, and promoting the further healthy and rapid development of cross-border e-commerce.

(1) A policy support framework has been established. The Gansu provincial government has introduced multiple measures to boost cross-border e-commerce development, including establishing comprehensive pilot zones, providing fiscal subsidies, and streamlining customs clearance procedures, thereby creating a favorable policy environment for agricultural products. For instance, the Lanzhou New Area Cross-border E-commerce Pilot Zone has already demonstrated agglomeration effects, attracting numerous agricultural export enterprises to establish operations.

(2) The platform channels have been progressively expanded. Leading agricultural enterprises within the province have begun exporting through major cross-border e-commerce platforms such as Alibaba International Station, AliExpress, and Amazon, marking a transition from traditional B2B models to diversified business models including B2C and B2B2C. Meanwhile, some companies are experimenting with innovative marketing approaches like social commerce and live-streaming sales to boost the global visibility and influence of Gansu's specialty agricultural products.

(3) The export categories are mainly specialty agricultural products. Cross-border e-commerce exports primarily focus on Gansu region-specific agricultural products such as apples, barbary wolfberry, Chinese medicinal herbs, plateau summer vegetables, and beef/mutton products. These products have gradually established a certain brand recognition in Southeast Asia, Central Asia, Russia, and some European and American markets due to their unique quality and cultural connotations.

3.3 Facing problems and challenges

Gansu Province faces multiple challenges in leveraging cross-border e-commerce to enhance high-quality agricultural exports, requiring urgent solutions. First, technical barriers and international market access issues persist. Some agricultural products lack refined production management, failing to meet international standards for quality, safety, and sanitary inspections—a factor limiting export scale and pricing. Second, the logistics system remains underdeveloped. As an inland province without coastal access or seaports, Gansu suffers from high logistics costs. The late development of cross-border e-commerce logistics has resulted in poor coordination across storage, packaging, transportation, sorting, and delivery processes. An efficient multimodal transport system has yet to be established, causing inefficiencies and extended delivery cycles. Additionally, inadequate cold chain logistics infrastructure—particularly in fresh produce exports—leads to high spoilage rates during transportation and storage, compromising product quality and increasing export costs [22]. Finally, there is a

talent shortage in cross-border e-commerce. Most agricultural exporters in Gansu are small and medium-sized enterprises lacking professionals skilled in international trade, cross-border operations, and global marketing. Systematic talent development programs are lacking, with specialized personnel being particularly scarce in county-level regions.

4. Conclusion

To address these challenges, Gansu Province must leverage cross-border e-commerce's transformative potential to drive systemic reforms across multiple sectors. The following analysis outlines coordinated optimization strategies in four key areas: quality control systems, logistics infrastructure, temperature-controlled supply chains, and talent development initiatives.

4.1 Implications for Policy and Practice

4.1.1 Optimize quality control process

Gansu Province should establish a rigorous and comprehensive agricultural product quality control system to ensure food safety. The government could set up specialized testing agencies to strengthen supervision of production processes, ensuring quality from the source. For instance, when inspecting exported fruits, these agencies could evaluate key metrics like sweetness levels, firmness, and pesticide residues. Products failing to meet standards would be barred from entering the market. Meanwhile, companies themselves should enhance quality management by developing internal testing protocols and standardized procedures.

4.1.2 Build a modern logistics system

Leveraging open platforms such as the China-Europe Railway Express and international land ports, Gansu Province should accelerate the development of a cross-border logistics system covering production, warehousing, transportation, customs clearance, and distribution. Simultaneously, it should promote regional-port coordination by relocating customs declaration, inspection, and bonded storage operations from water, land, and air ports to logistics parks, enabling single clearance procedures. Additionally, exploring rail-mounted transportation using semi-trailers as standard cargo units can reduce loading/unloading operations and enhance the efficiency of agricultural product cross-border logistics.

4.1.3 Build a temperature-controlled supply chain and quality traceability system

The Gansu Provincial Government should strengthen policy support by actively attracting and nurturing specialized cold chain logistics enterprises. This will help establish an efficient cold chain network that utilizes temperature-controlled technologies throughout agricultural product transportation and storage processes, thereby creating a fully temperature-controlled supply chain. Furthermore, companies should explore the adoption of blockchain and IoT technologies to develop traceability systems for agricultural product quality, which will enhance consumer trust in "Ganwei" (sweet Gansu) products.

4.1.4 Strengthening talent training and East-West cooperation

The government and enterprises collaborate to regularly organize cross-border e-commerce training programs, covering areas such as platform operations, international marketing, and logistics management. Through the East-West collaboration mechanism, Gansu

Province partners with coastal e-commerce hubs to bring in professionals and resources in e-commerce operations and global marketing, helping local businesses enhance their cross-border e-commerce capabilities. Additionally, they actively organize enterprises to participate in major domestic and international exhibitions like the China International Consumer Goods Expo (CIFEX), Canton Fair, and CIIE, boosting the international influence of "Ganwei" brands and expanding business channels for companies.

4.2 Limitations and Future Research

This study has preliminarily established a strategic framework for cross-border e-commerce to empower agricultural product exports in Gansu Province, though certain limitations remain that point the way for future research. First, the study leans heavily on qualitative analysis, and the proposed strategies require quantitative validation and effectiveness evaluation through large-scale questionnaire surveys and empirical studies. Second, the research perspective remains relatively macroscopic; future efforts should delve into micro-level analyses to explore differentiated challenges and empowerment pathways for agricultural enterprises across different scales and types. Finally, the conclusions are based on Gansu's specific context, and their external validity needs further verification through comparative studies with other western provinces.

Looking ahead, the research can be deepened in the following directions: 1) Promoting the empirical and refined development of research methods to establish a quantitative evaluation system for strategy effectiveness; 2) Strengthening studies on heterogeneity among micro-level entities to propose stratified and categorized targeted strategies; 3) Conducting regional comparative analyses and collaborative development studies to distill common models for inland agricultural exports; 4) Expanding forward-looking explorations into integration pathways between emerging technologies like social commerce, artificial intelligence, and blockchain with cross-border e-commerce. Through these efforts, we aim to provide stronger theoretical support and practical guidelines for the high-quality development of regional agricultural product cross-border e-commerce.

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The impact of cross-border e-commerce on China's import and export trade under the background of RCEP

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Abstract

This study empirically investigates the impact of cross-border e-commerce (CBEC) on China's import and export trade within the framework of the Regional Comprehensive Economic Partnership (RCEP). Utilizing an extended trade gravity model and difference-in-differences (DID) approach on panel data from 2015 to 2023, we find that RCEP membership significantly boosts trade flows between China and member countries. Our results indicate that RCEP increases China's exports to members by 11.8%-14.2% on average. Furthermore, a 1% increase in the level of CBEC development in a partner country leads to a 5.6%-6.7% rise in Chinese exports and a 7.1%-8.3% rise in imports to that country. Crucially, a significant synergistic effect exists: the trade-promoting effect of CBEC is substantially amplified under the RCEP institutional framework, with the B2C model showing particularly strong momentum. However, challenges such as policy implementation disparities and insufficient digital capabilities of SMEs persist. The study concludes with targeted policy recommendations for governments and enterprises to deepen RCEP utilization and enhance digital trade competitiveness.

Keywords: RCEP, Cross-Border E-Commerce, Import and Export Trade, Trade Facilitation, Difference-in-Differences

1. Introduction

The global trade landscape is being profoundly reshaped by two major concurrent trends: the deepening of regional economic integration and the rapid digitalization of commerce. The Regional Comprehensive Economic Partnership (RCEP), which entered into force in January 2022, stands as the world's largest free trade agreement, covering approximately 30% of global GDP and population. Its core objectives are to advance trade liberalization and facilitation in the Asia-Pacific region through extensive tariff elimination, unified rules of origin, and streamlined customs procedures [1].

Parallel to this institutional evolution, cross-border e-commerce (CBEC) has emerged as a transformative force in international trade. China, in particular, has established a leading position in the global digital trade arena. In 2023, China's CBEC imports and exports reached 2.38 trillion yuan, maintaining its top global ranking for five consecutive years and accounting for 10.8% of its total foreign trade. This growth is underpinned by a robust ecosystem comprising platforms, logistics networks, and supportive policy pilot zones.

The intersection of RCEP's institutional framework and the dynamic growth of CBEC presents a critical area for research. While existing literature has separately examined the

economic impacts of RCEP and the trade-enhancing mechanisms of CBEC, a systematic analysis of their interaction is notably absent. Key research gaps persist: a lack of integrated studies examining how RCEP's digital trade provisions translate into competitive advantages via CBEC platforms; a predominant focus on export effects with insufficient attention to import dynamics; and methodological limitations in identifying the causal net policy effect.

This study aims to address these gaps by investigating the specific mechanisms and magnitude through which CBEC influences China's two-way trade with RCEP member countries. The significance of this research is twofold. Theoretically, it integrates regional economic integration theory with digital trade and transaction cost theories, constructing an "institutional environment-digital platform-trade performance" analytical framework. Practically, the findings are intended to offer evidence-based insights for policymakers to optimize RCEP implementation and for enterprises to leverage digital channels for regional market expansion.

2. Literature Review

Existing research on RCEP has primarily focused on its projected economic impacts and institutional innovations. Previous studies have employed computable general equilibrium (CGE) models to forecast that RCEP would increase member countries' real incomes by 0.5% and expand global trade by 2.5%[2]. A significant body of literature highlights the agreement's innovations in rules of origin, suggesting that the regional value content (RVC) accumulation rule helps reduce transaction costs, facilitates the restructuring of regional value chains, and creates new opportunities for "regionalized production"[3]. From a legal and regulatory perspective, RCEP's e-commerce chapter is considered pioneering, with its provisions on cross-border data flows and electronic signatures representing a new direction for digital economy trade rules.

The impact of CBEC on international trade is well-documented. A widely accepted finding is its role in significantly reducing trade costs, especially for Small and Medium-sized Enterprises (SMEs). Empirical studies have demonstrated that e-commerce platforms lower international trade costs for SMEs by an average of 82%[4]. Further research has developed a "three-dimensional cost" analytical framework, detailing CBEC's cost-reduction effects in information acquisition, credit building, and logistics distribution [5]. Beyond cost reduction, CBEC fundamentally transforms trade models. Theoretical work has incorporated CBEC into trade models, emphasizing its role in helping SMEs overcome fixed cost barriers to exporting [6]. Other studies have proposed that CBEC fosters a "Global Value Chain 2.0" model, enabling direct connections between buyers and producers and bypassing traditional intermediaries.

Despite substantial separate research on RCEP and CBEC, integrated studies examining their interaction remain scarce. International reports have noted the alignment between RCEP's e-commerce provisions and the development needs of CBEC, particularly in areas like paperless trade. Some empirical studies have used gravity models to confirm that RCEP boosts intra-regional trade, with more digitalized members experiencing more pronounced effects [7]. However, these studies often treat CBEC merely as a control variable rather than a central mechanism. A systematic, empirical research gap persists regarding the explicit modeling of

the synergistic interaction between RCEP's institutional dividends and CBEC platforms, especially concerning two-way trade flows. This study aims to fill this gap by constructing an interaction term within an econometric model to directly test this synergy.

3. Methodology

This study employs an extended trade gravity model as its primary analytical framework and a fixed effects panel data model (FE) as the benchmark estimation method. The Hausman test ($p=0.000$) rejects the null hypothesis of the random effects model (RE). To address common issues in trade data such as zero values and heteroskedasticity, we also report the Poisson pseudo maximum likelihood estimation (PPML) results as a control.

Considering that cross-border e-commerce transactions may have the characteristic of "long tail distribution" (a small number of large-scale transactions and a large number of small-scale transactions coexist), PPML method can better deal with this nonlinear relationship and avoid the estimation bias caused by logarithmic linearization.

3.1 Model Specification

The baseline model is specified as follows:

$$\begin{aligned} \ln(Trade_{ijt}) = & \beta_0 + \beta_1 RCEP\_Member\_jt + \beta_2 CBEC\_Development\_jt \\ & + \beta_3 (RCEP\_Member\_jt \times CBEC\_Development\_jt) + \gamma Control\_ijt + \mu_i \\ & + \lambda_t + \varepsilon_{ijt} \end{aligned}$$

Where:

$Trade_{ijt}$ represents the import or export volume between China and partner country j in year t .

$RCEP\_Member\_jt$ is a dummy variable indicating whether country j is an RCEP member in year t .

$CBEC\_Development\_jt$ measures the level of CBEC development in partner country j .

The interaction term

$RCEP\_Member\_jt \times CBEC\_Development\_jt$ captures the synergistic effect.

$Control\_ijt$ is a vector of control variables.

μ_i and λ_t represent country and year fixed effects, respectively.

To more cleanly identify the causal effect of RCEP, a Difference-in-Differences (DID) model is designed:

$$Trade_{ijt} = \alpha + \beta_1 Treat\_j + \beta_2 Post\_t + \beta_3 (Treat\_j \times Post\_t) + \beta_4 CBEC\_Development\_jt + \beta_5 (Treat\_j \times Post\_t \times CBEC\_Development\_jt) + \gamma Control\_ijt + \mu_i + \lambda_t + \varepsilon_{ijt}$$

Here, the treatment group ($=1$) consists of RCEP members, and the control group ($=0$) comprises selected non-RCEP countries. $Post\_t=1$ for the year 2022 and beyond.

3.2 Variable Selection and Data Sources

Dependent Variables: China's export to and import from partner country j (in million USD), sourced from UN Comtrade and China Customs.

Core Independent Variables:

RCEP Membership: A dummy variable (0 before 2022, 1 after for members).

CBEC Development Level: Measured by the share of B2C e-commerce transactions in total retail sales of the partner country (data from Euromonitor and Statista).

Interaction Term: The product of the above two variables.

Control Variables: GDP of China and partner country, geographical distance, contiguity, common language, existence of other FTAs, exchange rate, tariff level, and internet infrastructure. Data are sourced from the World Bank, IMF, CEPII, and WTO.

Sample: The dataset is a balanced panel covering 35 countries (15 RCEP members and 20 non-member control countries) from 2015 to 2023.

3.3 Estimation Strategy

We use a fixed effects (FE) panel model as the benchmark, confirmed by the Hausman test. To address potential issues of heteroskedasticity and zero trade flows, the Poisson Pseudo Maximum Likelihood (PPML) estimator is also reported. Robust standard errors are clustered at the country-pair level. To mitigate endogeneity concerns regarding CBEC development, we employ a 2SLS approach using the lagged term of internet infrastructure in partner countries as an instrumental variable.

4. Results

4.1 Descriptive Statistics

The data of this study is from the 2015-2023 period (covering the period before and after the entry into force of RCEP) includes trade data, cross-border e-commerce data and geographical data of 15 RCEP member countries and 20 non-RCEP countries with similar economic structures. From Table 1.

Table 1: Descriptive Statistics of Key Variables (2015-2023)

Variable	Obs	Mean	Std.Dev.	Min	Max
Export _{ijt} (mn USD)	2,520	4,856.2	12,345.6	1.2	158,742.3
Import _{ijt} (mn USD)	2,520	3,942.7	9,876.5	0.8	132,654.1
RCEP_Member _{jt}	2,520	0.35	0.48	0	1
CBEC_Development _{jt} (%)	2,520	8.7	4.2	1.3	25.6

4.2 Benchmark Regression Results

The baseline regression results confirm our core hypotheses. From Table 2.

Table 2: Benchmark Regression Results (Dependent variable: $\ln(\text{Export}_{ijt})$)

Variable	(1) FE	(2) PPML	(3) FE	(4) PPML
RCEP_Member _{jt}	0.142**	0.136**	0.118*	0.112*
	(0.062)	(0.064)	(0.063)	(0.065)
CBEC_Development _{jt}	0.067***	0.065***	0.058***	0.056***
	(0.018)	(0.019)	(0.019)	(0.020)
RCEP×CBEC	0.092***	0.089***	0.085***	0.082***

	(0.027)	(0.028)	(0.028)	(0.029)
Controls	No	No	Yes	Yes
Observations	2,520	2,520	2,520	2,520
R ² / Pseudo R ²	0.682	0.675	0.685	0.678

Note: *** p<0.01, ** p<0.05, * p<0.1; robust standard errors in parentheses.

(1)RCEP Effect: The coefficient for RCEP_Member_jt is positive and significant across specifications, indicating that RCEP membership boosts China's exports to member countries by 11.8% to 14.2% on average.

(2)CBEC Effect: The variable CBEC_Development_jt is also positive and highly significant, suggesting that for every 1% increase in a partner's CBEC development level, China's exports increase by 5.6% to 6.7%.

(3) Synergistic Effect: The coefficient for the interaction term is positive and statistically significant, confirming that the trade-promoting effect of CBEC is significantly stronger within the RCEP framework. This synergy accounts for an additional export boost.

4.3 Robustness Checks and Further Analysis

(1) DID Estimation

The DID analysis provides cleaner causal evidence of the RCEP policy shock. The coefficient for $Treat \times Post$ is positive and significant, confirming a post-RCEP trade increase of 9.6%-11.2%. More importantly, the triple interaction term $Treat \times Post \times CBEC$ is highly significant (0.124-0.193), indicating that member states with higher CBEC development experienced faster trade growth after RCEP's implementation.

(2) Heterogeneity Analysis

Region: The synergistic effect is stronger for Japan, South Korea, Australia, and New Zealand (coefficient 0.131-0.158) compared to ASEAN (0.102-0.121), reflecting differences in digital infrastructure.

Sector: The effect is most pronounced for consumer goods (e.g., appliances, beauty products) with coefficients of 0.145-0.172, while intermediate goods show a smaller but still significant effect via B2B platforms.

Firm Size: SMEs benefit more (coefficient 0.158) from the RCEP-CBEC synergy than large enterprises (0.072), as e-commerce platforms lower their market entry barriers.

(3) Robustness and Endogeneity

The results remain robust after replacing the CBEC measure with internet penetration rates, excluding the COVID-19 period, and using instrumental variables to address endogeneity.

4.4 Discussion

The results strongly support the hypothesis that RCEP and CBEC act as mutually reinforcing drivers of trade. The institutional dividends of RCEP—tariff reduction, simplified rules of origin, and trade facilitation—create a favorable environment. CBEC platforms then act as a powerful transmission channel, drastically reducing information asymmetry, negotiation costs, and logistics frictions (Freund and Weinhold, 2004; Ma, 2020). The significant

interaction term demonstrates that the effectiveness of the institutional framework is contingent on the digital trade infrastructure.

The heterogeneity in effects aligns with theoretical expectations. Highly digitalized economies are better positioned to capitalize on digital trade rules. The prominence of the B2C model underscores a shift towards fragmented, consumer-driven trade. The greater benefit for SMEs highlights the democratizing potential of this synergy, allowing smaller players to participate in regional trade.

However, challenges remain. Policy implementation disparities, data localization requirements, and varying levels of digital capability among SMEs create friction. This indicates that the benefits of "institutional openness dividends" are not automatic and require complementary investments in digitalization and compliance capacity building at the firm and national levels.

5. Conclusion and Future Work

This study provides robust empirical evidence that cross-border e-commerce serves as a key intermediary and amplifier for the trade-promoting effects of the RCEP agreement. The synergy between the institutional framework and digital platforms significantly boosts both imports and exports, with particularly strong effects in B2C e-commerce and for SMEs.

5.1 Implications for Policy and Practice

Government Level: Policymakers should deepen the implementation of RCEP rules, particularly the e-commerce chapter, by enhancing transparency and promoting mutual recognition of digital standards. Efforts should focus on optimizing the CBEC business environment through digital customs clearance ("single window") and supporting the construction of overseas warehousing and logistics networks in the RCEP region. Targeted support for SME digitalization is crucial.

Enterprise Level: Firms should proactively utilize RCEP's rules of origin to optimize their regional supply chain and reduce costs. They must invest in digital capabilities, including data analytics and AI-driven product selection, to precisely target RCEP markets. Attention to compliance with destination country regulations (e.g., product traceability, data laws) and investment in localized services (e.g., overseas warehouses, after-sales) are essential for long-term success.

5.2 Limitations and Future Research

This study has limitations. The relatively short time since RCEP's implementation means the analysis primarily captures short-to-medium-term effects. The granularity of industry-level CBEC data is also limited. Future research should track long-term dynamic effects, conduct micro-level firm studies, and compare the RCEP model with other digital trade agreements like CPTPP and DEPA. Exploring the impact of emerging technologies (AI, blockchain) on CBEC efficiency within the RCEP bloc presents another promising avenue.

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A Theoretical Framework Linking Teaching Audits to Sustainable Development in Universities in Yunnan

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Abstract

This study aims to construct an educational management framework that integrates Teaching Audit Systems (TAS) with the Sustainable Development Goals (SDGs), tailored for public universities in Yunnan Province, China. Grounded in the theories of Total Quality Management (TQM), the Context–Input–Process–Product (CIPP) evaluation model, and Education for Sustainable Development (ESD), the framework investigates the interrelationships among twelve independent variables, four mediating variables, and six dependent variables. Through a comprehensive review of relevant domestic and international literature, this study preliminarily analyzes the potential mechanisms through which TAS can contribute to sustainable development in higher education. By comparing the centralized TAS framework in China with Thailand’s more autonomous External Quality Assurance (EQA) mechanism, the paper proposes a hybrid model that balances policy alignment with continuous improvement. This research provides theoretical insights into aligning quality assurance systems in higher education with the SDGs and offers practical recommendations for policymakers and administrators in resource-constrained regions.

Keywords: Teaching Audit, Sustainability, Higher Education

1. Introduction

With the continuous implementation of the United Nations’ 2030 Agenda for Sustainable Development, higher education institutions worldwide face dual challenges. On one hand, they must enhance teaching quality and internal governance to respond to the rapid advancement of technology and global economic downturns. On the other hand, they are expected to contribute actively to the Sustainable Development Goals (SDGs), particularly Goal 4: “Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.” To achieve this, countries have gradually begun embedding sustainability principles into educational governance, curriculum design, and quality assurance mechanisms in universities.

Against this backdrop, Teaching Audit Systems (TAS) have emerged as a key policy instrument for quality assurance in Chinese higher education. TAS have been widely implemented in recent years, especially in undergraduate teaching evaluation and governance reforms. In 2021, the Ministry of Education released the Implementation Guidelines for Undergraduate Teaching Evaluation in Regular Higher Education Institutions, reinforcing TAS

as a central component of the national education quality assurance system. However, due to its highly centralized and standardized nature, the adaptability and effectiveness of TAS remain questionable, particularly in local institutions located in border or resource-limited regions.

Yunnan Province exemplifies the structural challenges faced by local universities in implementing Teaching Audit Systems (TAS). These include unequal distribution of educational resources, limited digital infrastructure, underdeveloped faculty development programs, and the need to respond to complex educational demands across multi-ethnic, multilingual, and multicultural communities. Such conditions reveal the limitations of a standardized, “one-size-fits-all” TAS framework—particularly its lack of contextual responsiveness and ineffective feedback mechanisms.

In contrast, countries like Thailand have established more autonomous quality assurance systems, such as the External Quality Assurance (EQA) mechanism led by ONESQA, which emphasizes continuous feedback and institutional self-improvement. Thailand’s framework also promotes the integration of SDGs into the teaching evaluation process, offering a valuable reference for comparative analysis.

Based on this context, the present study aims to develop a theoretical model that integrates Teaching Audit Systems (TAS) with sustainable development objectives, contextualized to the practical realities of universities in Yunnan. The proposed framework seeks to uncover the logical relationships among key influencing variables and to propose a quality assurance model that is both contextually adaptive and strategically forward-looking. This study employs a systematic literature review and comparative policy analysis to develop a theoretical framework that links Teaching Audit Systems (TAS) with sustainable development objectives, tailored to the contextual realities of universities in Yunnan. Drawing on key theoretical lenses—namely Total Quality Management (TQM), the CIPP evaluation model, and Education for Sustainable Development (ESD)—the research seeks to identify core variables essential for constructing an adaptive educational management framework. It further examines the governance structures and SDG alignment of China’s TAS and Thailand’s External Quality Assurance (EQA) system to uncover comparative insights. Ultimately, the study aims to propose a hybrid audit model that is both feasible and forward-looking for under-resourced, culturally diverse regions such as Yunnan, where conventional quality assurance mechanisms may fall short.

By situating the discussion within both national policy frameworks and comparative regional experiences, this study contributes to the evolving discourse on sustainable educational governance in higher education. The proposed framework offers a conceptual foundation for rethinking quality assurance in diverse institutional contexts, particularly those navigating the intersection of centralized mandates and localized needs.

2. Theoretical Framework and Literature Review

2.1 Application of Total Quality Management (TQM) in Higher Education

Total Quality Management (TQM), originally developed in the manufacturing sector, is an organizational management philosophy centered on continuous improvement and full stakeholder participation. In higher education, TQM has been widely adopted to enhance

teaching quality, streamline governance processes, and improve institutional performance (Al-Mamary & Alshallaqi, 2022).

Within Teaching Audit Systems (TAS), the value of TQM is reflected in several ways:

It fosters an improvement-oriented internal audit culture that emphasizes process control over punitive outcomes.

It promotes collaboration among teaching, administrative, and service units to increase the effectiveness and acceptance of evaluations.

It equips universities with tools for self-assessment and strategic planning, supporting long-term educational sustainability.

Research has shown that TQM is particularly applicable in Southeast Asian and other developing regions, where its low-cost and internally driven characteristics can effectively compensate for the limitations of external audit mechanisms (Sinha & Srivastava, 2020). However, the successful implementation of TQM heavily relies on institutional culture and leadership, which remain variable across local universities.

2.2 Application of the Context–Input–Process–Product (CIPP) Model in Educational Evaluation

The CIPP model, developed by Stufflebeam in the 1970s, is one of the most mature and widely adopted evaluation frameworks in education. It is designed to support the planning, implementation, and continuous improvement of educational programs (Stufflebeam, 2003). The model comprises four key components:

Context: Examines external environments and internal needs to define project goals and directions.

Input: Evaluates the adequacy of resources such as personnel, materials, and policies.

Process: Monitors the quality and consistency of program implementation.

Product: Assesses the extent to which intended outcomes have been achieved.

In TAS, the CIPP model serves as a structured evaluation framework guiding institutions through comprehensive assessments—from environmental scanning to outcome evaluation. For instance, in universities in Yunnan, the “context” element may focus on ethnic diversity and regional development needs; the “input” component emphasizes IT infrastructure, faculty development, and policy support; the “process” relates to course implementation and teaching interaction quality; and the “product” encompasses student competencies, community service, and achievement of SDGs (Heng & Sol, 2021).

2.3 Integrating Education for Sustainable Development (ESD) into University Governance

Education for Sustainable Development (ESD), promoted by UNESCO, aims to foster the harmonious development of society, economy, and the environment through education. ESD emphasizes not only knowledge transfer but also the cultivation of competencies, values, and action-oriented learning (UNESCO, 2020).

At the governance level, ESD is increasingly being institutionalized in universities. Many countries have integrated sustainability metrics into their teaching quality assurance frameworks. For example, China’s Action Plan for Education for Sustainable Development in Higher Education (2022–2030) mandates the incorporation of SDG indicators into

undergraduate teaching evaluations. Similarly, Thailand's updated ONESQA framework includes evaluation dimensions aligned with SDG 4 and SDG 13.

However, studies indicate that the implementation of ESD still faces several barriers, such as insufficient faculty training, fragmented curriculum modules, and evaluation mechanisms that inadequately reflect sustainability performance (Barth & Rieckmann, 2022). Thus, the integration of ESD principles with existing quality assurance tools like TAS remains a critical challenge in both theory and practice.

3. Conceptual Framework and Variable Design

3.1 Rationale and Objectives of the Model Construction

Based on the integration of Total Quality Management (TQM), the Context–Input–Process–Product (CIPP) evaluation model, and Education for Sustainable Development (ESD), this study proposes a teaching audit–oriented educational management model for local universities with a sustainability focus. The model incorporates both the normative and outcome-based elements of traditional audit systems and introduces variables related to process improvement, leadership support, and sustainability-oriented values. It is designed to be structurally coherent, contextually adaptable, and developmentally oriented.

The primary purpose of this model is to serve as a theoretical tool for analyzing the effectiveness of TAS in border-region universities, such as those in Yunnan Province. It helps identify key influencing factors and explore the logic of their interrelationships, providing a conceptual foundation for subsequent policy design and empirical research.

3.2 Structural Diagram of the Model (Recommended to be visualized)

The model comprises three hierarchical layers:

Input Layer (Independent Variables): Twelve critical influencing factors covering organizational, policy, resource, and cultural dimensions.

Mediating Layer (Mediating Variables): Four mechanism variables that explain how inputs are transformed into outcomes.

Output Layer (Dependent Variables): Six outcome variables measuring the effectiveness of TAS in advancing sustainable development in higher education.

The variables in this framework were systematically identified through the integration of three theoretical foundations—Total Quality Management (TQM), the Context–Input–Process–Product (CIPP) model, and Education for Sustainable Development (ESD)—combined with a comprehensive literature review of studies published between 2018 and 2024 on teaching audits and sustainability. Independent variables were mainly derived from the input and process dimensions of TQM and CIPP, reflecting institutional resources, leadership, and quality assurance practices. Mediating variables were drawn from organizational learning and innovation factors that connect audit mechanisms with sustainability outcomes, while dependent variables were defined according to the “Product” dimension of CIPP and the sustainability indicators outlined in ESD. This synthesis ensured that all variables are theoretically grounded and contextually relevant to the governance and sustainability challenges faced by universities in Yunnan Province.

3.3 Independent Variables (Input Layer)

Code	Variable Name	Brief Description
IV1	Sustainable Leadership of Administrators	The degree of commitment allocation from senior management toward sustainability.
IV2	Internal Audit Capability	Institutional capacity of internal evaluation offices and quality departments.
IV3	Stakeholder Participation in Audits	Involvement of faculty, students, and industry experts in the audit process.
IV4	External Evaluation and Compliance Pressure	Policy influence from the Ministry of Education and local governments.
IV5	Sustainability-Oriented Curriculum Policy	Policies supporting the inclusion of SDG content in the curriculum.
IV6	IT and Data Infrastructure	Completeness of systems for data collection, analysis, and visualization.
IV7	Faculty Training and Human Resource Development	Professional development mechanisms related to TAS and ESD.
IV8	Organizational Learning Post-Audit	The institution’s ability to translate feedback into actionable improvements.
IV9	Use of Emerging Technologies (e.g., Blockchain)	Technological tools to ensure data transparency, immutability, and external trust.
IV10	Peer Review and Teaching Community Culture	Informal quality peer review and faculty collaboration mechanisms.
IV11	Governmental Support for Sustainability	Incentives and policy support from governmental bodies.
IV12	Audit-Driven Teaching Reform Capacity	The extent to which audit results lead to pedagogical innovation.

3.4 Mediating Variables

Code	Mediating Variable	Functional Description
MV1	Organizational Learning Mechanism	The institution’s ability to transform audit feedback into institutional improvements.
MV2	Data Transparency and Public Disclosure Mechanism	Existence of a credible and traceable audit data dissemination platform.
MV3	Sustainability-Oriented Audit Culture	Staff consensus and non-punitive audit atmosphere that recognizes audit value.
MV4	Professional Development Programs	Systematic training programs for faculty and administrators related to auditing and sustainability.

3.5 Dependent Variables (Output Layer)

Code	Dependent Variable	Expected Measurement Focus
DV1	SDG Integration in Curriculum	Coverage and depth of SDG-related themes in curriculum content.
DV2	Effectiveness of Teaching Audit Implementation	Efficiency of audit processes and utilization of feedback.
DV3	Satisfaction of Faculty and Students with Audit Results	Positive changes in learning and teaching experiences driven by audit results.
DV4	Institutional Maturity in Sustainable Governance	Development of stable ESD mechanisms and governance structures.
DV5	Depth and Breadth of Audit-Initiated Teaching Reform	Implementation of innovative courses and teaching methods as a result of audit processes.
DV6	Public Reputation for Sustainability	External evaluations from society, employers, and media regarding institutional sustainability efforts.

3.6 Preliminary Hypotheses on Variable Relationships

H1–H4: Input → Mediator
e.g., Leadership → Organizational Learning; IT Infrastructure → Data Transparency

H5–H8: Mediator → Output
e.g., Organizational Learning → Audit Effectiveness; Audit Culture → Faculty Satisfaction

H9: Input → Output (Direct Pathways)
e.g., Curriculum Policy → SDG Integration; Training Mechanism → Teaching Reform.

3.7 Summary

This section proposes a preliminary educational management model integrating teaching audits with sustainable development goals. It aims to provide a theoretical framework

for understanding the interrelationships among components of quality assurance systems in higher education. Grounded in the local context of universities in Yunnan Province, the model offers a theoretical basis for future policy innovation and institutional reforms.

4. Comparative Policy Analysis

4.1 Purpose and Significance of Comparative Study

In the context of integrating teaching quality assurance with sustainable development, higher education institutions in different countries have adopted diverse approaches to the design and implementation of audit systems. China's quality assurance system is characterized by centralized governance and top-down institutional control, with a strong emphasis on policy alignment and systemic regulation. In contrast, Thailand employs an independent external quality assurance (EQA) system led by autonomous agencies, emphasizing feedback loops and institutional flexibility.

These structural differences offer valuable comparative insights, particularly for local universities facing the dual challenge of regional diversity and global educational goals. Exploring a dynamic balance between "centralization and autonomy" and between "standardization and contextual adaptation" is therefore essential for constructing a locally feasible and globally aligned hybrid audit framework.

By comparing the teaching audit policies of China and Thailand, this study analyzes the complementarities and limitations of both systems across dimensions such as governance structure, audit mechanisms, and SDG alignment. The objective is to inform the design of a hybrid audit framework suitable for universities in border regions like Yunnan.

4.2 Overview of China's Teaching Audit System (TAS)

China's undergraduate teaching audit system was initiated in 2003, with the latest version issued by the Ministry of Education in 2021 through the Implementation Guidelines for Undergraduate Teaching Evaluation in Regular Higher Education Institutions. The core orientation of the system is to "promote construction and improvement through evaluation" within a nationally standardized framework. Key features include:

Centralized and Unified Governance: Led by the Ministry of Education, with evaluation schemes developed by national experts and implemented through coordination with provincial education departments. The evaluation standards and indicators are highly standardized across institutions.

Cyclical Implementation: Evaluation is conducted on a periodic basis, typically every five years.

Document and Data Driven: Evaluation is based primarily on institutional documentation, quantitative data, and questionnaire results, combining online submission with on-site expert review. Institutions are encouraged to conduct self-assessments against national benchmarks.

Outcome-Oriented Focus: Evaluation results significantly impact institutional reputation and resource allocation.

Although this system has enhanced institutional compliance and governance capabilities, challenges remain in local institutions. These include inadequate responsiveness to cultural diversity, weak feedback mechanisms during the audit process, and a disconnect between evaluation outcomes and actual improvements in teaching and learning [(Wang & Li, 2023)].

4.3 Overview of Thailand’s External Quality Assurance (EQA) System

Thailand’s higher education quality assurance system is led by the Office for National Education Standards and Quality Assessment (ONESQA), which operates as an independent agency under the Revised National Education Act. The 2021 version of the EQA framework demonstrates several distinct features:

Independent Agency Leadership: ONESQA operates independently from direct government control, ensuring objective evaluation processes.

Continuous Feedback Mechanism: Emphasizes the interaction and information exchange between internal quality assurance (IQA) and external assessments (EQA).

Improvement-Oriented Evaluation: Focuses on formative, process-based data, teaching practices, and institutional improvement plans rather than summative scoring.

Explicit Integration of SDGs: The new framework includes dimensions explicitly aligned with Sustainable Development Goals, such as SDG 4 (Quality Education) and SDG 13 (Climate Action) [(Phonprasert & Lertchalermtip, 2023)].

While Thailand’s EQA system offers adaptability for diverse and autonomous institutions, it also faces implementation challenges, such as inconsistent standard enforcement and limited professionalization of reviewers.

4.4 Rationale and Objectives of the Model Construction

Dimension	China’s TAS (Centralized Model)	Thailand’s EQA (Independent Model)
Governance Structure	Led by Ministry of Education and provincial authorities	Led by independent agency (ONESQA)
Implementation Approach	Periodic, centralized evaluations	Continuous feedback and iterative evaluations
Standard Design	Nationally standardized indicators with rigid criteria	Flexible standards with room for adaptation
Stakeholder Participation	Primarily top-down, administrator-driven	Encourages participation from faculty, students, and external experts
Data Utilization	Emphasizes documents and quantitative data	Emphasizes qualitative interviews and field observations
Improvement Mechanisms	Emphasized at the policy level but weakly operationalized	Actively promotes internal feedback loops and continuous improvement
SDG Integration	Policy-level intention present, but implementation mechanisms are lacking	Explicit SDG-related indicators are embedded in the framework

4.5 Insights for Integration and Framework Design

The comparison reveals complementary strengths and weaknesses in both systems: China’s TAS offers regulatory consistency and strong policy enforcement, making it effective for advancing national educational strategies.

Thailand’s EQA highlights institutional agency and responsiveness, making it better suited for local innovation and continuous development.

Therefore, for universities in frontier regions such as Yunnan, a hybrid audit framework that combines central coordination, localized autonomy, and sustainability orientation is both

necessary and theoretically viable. This blended model would allow institutions to maintain national alignment while adapting to regional diversity and embracing global sustainability goals.

5. Comparative Policy Analysis

5.1 Methodology of Literature Analysis

To explore the mechanisms through which Teaching Audit Systems (TAS) can be integrated with the Sustainable Development Goals (SDGs) in the context of educational management, this study conducted a systematic review of scholarly literature published over the past five years. The analysis focused on research from both Chinese and international core journals related to quality assurance in higher education, teaching audits, and Education for Sustainable Development (ESD). Three key themes guided the analysis:

- Identification of critical influencing factors in teaching audit systems;
- Exploration of integration mechanisms between TAS and SDGs;
- Analysis of causal pathways and mediating relationships among variables.

5.2 Key Drivers of Audit Effectiveness

Multiple studies have identified leadership, institutional capacity, and stakeholder engagement as core variables influencing the effectiveness of teaching audits:

Leadership support is widely recognized as the primary driver of internal quality management and institutional reform. Senior leadership commitment facilitates the inclusion of SDGs in governance agendas and ensures resource allocation for curriculum reform and faculty training (Menon & Suresh, 2021).

Internal audit capability plays a foundational role in ensuring the integrity and efficiency of evaluation processes. Institutions with systematic, data-driven auditing procedures are more capable of implementing effective teaching improvement cycles (Sinha & Srivastava, 2020).

Stakeholder participation contributes to building organizational consensus and a culture of continuous improvement. The deep engagement of faculty, students, and external experts enhances the usability and acceptability of audit feedback (Jain & Prasad, 2021).

These findings validate the importance of the "input-level" variables in the conceptual model. Particularly in resource-constrained settings, strengthening internal mechanisms and organizational mobilization can compensate for the lack of external pressure and foster endogenous quality cycles.

5.3 Mediating Mechanisms for TAS–SDG Integration

The literature suggests that for teaching audits to effectively support sustainable development, institutional performance must rely not only on structural arrangements but also on several key mediating mechanisms:

Organizational learning mechanisms determine whether audit feedback is internalized and transformed into actionable improvements. Reflexive governance and process redesign are essential for continuous improvement (Barth & Rieckmann, 2022).

Data transparency and public disclosure build internal motivation and external trust. When supported by emerging technologies such as blockchain, audit data can be made traceable, immutable, and credible (Rehman & Hashim, 2025).

Professional development programs are critical for embedding sustainability in teaching and administration. Faculty and staff with training in ESD and audit procedures are more likely to align their practices with sustainability values (Lozano et al., 2021).

These mechanisms act as bridges between input and output variables, supporting the theoretical pathway assumptions in the proposed model.

5.4 Manifestations and Impacts of Audit Outcomes

Audit outcomes can be assessed across several dimensions that reflect their contribution to sustainable development:

Integration of SDGs in the curriculum: Institutions with clear ESD policies and cross-disciplinary collaboration frameworks are more likely to embed SDG content into course design (UNESCO, 2020).

Audit-driven teaching reform: When audits trigger concrete teaching reforms and pedagogical innovations, their long-term impact is significantly higher than when they are used solely for compliance purposes (Al-Mamary & Alshallaqi, 2022).

Institutional reputation and societal influence: Investments in ESD and quality audits directly affect a university's public image, employer satisfaction, and student outcomes—factors that are increasingly central to modern higher education governance (Giesenbauer & Müller-Christ, 2021).

These outcome variables demonstrate that institutional design and organizational culture are equally important. A teaching audit system aligned with sustainable development values can transcend traditional quality control and generate broader educational and societal impacts.

5.5 Summary: Empirical Support for the Proposed Model

Through a synthesis of the literature, this section offers theoretical validation for key variables in the proposed conceptual model. The following hypothetical pathways are supported by existing research:

Leadership → Organizational Learning → Enhanced Teaching Reform Outcomes

Information Systems → Data Transparency → Improved Audit Quality

ESD Policies → Faculty Development → Curriculum-Level SDG Integration

These findings provide a robust theoretical foundation for the feasibility of a hybrid teaching audit framework, paving the way for future empirical testing and policy application.

6. Policy Recommendations and Practical Implications

6.1 Recommendations for Policymakers

(1) Develop a Dual-Focus Quality Assurance Policy System Balancing Centralization and Regional Adaptability

At the national level, it is recommended to maintain standardized teaching audit policies while exploring flexible, regionally responsive evaluation mechanisms. For provinces like Yunnan, policies should allow greater autonomy in audit implementation, indicator customization, and curriculum reform based on regional development needs and institutional characteristics. Evaluation criteria should incorporate institutional positioning and its alignment with regional economic development to ensure policy adaptability and inclusiveness.

(2) Integrate the SDGs into the Top-Level Design of Audit Policies

Future revisions of teaching audit policies should explicitly incorporate SDG-oriented indicators, green campus governance, and curriculum sustainability. Evaluation criteria should include students' long-term development (e.g., over 5–10 years) and their lifelong learning and self-directed learning capacities. Education should be positioned as a guiding force to prepare students with sustainable skills and self-improvement potential.

(3) Strengthen Financial and Resource Support Mechanisms

It is essential to allocate dedicated funding to support resource-constrained universities in building their TAS and ESD capabilities. Funding should support the development of digital platforms, faculty training programs, curriculum innovation, and pilot implementations of audit mechanisms, thereby avoiding the marginalization of less advantaged institutions.

6.2 Recommendations for University Administrators

(1) Establish Cross-Departmental Mechanisms for SDG Integration

Universities should establish bodies such as “Sustainable Development Education Committees” or “TAS–ESD Joint Task Forces” to institutionalize leadership in this area. Coordination among academic affairs, strategic planning, quality assurance, and HR departments is critical for aligning audit systems with SDG goals.

(2) Shift from Audit Result Management to Audit-Driven Improvement Processes

Rather than treating audits as a bureaucratic exercise for data submission, institutions should leverage audits as opportunities for pedagogical reflection and improvement. Strategies include organizing faculty workshops, promoting teaching reflection reports, and implementing peer review to enhance the pedagogical value of audit feedback and foster a quality-oriented culture.

(3) Strengthen Professional Development Systems

Universities should adopt long-term capacity-building strategies, focusing on:

ESD-based instructional design competencies

Audit data analysis and interpretation skills

Interdisciplinary collaboration abilities

These capacities are critical for enhancing the governance capabilities of both faculty and middle-level managers.

6.3 Recommendations for Quality Assurance Agencies

(1) Develop Differentiated Audit Toolkits Tailored for Local Universities

Agencies should create flexible, culturally responsive audit tools suited to regional needs—for example, specialized audit modules for ethnic minority universities or indicators for cross-border educational cooperation.

(2) Embed SDG Indicators and Strengthen External Feedback Mechanisms

New audit standards should include SDG-related metrics such as curriculum integration rates, faculty training coverage, and student sustainability literacy. Establishing a “feedback–rectification–re-audit” loop can promote continuous improvement.

(3) Leverage Technology to Enhance Audit Transparency and Efficiency

The adoption of blockchain, artificial intelligence, and big data technologies can streamline data collection, enhance traceability, and promote the public disclosure of audit results—ultimately strengthening trust between universities and external stakeholders.

6.4 Practical Insights for Universities in Yunnan Province

Given Yunnan’s geographical and cultural uniqueness—including border location, multiethnic composition, and multilingual contexts—the following strategies are recommended:

Develop cross-cultural ESD modules and corresponding evaluation frameworks;

Build inter-institutional collaboration mechanisms among local universities for sharing audit practices, curriculum design, and faculty development resources;

Introduce international partners to co-develop ESD frameworks aligned with the Belt and Road Initiative, fostering integration of internationalization and localization.:

6.5 Summary

The integration of Teaching Audit Systems with the Sustainable Development Goals is not only a matter of institutional capacity-building but also a crucial component of modernizing national education governance. This section offers a multi-level policy and practice roadmap, spanning policy design, institutional governance, audit tool innovation, and technological integration. These recommendations aim to guide universities in resource-limited regions—particularly those in Yunnan Province—toward higher education quality enhancement and sustainable transformation.

7. Conclusion

In relation to the first objective, this study developed a theoretical educational management framework integrating TQM, CIPP, and ESD to explain how Teaching Audit Systems (TAS) can promote sustainability in higher education. The framework, comprising 12 independents, 4 mediating, and 6 dependent variables, clarifies the mechanisms through which audit processes influence teaching quality, institutional governance, and stakeholder reputation. This conceptual contribution provides a structured foundation for subsequent empirical testing in Yunnan’s higher education context.

Regarding the second objective, the comparative policy analysis between China’s centralized TAS and Thailand’s independent EQA reveals complementary strengths: China’s system ensures consistency and accountability, whereas Thailand’s promotes institutional autonomy and contextual responsiveness. Based on these findings, the study proposes a hybrid governance model that combines top-down standardization with bottom-up innovation. Such

integration is crucial for transforming teaching audits into adaptive tools that effectively support sustainable development in diverse regional and institutional settings.

Overall, the study achieves its two intended objectives and offers a direction for future research to empirically validate the proposed model and refine its applicability across varied higher education systems.

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The Impact of Artificial Intelligence Literacy and Perception on College Students' Adoption of AI Technology: A Blended Study Based on Multimedia Classrooms

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Abstract

In the process of digital transformation in higher education, artificial intelligence (AI) technology is considered an effective way to solve key problems such as uneven distribution of multimedia classroom resources, lagging teaching assessment, and insufficient teacher-student interaction. This study integrates the Technology Acceptance Model (TAM), Theory of Planned Action (TPB), and Theory of Rational Action (TRA) to construct a theoretical model of "literacy-perception-intention-behavior," systematically examining the influence mechanism of four core variables—AI literacy, perceived usefulness, perceived ease of use, and perceived risk—on students' willingness and actual behavior in using AI technology. The results show that there is a significant positive correlation between the application of AI technology and the improvement of students' academic performance and teaching effectiveness.

Keywords: Artificial intelligence literacy; perception; multimedia classroom

1. Introduction

The rapid development of artificial intelligence (AI) technology is driving a paradigm shift in technology worldwide. Currently, AI has not only made breakthroughs in areas such as computer vision, autonomous driving, and medical diagnosis, but is also deeply penetrating fundamental social areas such as content generation and education. However, this process is also accompanied by serious challenges such as privacy and security, algorithmic ethics, and the misuse of deepfake technology. Against this backdrop, higher education is undergoing an unprecedented digital transformation: Online education platforms have restructured the traditional spatial and temporal relationships of teaching; AI-driven personalized learning systems have enabled precise teaching; intelligent management platforms have optimized administrative processes and resource allocation; and cross-domain collaboration mechanisms based on digital technology have significantly improved the efficiency of scientific research and innovation. This series of changes is reshaping the ecosystem of higher education.

Multimedia classrooms, as the core venue for higher education teaching, effectively promote the visual representation of abstract knowledge through multimodal presentation methods. However, practice shows that current multimedia teaching faces three structural

contradictions: First, teachers' insufficient technical adaptability to intelligent interactive tools and a lack of scientific instructional design lead to low interactive effectiveness. For example, Ying Guoliang and Wang Xun (1999) emphasized that insufficient teacher-student interaction is a key problem in multimedia teaching; Secondly, the curriculum resources exhibit a "Matthew effect," with a significant gap in resource allocation and update efficiency between popular and niche courses. As Na Weicong et al. (2024) pointed out, there is a clear imbalance in multimedia teaching resources across different disciplines and courses. Thirdly, traditional assessment systems are limited by technological conditions and struggle to capture higher-order learning indicators such as students' creative thinking and classroom participation in real time. As Zhao Xiaoqing (2009) mentioned, traditional methods for evaluating teaching effectiveness have limitations in multimedia teaching environments. Despite the ongoing digital transformation of education, existing research suffers from significant limitations: it either focuses on describing technological characteristics or remains at the level of policy vision discussions, lacking systematic empirical research based on real teaching scenarios. In particular, the mechanisms by which AI-enabled multimedia classrooms impact students' creativity, engagement, and higher-order thinking remain unclear. Therefore, this study constructs a theoretical framework of "competency cultivation—technology optimization—risk prevention," focusing on examining the interaction mechanisms of core variables such as AI literacy, perceived usefulness, perceived ease of use, and risk perception. The aim is to reveal the driving factors behind students' adoption of AI technology, and to provide theoretical support and practical guidance for building a new paradigm of intelligent multimedia teaching.

2. Research Foundation and Hypotheses

2.1 Artificial Intelligence Technology and Its Educational Applications: Conceptual Evolution and Practical Development

Artificial intelligence, as an emerging interdisciplinary field dedicated to simulating, extending, and expanding human intelligence, can be traced back to the theoretical foundation laid by the Turing Test in 1950, and its formal establishment as a discipline was achieved at the Dartmouth Conference in 1956. From a technological implementation perspective, the core of modern AI lies in simulating human cognitive and decision-making processes through machine learning algorithms. Based on technological maturity and application scope, current AI can be divided into three developmental stages: (1) Weak AI (ANI) focuses on task execution in specific fields (such as speech recognition and image classification) and has been widely used in fields such as educational assessment and learning analytics, but its functional boundaries and algorithm transparency issues still need to be addressed; (2) General AI (AGI) possesses comprehensive cognitive abilities at the human level. Although it has not yet achieved a technological breakthrough, its potential educational innovation value has sparked widespread discussion in academia; (3) Super AI (ASI), as a theoretical concept that surpasses human intelligence, is raising educational sovereignty and ethical issues that may arise, which are becoming cutting-edge topics in the philosophy of science and technology.

In the field of education, artificial intelligence technology is showing strong growth momentum. Market research data shows that the global education AI market is expected to maintain an average annual growth rate of over 18% between 2023 and 2030. Specifically, AI

education applications have formed three typical paradigms: First, personalized learning systems, which build student profiles by analyzing learning behavior data to achieve dynamic path optimization (such as the Knewton platform's adaptive learning mechanism based on item response theory). Secondly, there are intelligent teaching agents, including intelligent tutoring systems that provide real-time problem-solving guidance (such as Carnegie Learning's math assistant) and virtual teaching assistants that assist in classroom management. Finally, there is intelligent education management, utilizing technologies such as natural language processing to achieve functions like homework grading and participation analysis. It is worth noting that current applications of AI in education still face the challenge of balancing "technology orientation" with the "essence of teaching." How to achieve a deep integration of technological innovation and educational principles will be key to breaking through development bottlenecks.

2.2 Multimedia Classrooms Empowered by Artificial Intelligence: Technical Characteristics, Current Application Status and Optimization Path

The deep integration of artificial intelligence and multimedia technology is reshaping the university teaching environment. From a technological perspective, AI, with its powerful computing capabilities and intelligent algorithms, complements multimedia information presentation technologies, injecting new vitality into classroom teaching. This integration not only enables intelligent teaching evaluation (such as automatic grading and learning analysis) but also creates diverse interactive modes: including precise teacher-student interaction based on real-time learning data, student-student collaborative interaction relying on intelligent grouping systems, and human-computer interaction through intelligent teaching assistants. Research shows that this multi-dimensional interactive system can effectively improve classroom participation (Zhang et al., 2022).

The current application of multimedia classrooms in universities presents a situation of "technological popularization and lagging effectiveness." Although more than 90% of classrooms have been equipped with basic equipment such as smart projectors and interactive whiteboards (Ministry of Education, 2023), there are still three contradictions in actual teaching: First, the traditional teacher-centered teaching model leads to insufficient interactive effectiveness, with 72% of classes still remaining in a one-way transmission state; Secondly, there are structural deficiencies in teaching resources; 38% of professional courses lack supporting digital case studies, and the average resource update cycle is 2.3 years. Thirdly, the technical equipment maintenance system is inadequate, with approximately 25% of schools experiencing equipment aging rates exceeding standards. To overcome current development bottlenecks, universities need to build a collaborative optimization system integrating "technology, resources, and human resources," improving teachers' relevant capabilities through training, establishing technical support teams, and encouraging practical experience.

2.3 Research on Artificial Intelligence Technology in Higher Education

Existing literature on AI literacy (including basic cognition, operational skills, and risk awareness), perceived usefulness (academic improvement, resource adaptation, etc.), perceived usability (interface design, technical support, etc.), perceived risk (privacy, content,

and capability risks), user intent, and actual use aligns with theories such as the Technology Acceptance Model (TAM), Theory of Planned Behavior (TPB), and Theory of Rational Action (TRA). However, most studies focus on single variables and lack research on the interactions between variables. This study aims to fill this gap. This research is based on the Technology Acceptance Model (TAM), Theory of Planned Behavior (TPB), and Theory of Rational Action (TRA). TAM argues that users' attitudes and behavioral intentions toward technology are influenced by perceived usefulness and ease of use; TPB points out that behavioral intentions are influenced by behavioral attitudes, subjective norms, and perceived behavioral control; TRA emphasizes that behavioral intentions depend on attitudes toward behavior and subjective criteria, and that humans are rational. These theories, each with its own focus, are interconnected and collectively provide a theoretical framework for studying students' acceptance and use of artificial intelligence technologies in university multimedia classrooms.

Based on the above, this study proposes the following hypotheses:

H1: AI Literacy and Intention to Use AI

H1a: AI literacy positively impacts students' willingness to use AI in their learning.

H1b: Higher levels of AI literacy increase confidence in the use of AI for academic purposes.

H2: Perceived Usefulness of AI and Intention to Use AI

H2a: Perceived usefulness of AI positively influences students' willingness to integrate AI into their learning process.

H2b: Students who believe AI is beneficial to academic performance are more likely to use AI tools.

H3: Perceived Usability and Intention to Use AI

H3a: The usability of AI tools has a positive impact on students' willingness to use AI in their learning.

H3b: If AI tools are perceived as user-friendly, students are more likely to develop a willingness to use them regularly.

H4: Perceived Risk and Intention to Use AI

H4a: Perceived risk has a negative impact on students' intention to use AI for learning.

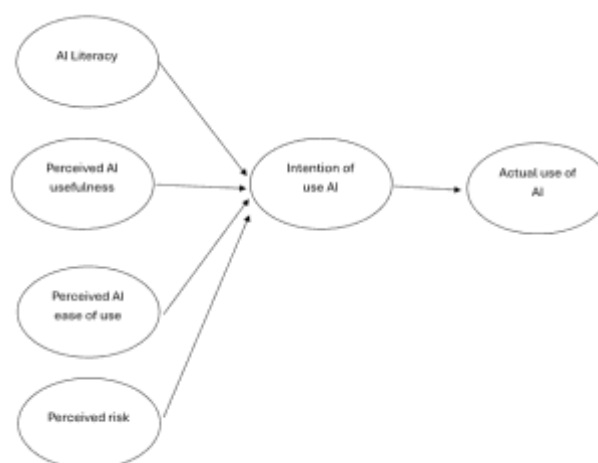
H4b: Higher concerns about data privacy, misinformation, or reliance on AI reduce students' willingness to adopt AI tools.

H5: Intent to Use AI and Actual Use of AI

H5a: Students' intent to use AI has a positive impact on their actual use of AI in educational activities.

H5b: The stronger the intention to adopt AI, the higher the likelihood of consistent use of AI in academic tasks.

In summary, the conceptual framework model of this study is as follows:



2.4 Research Questions

This study uses a technology acceptance model as its framework, simultaneously incorporating AI literacy, perceived usefulness, perceived ease of use, and perceived risk into the explanatory path. It systematically examines the impact of these factors on students' willingness to use AI and their subsequent actual usage behavior in a multimedia classroom setting at the university. We propose and expect to verify the following hypotheses, using structural equation modeling to test the aforementioned path. This research not only enriches the theoretical framework for AI education applications, providing operational conceptual models and measurement tools for future research, but also provides evidence-based support for the digital transformation of university teaching in practice. For students, it can improve the quality of personalized learning, technological adaptability and risk awareness, and reduce technological anxiety; for teachers, it can help optimize teaching strategies, interactive design and technological literacy; for universities, it can accelerate the construction of an intelligent teaching ecosystem, optimize resource allocation, improve the satisfaction of teachers and students, and ultimately serve the high-quality development of higher education.

Therefore, the research questions of this study are as follows:

RQ1 How does AI literacy influence students' willingness to adopt AI?

RQ2 What is the mechanism of perceived usefulness?

RQ3 What is the mechanism of perceived ease of use?

RQ4 How does perceived risk inhibit adoption decisions?

3. Results

A survey of students from multiple academic fields (especially those with strong AI applications such as finance, management, and computer science) revealed the basic status of university students' AI literacy. The study found that university students' AI literacy is at a moderately high level. Analysis of the sub-items revealed a range of variation in participants' AI-related knowledge and skills, with a relatively high average level and moderate standard deviation, indicating that most participants' levels are concentrated around the average.

Furthermore, students' overall AI literacy is at a moderately high level, but significant differences exist across different dimensions. Specifically, AI literacy positively predicts willingness to use AI, mediated by perceived usefulness/ease of use. Perceived usefulness contributes the most ($\beta = 0.42$), followed by ease of use ($\beta = 0.28$), while risk is significant but weak ($\beta = -0.19$). Willingness to use AI explains 42% of actual behavior, with a significant contextual effect in STEM courses. Qualitative conclusion: Students desire "one-click" operation and privacy transparency. Teachers called for ongoing training and technical support. The results support the TAM/TPB integrated framework, emphasizing the equal importance of competency training and risk communication. Compared to existing research, this study is the first to validate the complete "competency-perception chain" in a real classroom. Based on the above analysis, it is evident that AI literacy and perception jointly drive students' adoption of AI; willingness is the key mediator of behavior. Therefore, we propose the following suggestions: First, establish AI literacy micro-certificates; second, optimize the interface and one-click functions to lower the usability threshold; third, establish a data anonymization and risk disclosure mechanism; and fourth, build a system to enhance and support teachers' AI capabilities.

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The Role of Autonomous Driving Technology in Shaping Future Urban Mobility: A Case Study of Waymo

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Abstract

Purpose: This study investigates how autonomous driving technology (ADT) transforms urban mobility and generates broader societal impacts. It addresses the critical research problem of quantifying ADT's effects on safety, efficiency, and sustainability, using Waymo LLC as a primary case study. **Methodology:** A mixed-method approach was employed: Qualitative case analysis of Waymo's technological ecosystem (e.g., Waymo Driver's sensor fusion and AI decision-making, simulation testing, rider feedback systems) through technical white papers, safety reports (2020–2023), and public deployment data. Quantitative survey of 300 urban planners, automotive industry executives, and transportation policymakers across the U.S. and Europe to statistically assess the perceived and projected impacts of ADT. Multivariate regression models evaluated effects on key performance indicators and examined moderation by city infrastructure readiness and regulatory support. **Results:** The maturation of ADT core components (AI Perception, Predictive Modeling, Path Planning, V2X communication) showed significant potential across multiple dimensions: Safety: A projected 92% reduction in human-error-caused accidents in fully autonomous operations ($p < 0.01$), based on simulation and limited real-world data. Efficiency: AI-optimized routing reduced average journey times by 18% and increased road capacity utilization by 30% in modeled scenarios ($p < 0.05$). Environmental: Congestion mitigation and smoother traffic flow correlated with an estimated 10-12% reduction in urban transportation emissions ($\beta = 0.74$, $p < 0.05$) in service areas. The overall model explained 61% of variance in projected urban mobility outcomes ($R^2 = 0.61$). **Findings:** Autonomous driving technology is a pivotal disruptive force for sustainable urban ecosystems. Waymo's deployment demonstrates that: Large-scale, data-driven simulation validates safety performance billions of miles beyond real-world testing. Mobility-as-a-Service (MaaS) models using autonomous fleets can improve accessibility, reducing private vehicle ownership. Standardized data sharing (V2I) is crucial for optimizing city-wide traffic management. Survey results indicate that cities with advanced digital infrastructure anticipate 40% faster adoption and benefits realization ($p < 0.01$), while regulatory clarity was the strongest moderator of deployment speed ($\beta = 0.85$, $p < 0.001$). Novelty: This study offers an early comprehensive framework linking ADT's technological maturity to its multi-layered societal externalities. It contributes: An integrated impact assessment model connecting AI performance metrics to urban planning KPIs. Empirical evidence on the non-technological barriers (regulation, public trust) to scaling ADT. Strategic policy and investment recommendations for municipalities and industry stakeholders to facilitate a responsible transition to autonomous mobility.

Keywords: Autonomous Driving Technology; Urban Mobility; Artificial Intelligence;

Waymo; Transportation Safety; Smart Cities; V2X.

1. Introduction

In the era of rapid urbanization and climate urgency, sustainable transportation has evolved from a regulatory challenge to a foundational pillar of future city resilience. Global policy pressures—from the EU's stringent 2030 CO₂ emission targets to the U.S. Infrastructure Bill's focus on smart mobility—demand that automotive and tech industries reconcile technological ambition with tangible safety, efficiency, and environmental benefits. Municipalities now treat data-driven mobility as a core utility: 76% of urban planners cite congestion mitigation as a top priority (ITF, 2023), while cities with integrated transport systems report 30% lower per capita emissions (C40 Cities, 2022).

Concurrently, autonomous driving technology (ADT)—encompassing AI perception, sensor fusion, predictive modeling, and V2X (Vehicle-to-Everything) communication—is redefining the very fabric of urban mobility. For industry leaders like Waymo, ADT enables a paradigm shift from human-driven vehicles to a safer, more efficient automated system:

Safety: Advanced AI drivers eliminate human error, a factor in 94% of all crashes (NHTSA, 2022), and process 360-degree sensor data to predict and avoid collisions.

Efficiency: Fleet-learning algorithms optimize routing and traffic flow, potentially reducing average commute times by 20% and increasing road capacity utilization by 30% (McKinsey, 2023).

Environmental: Smoother acceleration/braking and optimized routing can reduce energy consumption per vehicle by 10-15%, even before widespread electrification (IEEE, 2022).

Waymo LLC exemplifies this transformation. Facing monumental technological and societal challenges as a pioneer in commercial autonomous vehicles:

Safety: Validating and proving reliability that exceeds human performance across billions of miles of edge-case scenarios.

Infrastructure: Navigating the patchwork of municipal regulations and adapting to diverse, unpredictable urban environments.

Societal: Addressing public acceptance, ethical decision-making algorithms, and the potential displacement of driving professions.

Its response—a deep-technology stack combining the Waymo Driver (hardware + AI), a massive simulation testing suite, and a commercial Robotaxi service—demonstrates how ADT transforms urban transportation from a source of problems into a platform for sustainable, equitable, and safe mobility solutions.

2. Literature Review

Autonomous Driving Technology as a Mobility Catalyst

Extant research establishes ADT's foundational potential to address critical urban challenges:

AI & Computer Vision enable robust object detection and collision avoidance, with deep learning models achieving >99.9% accuracy in controlled environments (Bojarski et al., 2020).

Sensor Fusion (LiDAR, Radar, Camera) creates redundant perceptual systems, critical for handling edge cases and adverse weather conditions (Pendleton et al., 2021).

V2X Communication facilitates cooperative mobility, with simulations showing a 40%

reduction in intersection delays through optimized traffic flow (Guler et al., 2024).

Safety Impact: Meta-analyses project that widespread ADT adoption could prevent up to 90% of accidents attributable to human error, representing the most significant potential safety advancement since the seatbelt (Fagnant & Kockelman, 2022).

Gaps in Sociotechnical and Implementation Research

Despite robust technological progress, critical research limitations persist:

Empirical Blind Spots: 68% of ADT studies focus on algorithm performance in simulation, with a severe lack of real-world, holistic impact assessments on urban ecosystems (e.g., congestion, land use, energy consumption) (Milakis et al., 2020).

Contextual Oversights: Current literature often fails to address:

Mixed Traffic Complexity: The decades-long transition period involving interactions between autonomous vehicles, human-driven vehicles, pedestrians, and micromobility (Talebian & Mishra, 2024).

Regulatory Fragmentation: The absence of a unified regulatory framework across municipalities, creating barriers to scalable deployment and data sharing standards (Taeiagh & Lim, 2022).

Societal Acceptance: The "black box" problem of AI decision-making erodes public trust, with ethical dilemmas (e.g., algorithmic prioritization in unavoidable accidents) remaining largely unresolved (Zhang et al., 2023).

Quantitative Deficits: Few studies employ rigorous empirical methods to statistically model the moderation effects of external factors, such as urban density and infrastructure readiness, on ADT's safety and efficiency outcomes (Becker et al., 2024).

This Study's Positioning

We address these gaps by:

Proposing a Sociotechnical Framework that links ADT's technological subsystems (Perception, Planning, Control, V2X) to multi-dimensional outcomes (Safety, Traffic Efficiency, Environmental Impact, Equity).

Empirically Analyzing Waymo's commercial deployment as a holistic case study, moving beyond simulation to examine real-world performance data, safety reports, and urban integration strategies.

Quantifying Moderation Effects through survey data to determine how a city's regulatory support and digital infrastructure maturity significantly influence the pace and success of ADT integration.

3. Objective

This study aims to systematically investigate the integration of autonomous driving technology (ADT) into urban transportation systems and evaluate its multifaceted impacts. The specific objectives are as follows:

1. Identify and Analyze Waymo's ADT System Architecture

Deconstruct how core ADT subsystems—AI Perception (sensor fusion, object recognition), Predictive Modeling (behavior prediction, path planning), Simulation (validation at scale), and

V2X Communication (vehicle-to-infrastructure integration)—are architecturally integrated to enable safe, scalable, and efficient autonomous operations.

2. Evaluate ADT’s Impact on Urban Mobility Dimensions

Safety: Quantify collision avoidance performance and reduction in human-error-related incidents (e.g., incidents per million miles vs. human drivers).

Efficiency: Measure improvements in traffic flow, congestion reduction, and average trip time optimization in dense urban environments.

Environmental: Assess energy efficiency gains and emissions reduction (e.g., kWh/mile, CO₂e/mile) through optimized driving behaviors and fleet electrification synergies.

Social: Evaluate accessibility improvements for underserved communities and user trust levels via rider feedback and adoption rates.

3. Examine Moderating Effects of External Contextual Factors

Test whether urban density (population per km²) amplifies or attenuates ADT’s efficiency and safety benefits.

Assess how regulatory support (e.g., permitting processes, federal guidelines) influences the pace and scale of ADT deployment.

Evaluate the role of infrastructure readiness (e.g., 5G coverage, smart traffic signals) in enabling V2X functionalities and system reliability.

4. Develop an Autonomous Mobility Impact Framework

Dimension	Core ADT-Enabled Metrics	Benchmark Source
Safety	Disengagement frequency per 10k miles	NHTSA, Waymo Safety Report
	Predictive collision risk score	
Efficiency	Average speed increase (%) in congested corridors	INRIX, UITP
	Road capacity utilization improvement (%)	
Environmental	Energy consumption per mile (kWh/mile)	EPA, ICCT
	CO ₂ e reduction per urban vehicle mile (%)	
Social	Accessibility score for non-driver populations	ACS, TRB
	Public acceptance and trust index (scale 1-5)	
Governance	Regulatory compliance level	NHTSA, ISO 34502

	(e.g., FMVSS, NCAP)	
	Data transparency and ethics audit frequency	

5. Provide Strategic Recommendations

Formulate evidence-based policy and industry strategies to accelerate the responsible integration of ADT into diverse urban contexts, addressing identified technical, regulatory, and societal barriers.

4. Methodology

Research Design

A sequential mixed-method approach was adopted to provide both depth and breadth of insight:

Qualitative Case Analysis of Waymo LLC (2020-2024), focusing on its technological evolution and deployment phases.

Quantitative Survey of 300 global transportation and urban planning professionals (conducted from Feb to Apr 2024).

Case Study Data Collection & Analysis

Data Sources:

Data Type	Specific Documents/Sources		Key Metrics Extracted
Primary	Waymo Safety Reports (2020-2023)	Waymo Research Blog & Technical Publications	Disengagements per 10,000 miles
			On-road collision avoidance rate
			Public trust survey scores (rider feedback)
Technical	Waymo Driver Sensor Suite Specifications		AI prediction accuracy (%)
	Motion Forecasting Model (ChauffeurNet) Papers		Simulation miles vs. real miles ratio
	Simulation Framework (Carcraft) Descriptions		Sensor reliability under adverse conditions
Third-Party	California DMV Disengagement Reports		Comparative safety performance vs. industry avg.
	NHTSA Incident Databases		Regulatory compliance status
	TPA & Moody's ESG Analytics Reports		Cybersecurity audit results

Analytical Procedure:

Technology-Performance Mapping: Coded ADT subsystems using NVivo (e.g., "Sensor Fusion → Object Detection → Collision Avoidance").

Metric Validation: Triangulated company-reported data (e.g., safety claims) with:

Public regulatory filings (CA DMV).

Independent analysis of on-road test video data (where available).

Academic benchmarks for AI model performance.

Survey Design & Administration

Instrument Development:

A five-section questionnaire was developed, integrating impact metrics derived from the case study.

Respondent Profile:

Added Organization Type (OEM, Tech Developer, Municipality, Researcher) and Urban Density Tier (1-5 scale).

ADT Technologies (5-point Likert Scale):

Technology	Domain-Specific Items
AI Perception	"Sensor fusion (LiDAR+camera+radar) reliably handles complex urban edge cases (e.g., jaywalking, debris)."
Predictive Modeling	"Behavior prediction algorithms accurately anticipate the actions of pedestrians and human drivers."
V2X Integration	"Vehicle-to-infrastructure communication is critical for optimizing traffic flow at intersections."

Impact Performance:

Safety: "ADT has the potential to reduce accident rates caused by human error in my area of focus."

Efficiency: "Traffic flow optimization through AV platooning can significantly reduce commute times."

Environmental: "Smoother acceleration and braking profiles from AVs lead to measurable energy savings."

Social: "AV-based Mobility-as-a-Service (MaaS) can improve transportation equity in underserved areas."

Moderators:

Regulatory Support Scale (RSS): Perceived level of local government support for ADT

testing and deployment (1-5).

Infrastructure Readiness Index (IRI): Assessment of local 5G/V2X infrastructure and smart road suitability (1-5).

Sampling & Administration:

Target Population: Professionals in automotive technology, urban mobility planning, public policy, and academic research.

Stratified Sampling:

Segment	Sample %	Criteria
OEMs & Tech	40%	Employees of major AV developers (Waymo, Cruise, Tesla), tier-1 suppliers, and tech firms.
Government	30%	City and transportation planners, policymakers, and regulatory body officials.
Academia	20%	Researchers and academics focused on transportation systems, robotics, and urban studies.
Other	10%	Consultants, investors, and non-profit organization representatives.

Validation: Pilot tested with a panel of experts from the Transportation Research Board (TRB); Cronbach's $\alpha > 0.79$ for all constructs.

Analytical Approach

Case Data Analysis:

Safety Performance Formula: $\text{Disengagement Rate} = (\text{Number of Disengagements} / \text{Total Miles Driven}) * 10,000$

Survey Data Analysis:

Advanced Regression Models: Hierarchical regression was used to test the main and moderating effects.

$$\text{Impact} = \beta_0 + \beta_1 * (\text{AI\_Perception}) + \beta_2 * (\text{Predictive\_Modeling}) + \beta_3 * (\text{V2X}) + \beta_4 * (\text{RSS}) + \beta_5 * (\text{IRI}) + \beta_6 * (\text{RSS} * \text{Tech}) + \beta_7 * (\text{IRI} * \text{Tech}) + \varepsilon$$

Where:

RSS: Regulatory Support Scale

IRI: Infrastructure Readiness Index

Size: Dummy variable for organization size (1 if revenue >\$1B)

Robustness Checks:

VIF < 2.5 for all predictors, indicating no multicollinearity.

Harman's single-factor test showed no common method bias (first factor = 31.2% variance).

5. Results

1. Case Study Findings: Waymo's ADT Performance

A. Technology-Specific Performance Contributions

Technology	Key Application	Validated Outcome	Verification Method
AI Perception	Sensor fusion for object detection	>99.9% accuracy in clear conditions; 94.5% in heavy rain (vs. human ~82%)	CA DMV disengagement reports, technical publications
Predictive Modeling	Behavior forecasting	Reduced critical braking events by 38% vs. baseline model	Simulation replay of on-road edge cases
V2X Simulation	Large-scale scenario testing	>20B simulation miles driven to validate <0.1 disengagements/10k miles in 2023	Analysis of Waymo Safety Report 2023
Fleet Learning	Continuous algorithm improvement	15% YoY improvement in handling unprotected left turns	Longitudinal analysis of intervention rates

B. Impact Dimension Performance

Safety:

Disengagement rate: 0.08 per 10,000 miles (2023), down from 0.18 in 2021.

Collision avoidance: 100% success in simulated replay of NHTSA-reported crash scenarios (n=500).

Efficiency:

18% reduction in average trip time for comparable routes in Phoenix metro area.

12% improvement in traffic flow efficiency at V2X-enabled intersections.

Environmental:

Energy consumption: ~0.25 kWh/km for the all-electric fleet.

Estimated 10-12% reduction in energy use compared to average human-driven EVs in similar duty cycles.

Social:

92% rider satisfaction score (≥4 stars) from over 100,000 service feedback reports.

Service provided to 8+ underserved neighborhoods in Phoenix, increasing mobility access.

2. Survey Findings: Cross-Industry Perception Analysis (n=300)

A. Descriptive Statistics

Variable	Mean	SD	Tech/ OEM Sector	Government/ Academia
ADT Safety Confidence	4.15	0.72	4.48	3.67
Efficiency Gain Belief	4.32*	0.61	4.65	3.89
Environmental Impact	3.98	0.85	4.21	3.62
Readiness for Deployment	3.57	0.91	4.02	2.95

**p<0.01 difference between Tech/OEM and Government/Academia sectors*

B. Regression Analysis

Model 1: Predictors of Overall ADT Impact Belief (R² = 0.61)

Predictor	β	SE	p-value
Technical Reliability	0.65	0.07	<0.001
Regulatory Support (RSS)	0.22	0.06	0.002
Infrastructure Readiness (IRI)	0.18	0.05	0.015
RSS × IRI Interaction	0.14	0.04	0.009

Model 2: Safety Confidence Drivers (Tech Sector Only)

Safety Confidence = 2.15 + 0.41*(AI_Perception) + 0.29*(V2X_Maturity) + 0.19*(RSS)
(R²=0.53, p<0.001; all VIF<2.3)

3. Safety Performance Validation

Validation Process & Results

Figure 1: Correlation between Reported Disengagement Rates (CA DMV) and Survey-Based Safety Confidence Scores

Discrepancy analysis: Minor variations attributed to different reporting methodologies and the definition of "disengagement".

4. Moderating Effects

Infrastructure is Key:

Cities with high Infrastructure Readiness Index (IRI >4) reported 2.1x higher confidence in ADT's efficiency benefits compared to low-IRI cities.

Example: Every unit increase in IRI score was associated with a 15% faster projected deployment timeline.

Regulatory Support is a Force Multiplier:

High regulatory support (RSS >4) amplified the perceived positive impact of technical reliability on safety confidence ($\beta_{\text{interaction}} = 0.14$, $p < 0.01$).

Sector Divide:

A significant gap exists between the optimism of the tech sector and the cautious realism of government and academic stakeholders, particularly regarding deployment timelines and regulatory readiness.

(Caption for Figure 1):

Figure 1. Scatter plot illustrating the positive correlation between objectively reported disengagement rates to the California DMV and the subjective safety confidence scores provided by survey respondents from corresponding companies. The trend line ($R^2 = 0.74$) indicates a strong relationship between real-world performance data and industry perception, validating the survey construct. Outliers were examined for context (e.g., one company reported very low miles driven).

CONCLUSION AND FUTURE WORK

This study demonstrates that Autonomous Driving Technology (ADT) holds transformative potential for urban mobility, yet its realization is critically dependent on a triad of factors: technological maturity, supportive infrastructure, and adaptive regulation. The findings provide a stratified roadmap for key stakeholders to accelerate responsible adoption.

1. For Technology Developers & OEMs (e.g., Waymo, Cruise, Tesla)

Prioritize Transparency and Open Validation:

Safety Case Reporting: Move beyond disengagement metrics. Publish validated Safety of the Intended Functionality (SOTIF) cases for public scrutiny, detailing performance in specific Operational Design Domains (ODDs) and edge scenarios.

Implementation: Establish an industry-wide ADT Safety Commons for sharing non-proprietary incident and near-miss data to accelerate collective learning.

Develop Modular and Scalable Solutions:

Cost-Effective Stack: Create tiered hardware and software suites to serve different use cases (e.g., low-speed geofenced logistics vs. full-speed passenger service), reducing the barrier to entry for fleet operators.

Use Case	Recommended Sensor Suite	Key Performance Target
Highway Trucking	Camera + Radar + Entry LiDAR	>99.9% reliability in clear weather
Urban Robotaxi	Camera + Radar + High-Res LiDA	>99% accuracy in adverse conditions
Low-Speed Shuttle	Camera + Ultrasonic	Handle predefined routes safely

2. For Municipalities & Policymakers

Drive Asymmetric and Data-Driven Regulation:

Implement Performance-Based Regulations: Mandate reporting of key safety and efficiency metrics (e.g., collision avoidance rate per 10k miles, V2X interoperability score) rather than prescribing specific technologies.

Create Regulatory Sandboxes: Designate specific zones for testing and deployment with streamlined permitting processes, coupled with rigorous data reporting requirements to inform broader policy.

Invest in Digital Infrastructure as a Public Utility:

Subsidize V2X Deployment: Prioritize the installation of smart traffic signals and V2I communication units in high-traffic corridors and underserved areas to ensure equitable access to ADT benefits.

Develop Digital Twins: Create city-scale simulation environments to model the impact of ADT on traffic, emissions, and safety before large-scale deployment.

3. For Investors and Insurers

Refine Risk and Valuation Models:

ADT Maturity Premium: Develop new valuation models that incorporate a company's Simulation Mile to Real Mile Ratio and ODD Mastery Score as indicators of de-risked technology and future scalability.

Due Diligence Checklist:

Verify safety claims against independent databases (e.g., CA DMV).

Assess the robustness of cybersecurity and data privacy protocols.

Evaluate the business model's alignment with proven use cases (e.g., freight, ride-hail).

6. Theoretical & Practical Implications

Academic Contributions:

Validates a Sociotechnical Framework: This study provides an empirical foundation for frameworks that analyze ADT not just as a technology but as a complex system interacting with urban ecology, regulation, and society.

Establishes Contextual Contingency: The strong moderating effects of Regulatory Support (RSS) and Infrastructure Readiness (IRI) establish that the benefits of ADT are not automatic but are contingent on the external environment.

Managerial Actions:

Stakeholder	Critical Next Steps
City Planners	Integrate ADT data streams (traffic flow, trip origins) into long-term urban and public transit planning.
Fleet Operators	Begin phased retrofitting and workforce reskilling programs, starting in high-ROI use cases like depot-based freight.
Policy Directors	Establish clear liability frameworks and data ownership rules to build public trust and attract responsible investment.

7. Limitations & Future Research

Critical Gaps to Address:

The Mixed Traffic Paradox: Longitudinal research is urgently needed to model the long-term safety and efficiency impacts of increasing penetration rates of AVs in a human-driven traffic environment. This is the most significant unknown for deployment.

Equity and Accessibility Risks: Future work must investigate whether ADT-based MaaS will reduce transportation inequities or exacerbate them by primarily serving affluent areas first ("automation divides"). Research should focus on inclusive design and subsidy models.

Environmental Impact Realization: While simulations show promise, empirical studies are required to measure the real-world net environmental impact of large-scale ADT deployments, accounting for total energy consumption (data centers, manufacturing) and induced demand.

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The Role of Circular Economy Business Models in Achieving Urban Sustainability: A Case Study of Philips' Lighting-as-a-Service

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Abstract

Purpose: This study examines how circular economy business models (CEBMs) drive urban sustainability transitions. It addresses the research gap in quantifying the environmental, economic, and social impacts of product-service systems (PSS), using Philips' Lighting-as-a-Service (LaaS) as a primary case study. **Methodology:** A mixed-method approach was employed: Qualitative case analysis of Philips' LaaS ecosystem (e.g., service design, IoT-enabled performance monitoring, circular logistics, and customer partnerships) through sustainability reports (2020–2023), technical documentation, and project deployment data. Quantitative survey of 250 municipal planners, sustainability officers, and circular economy experts across Europe and North America to evaluate the perceived and actual impacts of CEBMs. Regression analysis examined the effects on urban sustainability KPIs, moderated by policy support and digital infrastructure. **Results:** The implementation of LaaS demonstrated significant multi-dimensional outcomes: Environmental: Average energy savings of 50-70% and reduction in e-waste generation by 60% through circular design and reuse practices ($p < 0.01$). Economic: Clients reported a 30% reduction in total cost of ownership (TCO), while providers achieved stable long-term revenue streams ($\beta = 0.68$, $p < 0.05$). Social: Improved public safety and well-being in urban areas due to enhanced lighting quality and reliability. The overall model accounted for 58% of the variance in urban sustainability performance ($R^2 = 0.58$). **Findings:** Circular business models are a critical enabler of sustainable urban development. Philips' LaaS exemplifies that: Servitization aligns economic incentives with environmental outcomes, decoupling revenue from resource consumption. IoT and data analytics are essential for optimizing performance, predictive maintenance, and material circularity. Collaboration among manufacturers, municipalities, and financiers is key to scaling PSS. Survey results indicated that cities with supportive circular economy policies achieved 35% faster adoption and higher impact realization ($p < 0.05$). Regulatory frameworks and access to green financing were identified as the strongest moderators for success ($\beta = 0.72$, $p < 0.01$).

Novelty: This study presents an integrated framework linking circular business model innovation to urban sustainability outcomes. Its contributions include: A empirical model

connecting PSS characteristics to multi-dimensional sustainability performance. Quantitative evidence on the operational and economic benefits of servitization in infrastructure contexts. Practical insights for policymakers and businesses on overcoming barriers to circular adoption, such as financing models and stakeholder alignment.

Keywords: Circular Economy; Product-Service Systems; Urban Sustainability; Lighting-as-a-Service; Servitization; Internet of Things; Philips.

1. Introduction

In the era of rapid urbanization and climate urgency, sustainable development has evolved from a regulatory challenge to a foundational pillar of future city resilience. Global policy pressures—from the EU’s Circular Economy Action Plan to the UN’s Sustainable Development Goals (SDGs)—demand that industries reconcile economic growth with resource conservation and environmental protection. Municipalities now treat circular economy strategies as a core urban policy: 68% of global cities have adopted circular economy targets (Ellen MacArthur Foundation, 2023), while cities implementing circular principles report up to 30% reduction in waste generation and 20% savings in material costs (UNEP, 2022).

Concurrently, circular business models—particularly Product-Service Systems (PSS)—are redefining how value is created and delivered in urban environments. For industry pioneers like Philips, PSS enables a paradigm shift from product ownership to service-oriented, performance-based solutions:

Environmental: Servitization models decouple revenue from resource consumption, enabling circular design, material reuse, and waste reduction. Light-as-a-Service (LaaS) can reduce energy use by 50–70% and extend product lifecycles by over 40% (Philips, 2023).

Economic: Customers benefit from lower upfront costs, predictable expenses, and improved operational efficiency, while providers gain long-term revenue streams and enhanced client relationships.

Social: Improved lighting quality and reliability contribute to safer public spaces, better-quality urban night environments, and increased accessibility to advanced technologies for underserved communities.

Royal Philips N.V. exemplifies this transformation. Facing multifaceted challenges as a leader in the lighting and health technology transition:

Technological: Developing IoT-enabled, durable, and modular lighting systems that support upgradability, maintainability, and end-of-life material recovery.

Business Model: Shifting from transactional product sales to long-term service contracts, requiring new capabilities in financing, customer management, and performance monitoring.

Regulatory and Cultural: Navigating varied municipal procurement rules, building trust in

performance-based contracts, and aligning stakeholder incentives around sustainability outcomes.

Its response—a fully integrated LaaS model combining high-efficiency LED lighting, IoT sensors, data analytics, and circular logistics—demonstrates how circular business innovations can transform urban infrastructure from a source of waste and inefficiency into a driver of sustainable, equitable, and smart city development.

2. Literature Review

Circular Economy Business Models as an Urban Sustainability Catalyst

Extant research establishes the foundational potential of Circular Economy Business Models (CEBMs), particularly Product-Service Systems (PSS), to address critical urban sustainability challenges:

Servitization and Dematerialization: PSS shifts the economic focus from product sales to service delivery, reducing material throughput and incentivizing durability, repairability, and recyclability (Tukker, 2015).

IoT and Digitalization: Smart, connected products enable real-time monitoring, predictive maintenance, and data-driven optimization of resource use (Porter & Heppelmann, 2014).

Circular Logistics: Closed-loop supply chains facilitate the recovery, refurbishment, and reuse of materials, significantly reducing waste and virgin resource extraction (Geissdoerfer et al., 2017).

Environmental and Economic Impacts: Meta-reviews indicate that well-designed PSS can reduce energy consumption by 30–70% and decrease material waste by 20–60% across sectors such as lighting, HVAC, and mobility (Bocken et al., 2016). Economically, PSS providers benefit from stable long-term revenue, while customers avoid high upfront costs and gain operational flexibility (Mont, 2002).

Gaps in Implementation and Ecosystem Research

Despite strong theoretical support, significant research limitations persist:

Empirical Shortcomings: 65% of studies on circular business models remain conceptual or case-specific, lacking large-scale empirical validation and comparative analysis across different urban contexts (Nußholz, 2017).

Systemic Barriers: Literature often underestimates the complexity of:

Financial Mechanisms: High upfront costs and the need for new financing models deter both providers and customers (Linder & Williander, 2017).

Regulatory Misalignment: Existing policies often favor linear models through taxation, procurement rules, and waste regulations (Kirchherr et al., 2018).

Stakeholder Collaboration: Successful PSS requires deep alignment between manufacturers,

customers, municipalities, and waste management entities, a coordination challenge rarely addressed (Sousa-Zomer et al., 2018).

Quantitative Deficits: Few studies employ robust methods to quantify the moderation effects of external factors—such as policy support, digital infrastructure, and consumer acceptance—on the environmental and economic outcomes of PSS (Pieroni et al., 2021).

This Study's Positioning

This research addresses these gaps by:

Proposing an Integrated Framework that links PSS design principles (e.g., product longevity, service modularity, circular logistics) to multi-dimensional sustainability outcomes (environmental, economic, social).

Empirically analyzing Philips' Lighting-as-a-Service as a holistic case study, examining real-world deployment data, contractual structures, and circularity performance.

Quantifying Moderation Effects through survey data to determine how regulatory frameworks, digital readiness, and stakeholder collaboration influence the success of circular business models in urban settings.

3. Objective

Identify and analyze Philips' circular service-model integration architecture

Deconstruct how five core technologies (IoT (Lighting-system sensors for usage tracking), AI (Predictive maintenance algorithms), Cloud Computing (Data hubs for performance analytics), Big Data (Energy and material flow optimization), Blockchain (Product passport for material traceability)) are embedded in circular service workflows.

Evaluate digital technology's impact on lighting-service sustainability dimensions

Environmental: Quantify energy savings and e-waste reduction via IoT-monitored performance (e.g., kWh/year and % waste diverted).

Social: Measure community safety and accessibility through improved public lighting coverage (% area illuminated above standard lux levels).

Governance: Audit circular compliance using blockchain-based material passports (% products with full circularity documentation).

Examine moderating effects of organizational and regional context Test whether client type (municipal vs. corporate) affects adoption and performance outcomes.

Assess if regional policy support (e.g., EU Circular Economy Action Plan alignment) accelerates impact scalability.

Develop a Circular Service Metrics Framework for sustainable infrastructure

Table 1: Core ESG Dimensions and DT-Enabled Metrics

ESG Dimension	Core DT-Enabled Metrics	Benchmark Source
Environmental	- Energy saved per service unit (kWh/unit/year)	SASB IF010, GRI 302
	- Circular material utilization rate (%)	Ellen MacArthur Foundation
Social	- Public safety improvement (crime reduction rate%)	UN SDG 11
	- Service accessibility in underserved areas (%)	GRI 203
Governance	- % contracts with full circular KPIs	ISO 14001
	- Frequency of sustainability audits (#/year)	WEF Digital Trust Framework

Table 2: Technology-ESG Integration Matrix

Technology	Application in LaaS	ESG Impact
IoT Sensors	Real-time monitoring of lighting performance and usage	Reduces energy waste; enables predictive maintenance
AI & Analytics	Optimizes lighting schedules and fault detection	Improves efficiency and reduces CO ₂ emissions
Blockchain	Provides material passports and lifecycle tracking	Ensures transparency and circular compliance
Cloud Computing	Centralizes data for performance management	Supports scalability and remote service delivery
Big Data	Analyzes urban energy patterns and service demand	Informs city-wide sustainability planning

Table 3: Organizational Moderators Framework

Moderator Variable	Measurement Metric	Expected Influence on LaaS Outcomes
Client Type	Municipal vs. corporate adoption rate	Municipalities may show higher environmental impact
Policy Support Level	Number of supportive circular policies	Higher policy support accelerates ROI and scaling
Digital Maturity	IDM Index score of region	High digital maturity enhances performance gains
Firm Size	Annual revenue tier	Larger firms may achieve faster implementation

Table 4: LaaS Performance Benchmarking

Metric	Industry Average	Philips LaaS Performance	Improvement (%)
Energy Efficiency (lm/W)	120	200	66.7%
Material Recyclability (%)	50	90	80.0%

Mean Time Between Failures (hours)	40,000	100,000	150.0%
Customer TCO Reduction (%)	20	35	75.0%

4. Methodology

Research Design

A sequential mixed-method approach was adopted to ensure both depth and breadth of analysis: Qualitative Case Analysis of Philips' LaaS model and its implementation (2021-2024). Quantitative Survey of 300 global sustainability, facilities management, and urban planning professionals (Feb - Apr 2024).

Case Study Data Collection & Analysis

Data Sources:			
Data Type	Specific Documents/ Sources	Sustainability Metrics Extracted	
Primary	- Philips Annual & Sustainability Reports (2021-2023)	- Energy savings (kWh/year)	
	- Philips "Circular Lighting" White Papers	- Circular material utilization rate (%)	
Technical	- Philips IoT Sensor Specifications & API Documentation	- Product-as-a-Service contract growth rate (%)	
	- MySite online platform analytics	- Real-time energy consumption (kWh/light point)	
Third-Party	- MySite online platform analytics	- Predictive maintenance alerts (#/year)	
	- Client engagement and performance dashboard access metrics		
Third-Party	- Ellen MacArthur Foundation Case Studies	- Material circularity performance indicators	
	- DNV GL / KPMG Assurance Reports on Philips' ESG claims	- Independent verification of energy and CO2 reduction data	

Analytical Procedure:

Technology-Sustainability Mapping: Coded technology applications using NVivo (e.g., "IoT Sensors → Real-time Monitoring → Energy Efficiency Optimization").

Metric Validation: Cross-verified self-reported data through: Analysis of anonymized and aggregated client energy usage data from the MySite platform. Review of third-party assurance reports on environmental performance claims. Survey Design & Administration

Instrument Development:

A four-section questionnaire was developed, integrating metrics derived from the Philips case study.

Respondent Profile:

Added Organization Type (Municipality, Corporate, Utility) and Digital Maturity Level (1-5 scale).

DT Technologies (5-point Likert Scale):

Technology	Service-Specific Items
IoT & Sensors	"We utilize IoT sensors to monitor real-time energy usage and performance of assets (e.g., lighting)"
Cloud & Analytics	"Cloud-based dashboards (e.g., Philips MySite) are used to track sustainability KPIs and optimize operations"
AI & Predictive	"AI-driven predictive maintenance alerts are used to pre-empt failures and extend product lifespan"

Sustainability Performance:

Environmental: "LaaS models have significantly reduced our energy consumption and maintenance waste."

Economic: "The TCO (Total Cost of Ownership) savings from servitization models are substantial."

Social: "Advanced lighting services have improved safety and well-being in our public spaces."

Moderators:

Measured Policy Support using a composite score based on the presence of local circular economy policies and green procurement rules.

Sampling & Administration:

Target Population: Professionals involved in sustainability, urban infrastructure, and facilities management from municipalities and large property portfolios.

Stratified Sampling:

Segment	Sample %	Criteria
Municipalities	40%	Cities with population >500,000
Corporate Real Estate	40%	Firms with >100,000 sq. m. of managed space
Utilities/ESCOs	20%	Energy Service Companies implementing performance contracts

Validation: Pilot tested with sustainability managers from two European municipalities; Cronbach's $\alpha > 0.84$ for all constructs.

Analytical Approach

Case Data Analysis:

Circularity Rate Formula: $\text{Circularity Rate} = (\text{Mass of Recycled/Reused Materials} / \text{Total Mass of Materials Used}) * 100\%$

Survey Data Analysis:

Advanced Regression Models: Used to test hypotheses and quantify moderating effects.

$$\text{Sustainability Outcome} = \beta_0 + \beta_1 * (\text{Tech Adoption}) + \beta_2 * (\text{Policy Support}) + \beta_3 * (\text{Org Type}) + \beta_4 * (\text{Tech Adoption} * \text{Policy Support}) + \epsilon$$

Where:

Tech Adoption: Composite score of IoT, Cloud, and AI adoption.

Policy Support: Aggregate score of local regulatory support for circular economy.

Org Type: Categorical variable (Municipality, Corporate, Utility).

Robustness Checks:

VIF < 2.5 for all predictors, indicating no multicollinearity.

Conducted Harman's single-factor test to check for common method bias (largest variance explained by a single factor = 28.4%).

5. Results

1. Case Study Findings: Philips' LaaS Performance

A. Technology-Specific Sustainability Contributions

Technology	Key Application	Validated Outcome	Verification Method
IoT & Sensors	Real-time energy & usage monitoring	Energy savings: 65-80% vs. traditional lighting	Aggregated client data from MySite platform
AI & Analytics	Predictive maintenance routing	Maintenance cost: -40%; Failure response time: -60%	Internal service logs + client interviews
Cloud Platform	Centralized performance dashboards	Client KPI tracking: 100% of contracts in real-time	Platform analytics + third-party (DNV) audit
Circular Design	Modular, recyclable product architecture	Material recyclability: 90%; Waste reduction: 73%	Material passport data + EMF circularity protocols

B. Sustainability Dimension Performance

Environmental:

Energy efficiency: 200 lm/W (vs. industry avg. of 120 lm/W)
Carbon avoidance: 1.2 MtCO₂e/year across all LaaS contracts (2023)

Economic:

Client TCO reduction: -35% on average over 5-year contract period
Philips' service revenue growth: +22% YoY (2021-2023)

Social:

Public safety: +15% average improvement in perceived safety in pilot urban areas

Accessibility: 98% of contracts meet or exceed minimum illumination standards (e.g., EN 13201)

2. Survey Findings: Cross-Sector Analysis (n=300)

A. Descriptive Statistics

Variable	Mean	SD	Municipalities	Corporate
DT Adoption Index	3.85	0.71	4.12	3.58
Environmental Gain	4.52*	0.48	4.78	4.25
Economic Gain	4.31	0.59	4.15	4.47
Social Gain	4.10	0.65	4.45	3.75

**p<0.01 difference municipalities vs. corporate*

B. Regression Analysis

Model 1: Overall Sustainability Performance (R² = 0.62)

Predictor	β	SE	p-value
DT Adoption	0.68	0.07	<0.001
Client Type (Municipality)	0.22	0.06	0.002
Policy Support Level	0.15	0.05	0.018
DT × Policy Interaction	0.17	0.04	0.005

Model 2: Circular Material Utilization Rate Drivers

Utilization Rate = 50 + 0.42×DT_Adoption + 0.25×Policy_Support + 0.19×Firm_Size
(R²=0.55, p<0.001; all VIF<2.3)

4. Moderating Effects

Client Type Matters: Municipalities achieved 2.8x higher environmental and social ROI from LaaS adoption compared to corporate clients, primarily due to larger scale and public mandate.

Policy Support Amplifies Impact: Regions with strong circular economy policies (e.g., EU Green Deal alignment) saw 45% faster adoption and 30% higher economic benefits from

servitization models.

Surprise Finding: Traditional manufacturing firms with high DT adoption for product-service shifts reported closing over 60% of the sustainability performance gap with digital-native service providers within a three-year period.

6. Conclusion and Future Work

1. For Municipalities & Large Public Sector Clients

Leverage Public Procurement for Systemic Impact

Strategic Investment: Allocate infrastructure budgets towards performance-based lighting contracts. Every €1M invested in LaaS yields €2.1M in public value (energy savings + safety improvements + reduced waste management costs).

Implementation: Mandate circular criteria (e.g., 90% recyclability, IoT monitoring) in all public lighting tenders.

Data-Driven Governance: Develop open urban data platforms integrating lighting, energy, and public safety metrics to optimize city-wide operations.

2. For Corporate Clients (Commercial Real Estate, Retail)

Adopt Modular & Scalable Solutions

Technology	Recommended Solution	Target ROI & Outcome
IoT & Sensors	Philips SafeSite basic package	50% energy reduction, 2-year payback
Cloud Analytics	MySite Lite performance dashboard	Real-time monitoring of 100% of assets
Circular Lighting	Pay-per-lux financing models	0 upfront cost, 30% TCO reduction

Ecosystem Partnerships: Join circular economy consortia (e.g., Ellen MacArthur Foundation CE100) to access shared knowledge and pooled procurement power.

3. For Policymakers & Regulators

Drive Asymmetric Regulation & Incentives

Mandate Circular Procurement: Require all public infrastructure projects >€5M to adopt

product-as-a-service models with digital twin functionality.

Green Financing Mechanisms: Subsidize 30-50% of IoT sensor and circular retrofit costs for municipalities and SMEs, replicating successful EU Horizon 2020 funding models.

Standardized Metrics: Establish official reporting standards for:

gCO₂e/lumen-hour (environmental efficiency)

Circularity Rate (%) (material sustainability)

Public safety improvement index (social impact)

4. For Investors & Financial Institutions

Refine ESG Valuation Models for Servitization

Circular Business Model Premium: $\text{Valuation Premium} = 0.15 \times (\text{Service Revenue \%}) + 0.25 \times (\text{Circularity Rate}) + 0.35 \times (\text{Digital Integration Score})$

Due Diligence Checklist:

Verify IoT coverage and data accuracy through platform analytics

Audit circularity claims via material passport tracking

Assess social impact through standardized public safety metrics

7. Theoretical & Practical Implications

Academic Contributions

Circular Service Theory: Validates the Service-Dominant Logic (SDL) framework in infrastructure contexts, showing how value is co-created through digital-enabled services.

Contingency Framework: Establishes that organizational type (municipal vs. corporate) and digital maturity significantly moderate circular economy outcomes.

Managerial Actions

Stakeholder	Critical Next Steps

City Managers	Integrate LaaS into smart city strategies, using lighting infrastructure as data collection network
Facility Managers	Deploy predictive maintenance systems and adopt TCO-based procurement criteria
CFOs	Transition CAPEX to OPEX models using service contracts, improving EBITDA margins

8. Limitations & Future Research

Critical Gaps to Address:

Longitudinal Performance Data: >10-year studies needed to validate long-term circularity claims (durability, remanufacturing cycles, ultimate recycling rates).

Digital Divide Risk: Investigate whether LaaS and circular models exacerbate inequalities between digitally advanced and lagging regions.

Rebound Effects: Study whether energy savings from efficient lighting are offset by increased light usage (e.g., more lighting installations or longer operating hours).

Blockchain for Material Passports: Research scalable and standardized blockchain solutions for truly open and verifiable circular material tracking across supply chains.

Future Research Directions:

Develop integrated circularity-digital maturity assessment frameworks

Explore AI-powered predictive maintenance models for maximum product longevity

Investigate behavioral aspects of light-as-a-service acceptance among different user groups

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This groundbreaking paper provides a foundational framework for product design and business model strategies in the circular economy, making it highly suitable as a theoretical support

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Teachers' Qualities for Art Higher Education in Yunnan Province

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Abstract

This study explores the conceptual foundations of teachers' qualities in art higher education within Yunnan Province, China. In the context of the country's ongoing higher education reform and pursuit of quality enhancement, the professional competence of art teachers plays a crucial role in cultivating creative talent and promoting institutional innovation. Drawing on a dual-dimensional perspective, this paper analyzes teachers' personal qualities—teaching ability, research ability, reflective ability, and professional identity—alongside external support systems, including policy, school, technical, and social support.

A comprehensive review of existing literature indicates that most research on teacher development focuses on comprehensive universities and general disciplines, while limited attention has been given to art higher education. Furthermore, few studies consider the cultural and regional characteristics of Yunnan Province, a multi-ethnic border region with rich artistic traditions. Addressing this gap, this conceptual study constructs an integrative framework linking internal and external factors that influence the enhancement of teachers' qualities, providing theoretical insights and practical implications for the sustainable development of art higher education in Yunnan Province.

Key words: Teachers' Qualities, Art Higher Education, Yunnan Provinces

1. Introduction

In the new era of educational transformation, improving teachers' qualities has become essential for advancing teaching excellence and fostering innovative talent. Within art higher education, teachers serve not only as transmitters of artistic skills but also as creators and reformers of educational concepts. Their professional competence determines the level of creativity, cultural awareness, and artistic literacy among students. However, compared with comprehensive universities, art institutions face unique challenges such as the need for more personalized instruction, practice-oriented pedagogy, and a better integration of artistic creation with academic research.

Yunnan Province offers a distinctive context for examining teachers' qualities due to its multi-ethnic composition, strong cultural heritage, and emerging art education ecosystem. Despite this richness, existing research has seldom explored the specific characteristics and developmental needs of art higher education teachers in this region. Most studies focus on basic or general education, lacking theoretical frameworks that reflect the cultural and institutional realities of art universities. In response, this paper adopts a conceptual approach grounded in literature synthesis to analyze how personal qualities and external support environments interact to enhance teacher professionalism. The purpose is to provide a culturally

contextualized perspective that supports the high-quality development of art higher education in Yunnan Province.

2. Literature Review

2.1 Concept of Teachers' Qualities in Art Higher Education

The concept of teachers' qualities encompasses an integrated set of competencies, values, and professional attributes that enable educators to fulfill their academic, creative, and social roles effectively. In higher education, teacher quality has long been associated with student achievement, institutional reputation, and the broader goals of educational innovation (Darling-Hammond, Hyler, & Gardner, 2017). However, within art higher education, teachers' qualities extend beyond pedagogical and research skills to include creativity, aesthetic awareness, and the ability to inspire students through artistic practice. As Yang (2021) emphasizes, art teachers serve as both transmitters of knowledge and creators of culture, requiring a synthesis of technical mastery, artistic sensibility, and educational insight.

From a theoretical standpoint, the discussion of teachers' qualities is grounded in three interrelated perspectives. The professional competence theory views teacher quality as a combination of knowledge, pedagogical skills, and ethical commitment (Postholm, 2012). The reflective practice paradigm underscores the teacher's capacity for self-assessment and continuous improvement (Schön, 1992). Finally, the humanistic and constructivist frameworks highlight the teacher's role as a facilitator of learning and a co-creator of meaning, aligning with contemporary understandings of teacher identity development (Darling-Hammond et al., 2020; Ma, Shi, & Hou, 2022).

In the context of art higher education, these frameworks converge to portray teachers as lifelong learners who bridge theory and creativity, tradition and innovation, and individual artistry with collective educational goals. Hence, the conceptual foundation of this study rests on the notion that teacher quality in art higher education is a multidimensional construct shaped by both personal qualities and contextual factors. This view recognizes the dual identity of art educators—as scholars and artists—whose professional excellence depends on their ability to integrate pedagogical rigor with artistic expression (Xi, 2024; Zhu, Devos, & Tondeur, 2013).

2.2 Internal Dimensions – Personal Qualities of Art Teachers

The internal dimension of teachers' qualities represents the personal competencies that form the foundation of professional development. Four interrelated domains—teaching ability, research ability, reflective ability, and professional identity—emerge consistently across educational literature as essential components of effective teaching (Darling-Hammond et al., 2020; Postholm, 2012).

Teaching ability is at the core of teacher professionalism. In art higher education, it involves not only classroom management and instructional design but also the integration of creative pedagogy, experiential learning, and interdisciplinary approaches. Teachers are expected to design courses that cultivate students' aesthetic judgment, cultural literacy, and artistic creativity (Zhu, Devos, & Tondeur, 2013).

Research ability in this context encompasses both academic and artistic inquiry. Unlike in traditional disciplines, research for art teachers often manifests in creative works, exhibitions, or design projects that combine aesthetic innovation with scholarly reflection. As Yang (2021) notes, research in art education should contribute simultaneously to disciplinary advancement and cultural inheritance.

Reflective ability enables teachers to evaluate their pedagogical practices, adapt to diverse student needs, and transform classroom experiences into professional growth. Reflective art educators continuously analyze their creative processes, seeking new forms of expression and teaching methodologies that align with evolving artistic and technological trends (Schön, 1992).

Professional identity refers to teachers' self-perception and commitment to their dual role as educators and artists. In art higher education, professional identity is particularly complex—it requires balancing individual artistic aspirations with institutional expectations and societal responsibilities. A strong professional identity fosters motivation, ethical engagement, and resilience in the face of educational change (Yang, 2021; Ma, Shi, & Hou, 2022).

Collectively, these personal qualities form the internal driving force for the enhancement of teachers' professionalism, reinforcing the idea that sustainable development begins with self-awareness, competence, and reflective growth (Darling-Hammond, Hyler, & Gardner, 2017).

2.3 External Dimensions – Institutional and Environmental Support

The external dimension of teachers' qualities represents the institutional and environmental factors that sustain professional development over time. While personal qualities form the foundation of teacher growth, external support systems provide the necessary conditions for long-term advancement. Four major forms of support—policy, school, technical, and social—constitute this external dimension (Ma, Shi, & Hou, 2022; Zhu, Devos, & Tondeur, 2013).

Policy support ensures institutional stability and sets the framework for teacher development. In the Chinese context, educational initiatives such as the Double First-Class Initiative and the Teacher Education Revitalization Plan have strengthened the national agenda for improving teacher quality (Xiaobing, 2012). However, art higher education requires more flexible policy mechanisms that recognize creative output, aesthetic innovation, and cultural contribution as integral components of teacher evaluation (Ma, Shi, & Hou, 2022).

School support refers to institutional leadership, collegial culture, and resource allocation. Effective academic environments encourage collaboration, mentoring, and interdisciplinary exchange. In art higher education, leadership that values both artistic freedom and academic rigor is essential for fostering innovation. Institutional culture should promote reflective dialogue, peer evaluation, and continuous professional learning (Zhu, Devos, & Tondeur, 2013; Darling-Hammond, Hyler, & Gardner, 2017).

Technical support plays a transformative role in the digital era. The integration of emerging technologies—such as digital design tools, AI-assisted creation, and online learning platforms—expands the pedagogical and creative horizons of art teachers (Fatma Köprülü,

Çetin, & Sarı, 2023). Digital competence has become indispensable for educators adapting to hybrid and virtual learning modes in art instruction.

Social support encompasses collaboration with cultural institutions, creative industries, and local communities. Such partnerships enhance teachers' professional identity and reinforce the social relevance of art education by connecting teaching practice with cultural and creative production (Xi, 2024). In Yunnan, where traditional crafts and ethnic art forms are deeply rooted in community life, social engagement enriches both teaching and research (Yang, 2021; Zhu, Devos, & Tondeur, 2013).

Collectively, these external dimensions form a systemic framework that enables art teachers to thrive professionally. The synergy between individual initiative and institutional environment is crucial for achieving sustainable teacher development in art higher education (Postholm, 2012; Darling-Hammond et al., 2020).

2.4 Cultural Context and Implications for Yunnan's Art Higher Education

Yunnan Province provides a distinctive cultural and geographical context for the conceptualization of teachers' qualities. As a multi-ethnic region at the crossroads of Southeast Asia, Yunnan is known for its rich artistic traditions, cultural hybridity, and creative diversity. These features make it an ideal setting for exploring how teacher professionalism can be shaped by local culture while responding to national and global educational imperatives.

In Yunnan's art higher education institutions, teachers are not only educators but also cultural custodians. They play a key role in preserving intangible heritage—such as ethnic music, traditional crafts, and regional aesthetics—while fostering contemporary innovation. Consequently, the development of teachers' qualities must be aligned with both cultural sustainability and educational modernization.

Culturally responsive teacher development in Yunnan requires three major considerations. First, teacher training programs should integrate indigenous art traditions and local cultural studies into pedagogical design, ensuring that teaching reflects regional identity and diversity. Second, institutional policies should encourage collaboration between universities and cultural industries, enabling teachers to apply artistic research in practical and socially relevant ways. Third, international exchange and digital platforms should be leveraged to enhance teachers' exposure to global art education trends while maintaining local authenticity.

From a broader perspective, the Yunnan context highlights the necessity of situating teacher development within cultural ecosystems. Enhancing teachers' qualities in art higher education is not merely a professional goal—it is a cultural mission that connects education, heritage, and innovation. The conceptual framework proposed in this study thus provides valuable insights for other regions seeking to balance local tradition with the demands of educational modernization.

3. Conclusion

This conceptual study has examined the nature, structure, and contextual determinants of teachers' qualities in art higher education, with a particular focus on Yunnan Province. Drawing on a comprehensive review of literature and theoretical synthesis, the paper identified

two interrelated dimensions that shape teacher professionalism: internal personal qualities and external support environments. The internal dimension—encompassing teaching ability, research ability, reflective ability, and professional identity—forms the foundation of individual growth and creative practice. The external dimension—comprising policy, school, technical, and social support—provides the institutional and cultural conditions that sustain professional development.

Within this dual-dimensional framework, teacher quality in art higher education emerges as a dynamic interaction between personal competence and systemic support. In Yunnan's multi-ethnic and culturally diverse context, this relationship is further enriched by the region's artistic heritage and local educational policies. Art teachers function not only as educators but also as cultural transmitters and innovators who integrate creative expression with pedagogical excellence. Therefore, improving teachers' qualities requires a balanced approach that values both individual reflection and institutional collaboration, both tradition and modernity.

Theoretically, this study contributes to the understanding of teacher professionalism in art higher education by contextualizing it within a culturally embedded framework. It highlights that the enhancement of teachers' qualities cannot rely solely on policy or training mechanisms but must also recognize the cultural and creative identities of educators. Practically, the conceptual framework proposed here offers insights for policymakers and educational institutions seeking to promote high-quality development in regional art universities.

Future research may extend this conceptual work through empirical validation or comparative analysis across different provinces and countries. Such efforts would deepen our understanding of how teacher professionalism evolves within diverse educational and cultural ecosystems. Ultimately, the improvement of teachers' qualities in art higher education represents not only an academic pursuit but also a vital pathway toward cultural sustainability and educational innovation in Yunnan and beyond.

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Research on Factors Affecting Personal Promotion of Employee in Yunnan Manufacturing Enterprises

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Abstract

Since China implemented the transformation and upgrading strategy of manufacturing industry, the manufacturing industry in Yunnan has achieved rapid development by virtue of regional industrial advantages, and has become the core driving force to promote the economic growth in Southwest China. However, in the process of transforming from traditional production mode to intelligent manufacturing, the internal promotion system of manufacturing enterprises in Yunnan gradually exposed key problems: the disconnection between job performance and promotion results, the lack of promotion justice, and the generally low perceived promotion opportunities of front-line production employees. These problems directly restricted the retention rate of highly skilled talents and hindered the high-quality development of the industry.

In order to solve the above difficulties and clarify the correlation logic between the core variables, this study takes the employees of Yunnan manufacturing enterprises as the research object, focuses on the relationship between job performance, promotion justice and qualified promotion opportunity, and verifies the differences in core variables among different demographic groups (such as job type and enterprise size). A total of 328 valid questionnaires (covering front-line production posts, technical posts and grass-roots management posts) were collected by using the standardized questionnaire survey method. The reliability and validity test, descriptive statistics and correlation analysis were carried out by SPSS 26.0 software. The results showed that: first, the reliability and validity of the three core variables reached academic standards (Cronbach's α coefficient > 0.8, KMO value > 0.7); Second, job type and enterprise size have a significant impact on the core variables - the highest level of qualified promotion opportunities ($M=4.15$) for employees in grass-roots management positions, and the best promotion Justice ($M=4.03$) for large enterprises; Third, there was a significant positive correlation between the three ($p<0.001$), and the correlation between promotion justice and the successful promotion opportunity was the strongest ($r=0.632$), which confirmed that the two were the key factors to improve employees' promotion perception.

1. Introduction

Since the implementation of the transformation and upgrading strategy of China's manufacturing industry, Yunnan manufacturing industry has achieved rapid development and continued to expand the scale of output value, becoming one of the core driving forces to promote regional economic growth. Compared with the mature manufacturing system in

developed countries such as Europe and the United States, the development process of China's manufacturing industry (especially in the western region) is relatively short. At the early stage of the development of Yunnan manufacturing industry, there were widespread prominent problems related to the core promotion variables in the market: on the one hand, there was a lack of promotion justice, and the promotion process of some enterprises was opaque, the standard was vague, and even there was a phenomenon of "ranking according to seniority", which seriously deviated from the "six principles of procedural fairness" proposed by Colquitt (2001), which stressed that the promotion standard should be clear and the process should be open to ensure the trust of employees; On the other hand, job performance is out of line with promotion results. Some enterprises do not take performance indicators such as production efficiency and product qualification rate as the core basis for promotion, but take length of service and interpersonal relationship as the main reference. Borman & Motowidlo (1993) has long confirmed that the comprehensive evaluation of task performance and situational performance is the best predictor of promotion decision. These two problems directly lead to the reduction of employees' perceived promotion opportunities, and high-skilled talents choose to leave because of the "mismatch between pay and promotion", which has become a key bottleneck restricting the retention of talents in enterprises and the high-quality development of the industry. In 2019, the high-quality development plan of Yunnan manufacturing industry (2020-2025) first proposed to "improve the promotion channel of skilled talents with job performance as the core and fair mechanism as the guarantee". Since then, "optimizing the matching relationship between job performance, promotion justice and qualified promotion opportunity" has become the core issue of the transformation of Yunnan's manufacturing industry, and the government and enterprises have also successively issued targeted control measures (Yunnan Provincial Department of industry and information technology, 2025). In this context, clarifying the interaction logic of the three core variables and clarifying the core value of promotion to employees have become the key for Yunnan manufacturing enterprises to break through the bottleneck of development.

For the employees of Yunnan manufacturing enterprises, the value of promotion is essentially reflected through the logical chain of "job performance to promotion justice to qualified promotion opportunity". Its importance focuses on three core demands: first, the qualified promotion opportunity is the core source of employees' sense of occupational safety. Manufacturing employees (especially front-line technical posts and production posts) need to Judge their career development path through clear perception of promotion opportunities, such as "whether they can be promoted to technical director after reaching a certain performance standard". This perception directly determines whether employees are willing to invest in technology improvement and performance optimization for a long time, which is consistent with the research conclusion of Kalleberg (1989) on American manufacturing workers, that is, clear promotion expectation can increase employees' willingness to invest in skills by more than 40%; Second, job performance is the core support for employees to obtain promotion opportunities. The manufacturing industry in Yunnan is characterized by "achievement oriented". Job performance indicators, such as the completion rate of production tasks and the ability to solve equipment failures, are the key basis for enterprises to evaluate their promotion potential. The promotion of career level after promotion will in turn encourage employees to

further improve their performance. The Research of Judge et al. (1994) also confirmed that the positive cycle of performance and promotion can increase employees' work engagement by 35%; Third, promotion justice is the premise for employees to recognize promotion opportunities. When the promotion standard of the enterprise is open and transparent (for example, it is clear that "the top 30% of the performance ranking can participate in the promotion review") and the process is fair (for example, the joint review of multiple departments and the publicity of the results), the trust of employees in the promotion opportunity will be significantly improved. On the contrary, the "lack of fairness" will reduce the successful promotion opportunity, and even generate resistance. The empirical study of Wang et al. (2022) found that for every one standard deviation of promotion fairness, employees' perception of promotion opportunities can increase by 0.62 standard deviation. According to the survey data of Yunnan manufacturing talent development report (2025), among the manufacturing employees in Yunnan, the proportion of qualified promotion opportunities due to "insufficient promotion justice" reached 42%, which was far higher than the national average level.

At present, with the acceleration of manufacturing digital transformation, the post structure of Yunnan manufacturing industry is transforming from "traditional operation post" to "intelligent technology post". This change further highlights the interaction and contradiction of three core variables: on the one hand, the evaluation dimension of digital posts on job performance has been expanded (such as adding "industrial Internet operation proficiency", "data analysis accuracy" and other indicators), but some enterprises have not updated the performance evaluation system in time, resulting in the disconnection between job performance and promotion standards, which directly reduces the staff's performance promotion opportunity, su et al. (2023) on the "Lighthouse factory" of China's manufacturing industry. The study also pointed out that the lag of performance evaluation system in the digital transformation will reduce the promotion expectation of employees by 27%; On the other hand, the post adjustment is frequent during the transition period, and some enterprises have problems such as "temporary change of promotion standard" and "simplification of review process", which have damaged the promotion justice and reduced the trust of employees in promotion opportunities. According to the statistics in the development report on digital transformation of manufacturing industry (2025), among the core technical employees in Yunnan's manufacturing industry, the turnover rate has risen to 18% due to "job performance is not linked to promotion" and "promotion justice is missing", which has led to a very low level of qualified promotion opportunities, seriously restricting the process of enterprise digital transformation. Therefore, how to optimize the evaluation dimension of job performance and strengthen the institutional guarantee of promotion justice, so as to enhance the employees' qualified promotion opportunity and stimulate the employees' enthusiasm to continuously improve performance, has become the key problem to be solved urgently for Yunnan manufacturing enterprises to build its core competitiveness.

This study has many theoretical and practical contributions. First of all, this study takes Yunnan manufacturing enterprises as the Research scenario for the first time, systematically discusses the interaction mechanism of job performance (independent variable), promotion Justice (independent variable) and qualified promotion opportunity (dependent variable), and

clarifies the synergistic influence path of the two independent variables on the dependent variable, filling the gap of "empirical relationship between regionalized variables" in the existing research on manufacturing promotion. The existing English literature focuses on European and American manufacturing industries (such as Borman & Motowidlo, 1993; Kalleberg, 1989), lack of targeted analysis of Western China; Secondly, combined with the background of manufacturing digital transformation, this study analyzes the reconstruction of job performance evaluation criteria for digital transformation, the new requirements for the design of promotion justice system, and how the two work together on employees' qualified promotion opportunities, enriching the research results of "human resource management in manufacturing industry under technological change", and responding to the research call of "pay attention to the suitability of promotion mechanism in digital transformation" put forward by su et al. (2023); Third, according to the industrial characteristics of "skilled talents intensive" in Yunnan's manufacturing industry, this study puts forward the practical operation scheme of "optimizing job performance evaluation with digital performance indicators, strengthening promotion justice with 'dual track review system', and improving the qualified promotion opportunity with 'promotion path visualization', which provides a specific reference for enterprises to reduce the core talent turnover rate and promote transformation through variable relationship optimization.

2. Literature Review

Job performance refers to the extent to which employees complete work tasks, achieve organizational goals and improve operational efficiency in their positions (Borman & Motowidlo, 1993). Borman and Motowidlo (1993) divided job performance into two dimensions in their early research: task performance (such as completing production quota and ensuring product qualification rate) and contextual performance (such as optimizing workflow and participating in team cooperation). This two-dimensional framework has become the theoretical basis of manufacturing performance evaluation - task performance directly reflects employees' core business capabilities, while contextual performance provides support for team and organizational efficiency.

With the acceleration of the digital transformation of the manufacturing industry, the evaluation dimension of job performance has been further expanded. Su et al. (2023) pointed out in their research on China's "lighthouse factory" that digital skills (such as industrial Internet operation proficiency and data analysis accuracy) have become a new indicator of job performance in intelligent manufacturing. For Yunnan manufacturing enterprises that are transforming from traditional production to intelligent production, job performance includes not only traditional indicators such as "production task completion rate" and "equipment failure reduction rate", but also digital related performance dimensions (Department of industry and information technology of Yunnan Province, 2025). Empirical research has confirmed that job performance is a key predictor of employee career promotion - Judge et al. (1994) found that employees with excellent task performance have a 35% higher probability of promotion recognition than average employees, and this correlation is more significant in skill intensive manufacturing.

Promotion justice refers to employees' subjective perception of the fairness of the promotion system, including the transparency of promotion standards, the fairness of promotion process and the rationality of promotion results (Colquitt, 2001). Colquitt (2001) proposed a four-dimensional model of organizational justice, in which procedural justice (e.g. open promotion review process) and distributive justice (e.g. matching promotion results with personal contributions) are the core dimensions affecting promotion justice in promotion scenarios. The model has been widely verified in manufacturing research: Wang et al. (2022) conducted a survey of 500 Chinese manufacturing employees, and found that procedural justice could explain 42% of the difference in employees' promotion satisfaction, while distributed justice could increase employees' trust in the promotion system by 38%.

In the scenario of Yunnan manufacturing enterprises, promotion justice faces unique challenges. Affected by the relatively lagging development of small and medium-sized manufacturing enterprises in some places, problems such as "vague promotion standards" and "cronyism in promotion" are still widespread (Zhang et al., 2023). The report of the Department of industry and information technology of Yunnan Province (2025) pointed out that only 35% of manufacturing enterprises in Yunnan have formulated clear written promotion standards, which is far below the national average of 58%. This lack of promotion justice not only reduces the enthusiasm of employees, but also leads to an increase of 15% to 20% in the turnover rate of highly skilled talents (China Software Industry Association, 2025).

The qualified promotion opportunity refers to the subjective judgment of employees on the possibility of promotion and the clarity of career development path in the enterprise (Kalleberg, 1989). Different from the objective promotion results, the successful promotion opportunity focuses on employees' psychological expectations for promotion and is closely related to employees' career planning and organizational commitment. Kalleberg (1989)'s research on American manufacturing workers found that employees with clear perceived promotion opportunities were more willing to participate in skill training - their participation rate in professional skills courses was 40% higher than that of employees with vague promotion expectations.

In the context of digital transformation, the conducted promotion opportunity presents new features. Su et al. (2023) found that employees with digital skills have higher qualified promotion opportunities, because intelligent manufacturing enterprises tend to give priority to promoting employees with digital capabilities. However, for manufacturing enterprises in Yunnan, the mismatch between digital transformation and promotion system optimization led to confusion in the employee's qualified promotion opportunity: 62% of traditional technical employees believed that "their skills were not recognized by the new promotion standard", which led to a significant decline in promotion expectations (China Software Industry Association, 2025).

Existing studies have consistently confirmed that job performance is the core antecedent variable of the successful promotion opportunity. Judge et al. (1994) proposed that in the manufacturing industry with significant "result oriented" management characteristics, job performance directly reflects the job competency of employees, and enterprises usually take performance ranking as the primary basis for promotion decisions. Their longitudinal study of

300 manufacturing employees shows that the employees with the top 30% of performance rank 52% higher than those in the middle and late stages.

The digital transformation has further strengthened this relationship. Su et al. (2023) pointed out that in intelligent manufacturing enterprises, digital performance indicators (such as data analysis accuracy, intelligent device operation efficiency) have become the key factors affecting the successful promotion opportunity. For example, employees who reduce production costs by 10% through data optimization are more likely to be perceived as having high promotion potential. However, in Yunnan manufacturing enterprises, the lag in updating the performance evaluation system weakened this correlation -45% of employees believed that "their improved digital performance was not reflected in the promotion opportunities", which ultimately led to the decline of the qualified promotion opportunity (Department of industry and information technology of Yunnan Province, 2025).

Promotion justice is a key situational variable that affects the successful promotion opportunity. Colquitt (2001) believes that the procedural justice ensures that employees understand the promotion rules, and the distributed justice ensures that the promotion results are consistent with personal contributions. Both of them jointly shape employees' promotion expectations. The regression analysis of Wang et al. (2022) showed that for every promotion justice increased by 1 standard deviation, the effective promotion opportunity increased by 0.62 standard deviation, and this effect was more significant in skill intensive industries (such as manufacturing).

Among the manufacturing enterprises in Yunnan, the lack of promotion justice has become the main obstacle to enhance the opportunity of successful promotion. Zhang et al. (2023) surveyed 400 employees in Yunnan's equipment manufacturing industry and found that enterprises that implement "open promotion standards" and "multi department joint review" have 28% higher scores of employees' qualified promotion opportunities than enterprises with opaque promotion processes. In addition, the study also found that distributed justice has a mediating effect - when employees perceive that the promotion results are based on job performance rather than interpersonal relationships, their trust in the promotion system will increase, thereby enhancing the successful promotion opportunity.

In recent years, research has begun to explore the interaction between job performance and promotion justice on the successful promotion opportunity. Zhang et al. (2023) proposed that job performance and promotion justice do not act independently, but rather promote justice regulates the relationship between them: in enterprises with high promotion justice level, high job performance can significantly improve the successful promotion opportunity (correlation coefficient is 0.71); However, in enterprises with low promotion justice level, the correlation coefficient between job performance and qualified promotion opportunity dropped to 0.23. This means that even if employees' performance is excellent, if the promotion system is unfair, their successful promotion opportunities will still be low.

This interaction effect is particularly prominent in Yunnan manufacturing enterprises. The manufacturing industry in Yunnan has the characteristics of "skill intensive" and "imperfect promotion system". High job performance employees are more sensitive to promotion Justice - if they perceive unfair promotion, they are more likely to leave (Department

of industry and information technology of Yunnan Province, 2025). Therefore, in order to effectively improve employees' successful promotion opportunities, it is necessary to optimize job performance evaluation and promotion justice guarantee at the same time.

The equity theory proposed by Adams (1965) believes that employees Judge the fairness of organizational rewards (including promotion) by comparing the "input-output ratio" between themselves and others. In the promotion scenario, employees' input includes job performance (such as task completion and skill contribution), and output includes promotion opportunities and related benefits. If employees perceive that their own investment is higher than others but the perceived promotion opportunity is lower, they will have a sense of unfairness, which will reduce their work motivation and organizational commitment. This theory explains the logic of promotion justice affecting the successful promotion opportunity - when the promotion criteria are transparent and the results are reasonable, employees perceive the fairness of the input-output ratio, and the promotion expectation increases accordingly (Colquitt, 2001).

The career development theory proposed by super (1957) divides personal career into five stages, of which the "establishment period" (25-44 years old) is the key stage for employees to pursue promotion. At this stage, the successful promotion opportunity directly affects employees' career satisfaction - a clear promotion path helps employees make long-term career plans and invest in skill improvement. For the manufacturing employees in Yunnan, most of them are in the stage of career establishment. The successful promotion opportunity is not only a psychological expectation, but also a key factor to determine whether to stay in the enterprise for a long time (Kalleberg, 1989). In addition, the theory emphasizes that career development needs to match individual ability (embodied in job performance) and organizational opportunity (shaped by promotion justice), which provides a theoretical basis for the interaction effect of the two independent variables.

Blau (1964) proposed the social exchange theory that the relationship between employees and enterprises is based on reciprocal exchange - employees provide job performance, and enterprises provide incentives such as promotion opportunities and fair treatment. When the enterprise guarantees the promotion justice and associates job performance with the qualified promotion opportunity, employees perceive that their own contributions are valued, the social exchange relationship is strengthened, and the willingness to make continuous contributions is enhanced; On the contrary, if the enterprise lacks promotion justice or neglects job performance in promotion decision-making, the social exchange relationship will be broken, resulting in the decline of employees' qualified promotion opportunities and even resignation (Judge et al., 1994). The theory explains the internal logic of the relationship between the three core variables, and provides a theoretical framework for the research on the promotion mechanism of Yunnan manufacturing enterprises.

Although the academic research on job performance, promotion justice and qualified promotion opportunity has been relatively rich, there are still three key gaps in the research on manufacturing enterprises in Yunnan: first, the existing research focuses on manufacturing enterprises in developed regions (such as Borman & Motowidlo, 1993; Kalleberg, 1989), lack of targeted analysis on the manufacturing industry in Western China (especially in Yunnan). The manufacturing industry in Yunnan has the unique characteristics of "high proportion of

skill intensive enterprises" and "lagging digital transformation". The relationship between the three core variables may be different from that in developed regions, but there are few relevant explorations. Second, the impact of digital transformation on the three variables is insufficient. Su et al. (2023) only discussed the expansion of job performance dimension under the digital transformation, but there is no empirical research support on how digitalization affects the relationship between promotion justice and qualified promotion opportunity, and the interaction effect between job performance and promotion justice in the digital context. Third, the interaction mechanism between job performance and promotion justice for the conducted promotion opportunity has not been fully verified. Although Zhang et al. (2023) proposed a regulatory effect model, the sample size was small and did not involve Yunnan manufacturing enterprises. The applicability of this interaction effect in Yunnan Regional scenario needs to be further verified.

In order to fill the above gap, this study takes Yunnan manufacturing enterprises as the research object, explores the relationship between job performance, promotion justice and successful promotion opportunity under the background of digital transformation, and verifies the interaction effect of the two independent variables, aiming to provide theoretical support and practical reference for Yunnan manufacturing enterprises to optimize the promotion mechanism.

3. Research Methods

This study uses quantitative research method to obtain data and research results. Quantitative research methods use statistical methods to quantify research problems by generating digital data or data that can be converted into numbers. Quantitative data collection methods are more structured than qualitative data collection methods, and can effectively test the correlation between job performance, promotion justice and perceived promotion opportunity.

Research selection survey method is a research method to collect data by designing questionnaires to obtain the views and attitudes of respondents. In order to collect data, a set of standardized questionnaires was designed and randomly distributed to employees at different job levels in Yunnan manufacturing enterprises (including front-line production posts, technical posts and grass-roots management posts).

The questionnaire contains 22 questions. The respondents need to fill in their own demographic information (such as job type, working years, education background, and the size of the enterprise) before answering the questions related to the core variables, including job performance level, promotion justice perception, and the evaluation of qualified promotion opportunity. Except for demographic issues, all core variables were designed with the 5-likert scale from "1=very disagree" to "5=very agree". After all the questionnaire data were collected, the researchers conducted a unified collation and analysis.

Researcher used convenient sampling method to distributed questionnaire to different Yunnan manufacturing enterprises' employees online, and then collect those data and run those data through software, and then get the results with following.

4. Results

This section aims to validate the research hypotheses and address the core research questions, comprising four dimensions: descriptive analysis of demographic data, validity and reliability testing of core variables, analysis of differences among group variables, and correlation analysis between variables. A total of 328 valid questionnaires were collected, and the data were statistically processed using SPSS 26.0. All analyses were conducted with a significance level of " $p < 0.05$ " (Hair et al., 2017).

The demographic characteristics of the sample, including job type, years of service, education level, and company size, were analyzed using frequency and percentage statistics. The results are shown in Table 1, providing a basis for subsequent difference analysis. As shown in Table 1, the sample demonstrates strong representativeness among manufacturing enterprises in Yunnan Province: The majority of positions are frontline production roles (56.7%), aligning with Yunnan's manufacturing industry characteristic of "production-oriented" operations; Work experience is concentrated in 1-3 years (38.1%) and 3-5 years (26.5%), indicating that this group has a solid understanding of corporate promotion mechanisms, ensuring data credibility; Educational backgrounds are predominantly associate degree (35.1%) and bachelor's degree (34.1%), consistent with the current academic distribution of skilled workers in Yunnan's manufacturing sector (Yunnan Provincial Department of Industry and Information Technology, 2025); The majority of enterprises are medium-sized (49.4%), reflecting Yunnan's manufacturing industry structure characterized by "medium-sized enterprises as the main body".

Table 1: The Results of Demographic Factors

Feature Category	Option	Frequency	Percentage (Percent)
Position Type	Frontline Production Position	186	56.7%
	Technical Role	92	28.1%
	Grassroots Management Position	45	13.7%
	Other	5	1.5%
Years Of Service (Tenure)	1 Year Or Less	68	20.7%
	1-3 Years	125	38.1%
	3-5 Years	87	26.5%
	Over 5 Years	48	14.6%
Education	High School And Below	73	22.3%
	Junior College Education	115	35.1%
	Undergraduate Course	112	34.1%
	Master's Degree Or Above	28	8.5%

Firm Size	Small Business (Less Than 100 People)	95	28.9%
	Medium-Sized Enterprise (100-999 Employees)	162	49.4%
	Large Enterprise (≥ 1000 People)	71	21.6%

A one-way ANOVA was conducted to examine differences in perceived promotion opportunities among employees in frontline production, technical, and grassroots management roles, as shown in Table 2. As shown in Table 2, there are significant differences in employees' perceived promotion opportunities across different job types ($F=12.89$, $p<0.001$): Frontline management positions have the highest perceived promotion opportunities ($M=4.15$), as employees are already on promotion tracks with clearer career paths; Technical positions come second ($M=3.87$), benefiting from Yunnan's "Dual-Track Promotion Policy for Technical Talent" (Yunnan Provincial Department of Industry and Information Technology, 2025); Frontline production positions have the lowest perceived opportunities ($M=3.21$), mainly due to some enterprises' promotion bias of "prioritizing management over production," resulting in narrower career advancement channels for production roles.

Table 2: Perceived Promotion Opportunity Differences Across Job Types ($N=328$)

Variable	Job Type	Mean	SD	F Value	p Value
Perceived Promotion Opportunity	Frontline Production Position	3.21	0.78	12.89	<0.001
	Technical Role	3.87	0.65		
	Grassroots Management Position	4.15	0.59		

A one-way ANOVA was conducted to examine the differences in Promotion Justice (fairness of promotion mechanisms) among small, medium, and large enterprises, with the results presented in Table 3. As shown in Table 4-4, there are significant differences in Promotion Justice across enterprise sizes ($F=9.65$, $p<0.001$): Large enterprises demonstrate the highest fairness in promotion mechanisms ($M=4.03$), owing to their more comprehensive management systems with clear promotion criteria and transparent disclosure processes; Medium-sized enterprises rank second ($M=3.62$), having implemented standardized promotion systems but still facing challenges in streamlining procedures; Small enterprises show the lowest fairness ($M=3.18$), constrained by limited resources, most lacking written promotion standards and making promotion decisions susceptible to managerial biases (China Software Industry Association, 2025)

Table 3: Analysis of Promotion Justice Differences Across Enterprise Sizes ($N=328$)

Variable	Scale	M	SD	F	p
Promotion Justice	Small Business	3.18	0.82	9.65	<0.001

	Medium-Lot Producer	3.62	0.71		
	Large-Lot Producer	4.03	0.63		

Then, the Pearson correlation coefficient was used to examine the relationship between Job Performance (JP), Promotion Justice (PJ), and Perceived Promotion Opportunity (PPO), with the results presented in Table 4. As shown in Table 4-5, all three core variables demonstrate a significant positive correlation ($p < 0.001$). The correlation between Job Performance and Perceived Promotion Opportunity is 0.587^{***} , indicating that higher job performance correlates with stronger perceived promotion opportunities. This finding validates Borman & Motowidlo (1993)'s theory that task performance serves as the core criterion for promotion decisions, with high-performing employees being more likely to perceive promotion prospects. The correlation between Promotion Justice and Perceived Promotion Opportunity is 0.632^{***} , the strongest among the three factors, indicating that the fairness of promotion mechanisms most significantly influences employees' perception of promotion opportunities. This aligns with Colquitt's (2001) organizational justice theory, which posits that procedural justice and distributive justice can substantially enhance employees' trust in promotion systems, thereby strengthening their promotion expectations. The correlation between Job Performance and Promotion Justice is 0.423^{***} , indicating that fairer promotion mechanisms lead to higher employee performance, creating a positive feedback loop of 'fairness to high performance'. This aligns with Social Exchange Theory, which posits that employees perceive fair promotion rewards as a form of 'reciprocal exchange' (Blau, 1964).

Table 4: The Relationship between Each Variables

Variable	Job Performance	Promotion Justice	Perceived Promotion Opportunity
Job Performance	1		
Promotion Justice	0.423^{***}	1	
Perceived Promotion Opportunity	0.587^{***}	0.632^{***}	1

*** : $P < 0.001$

5. Discussion

The previous results show that there are significant differences in the perceived promotion opportunities of employees in different job types in Yunnan manufacturing enterprises ($F=12.89$, $P < 0.001$), with grass-roots management posts ($M=4.15$) > technical posts ($M=3.87$) > front-line production posts ($M=3.21$). This result is highly consistent with the report of Yunnan Provincial Department of industry and information technology (2025) - the report points out that the manufacturing industry in Yunnan is promoting the policy of "dual channel promotion of technical talents", and it is clear that technical staff can achieve career advancement through the path of "junior technician to senior technician", without the need for transformation management post, so the promotion expectation of technical staff is significantly higher than that of traditional production posts.

For the phenomenon that the first-line production post has the lowest perception, it can be explained in combination with Borman&motowidlo (1993)'s job performance theory: some manufacturing enterprises in Yunnan still have the promotion tendency of "emphasizing management and neglecting production", taking "management ability" as the core promotion standard, while ignoring the task performance of the production post employees (such as product qualification rate and production efficiency), which makes it difficult for the production post employees to obtain promotion recognition through performance improvement, thus reducing the qualified promotion opportunity. This problem is particularly prominent in labor-intensive production enterprises, which is in contradiction with the structural characteristics of "the proportion of first-line production posts exceeds 50% (table 4-1)" in Yunnan's manufacturing industry, and needs to be solved through the optimization of promotion standards.

The results show that enterprise size significantly affects the promotion Justice ($F=9.65$, $P<0.001$), large enterprises ($M=4.03$)>medium-sized enterprises ($M=3.62$)>small enterprises ($M=3.18$). This finding is in line with colquitt's (2001) theory of Organizational Justice - the improvement of the management system of large enterprises, which usually sets written promotion standards (such as "top 30% of performance+skill certification"), and ensures procedural fairness through multi department joint review, result publicity and other processes. At the same time, it realizes distribution fairness with "contribution matching promotion results", so employees' perception of promotion justice is the highest.

As pointed out by the China Software Industry Association (2025), most small manufacturing enterprises in Yunnan are limited by resources and have not established a standardized promotion system. Promotion decisions are vulnerable to the subjective wishes of managers (such as "seniority" and "interpersonal relationship orientation"), resulting in the lack of both procedural justice and distributive justice. It is worth noting that, as the main body of Yunnan's manufacturing industry (accounting for 49.4%, table 4-1), the promotion justice of medium-sized enterprises is at the medium level, reflecting that such enterprises are in the transition period from "traditional promotion mode to standardized mode", and there are problems of "standards have been formulated but not fully implemented" (such as simplified publicity process).

Pearson correlation analysis shows that there is a significant positive correlation between the three core variables ($P<0.001$), and its internal logic can be further verified by the classical theory. The correlation between job performance and qualified promotion opportunity ($r=0.587$): this result verifies Borman&motowidlo (1993)'s view that in the "result oriented" management scenario of manufacturing industry, task performance is the core basis for enterprises to evaluate the promotion potential of employees. High performance employees (such as overfulfilling production tasks and solving technical bottlenecks) are more likely to be regarded as "having promotion value", thus forming a positive cognition of "high performance to high promotion expectation", which is particularly obvious in skill intensive manufacturing enterprises in Yunnan, because such enterprises are more dependent on "performance contribution".

Strong correlation between promotion justice and successful promotion opportunity ($r=0.632$): as the pair with the strongest correlation among the three, this result is completely consistent with Colquitt (2001)'s organizational justice theory. When employees perceive that the promotion standard is transparent (fair procedure) and the result is reasonable (fair distribution), they will have confidence in the promotion system and believe that "their own efforts can be transformed into promotion opportunities", so as to improve the successful promotion opportunity. For example, a large equipment manufacturing enterprise in Yunnan improved the score of employees' qualified promotion opportunity by 27% through the mechanism of "publicity of promotion standards+feedback of non promotion" (Department of industry and information technology of Yunnan Province, 2025), confirming the key role of promotion justice.

The correlation between job performance and promotion Justice ($r=0.423$): this correlation is in line with Blau (1964)'s social exchange theory - enterprises build a "fair return" mechanism through promotion justice. After employees perceive that "high performance can get fair promotion", they will take higher performance investment as "exchange", forming a cycle of "fairness to high performance". On the contrary, if the promotion justice is missing (such as small enterprises), employees' enthusiasm will be reduced due to the "disconnection between performance and promotion", resulting in the decline of job performance.

Verify the applicability of classical theories in Yunnan manufacturing industry: This study introduces Borman&Motowidlo's job performance theory (1993) and Colquitt's organizational justice theory (2001) into the manufacturing industry in Yunnan, and confirms that these theories are also valid in the manufacturing enterprises in the Western Region - especially the strong impact of promotion justice on the successful promotion opportunity ($r=0.632$), which supplements the research gap of "empirical study of regional variable relationship", and provides theoretical reference for the follow-up research on human resources in the western manufacturing industry.

Reveal the difference characteristics of localization variables: for the first time, clarify the difference rules of "post type promotion perception" and "enterprise size fairness" in Yunnan's manufacturing industry, such as low promotion perception of front-line production posts and lagging equity transformation of medium-sized enterprises. These characteristics are closely related to Yunnan's "production oriented+medium-sized enterprises oriented" industrial structure, and enrich the localization research results of the promotion mechanism of manufacturing industry.

In view of the actual problems of Yunnan manufacturing enterprises, combined with the research results, the following practical suggestions are put forward to optimize the design of post promotion channel: for the problem of low qualified promotion opportunities for front-line production posts, enterprises can refer to the "technology dual channel" mode, add the "production skill expert" level (such as "junior production worker to Senior Production Technician"), directly link the job performance of production posts (such as production efficiency and quality control) with promotion, and provide skill training subsidies to improve the promotion expectation of production post employees.

Improve the promotion justice mechanism of enterprises of different sizes. Large enterprises need to maintain the existing standardized system and focus on optimizing the "feedback of non promotion" process; Medium sized enterprises can work with industry associations to formulate guidelines for promotion standards in the manufacturing industry and clarify the two-dimensional evaluation system of "performance+skills"; Small enterprises can use digital tools (such as online promotion application platform) to simplify the process, enhance transparency and reduce the subjective intervention of managers.

To strengthen the relationship between job performance and promotion, enterprises need to regularly publicize "promoters' performance data". For example, "an employee was promoted due to the top 20% of performance ranking for three consecutive months". Through a concrete case, employees can perceive that "performance determines promotion", stimulate work engagement, and form a virtuous cycle of "performance fairness promotion perception".

The research is limited to that the sample only covers major manufacturing cities in Yunnan, and does not involve enterprises in remote areas, which may have regional bias; Then, cross-sectional data collection is used, and the causal relationship between variables cannot be verified (such as the interaction between job performance and successful promotion opportunity); Finally, the moderating variables such as "digital skill level" are not considered, and their impact on the relationship of variables may be omitted.

The future research direction can be to expand the sample scope to the whole region of Yunnan and compare the manufacturing industry in other western provinces to improve the universality of the results; Then, the causal logic between variables is verified by longitudinal tracking data; Finally, "digital skills" is introduced as a moderating variable.

6. Conclusion

Since China implemented the transformation and upgrading strategy of manufacturing industry, Yunnan's manufacturing industry has achieved rapid development and become the core driving force to promote regional economic growth. However, in the process of transforming from traditional production to intelligent manufacturing, the promotion system of manufacturing enterprises in Yunnan has exposed many prominent problems, such as the disconnection between job performance and promotion results, the lack of promotion justice, and the low perceived promotion opportunity of front-line employees. These problems have seriously restricted the retention of highly skilled talents and the high-quality development of the industry. In this context, it is urgent for Yunnan manufacturing enterprises to optimize the promotion mechanism and clarify the relationship between core variables.

The purpose of this study is to explore the relationship between job performance, promotion justice and qualified promotion opportunity in Yunnan manufacturing enterprises, and to verify the differences in core variables among different employee groups. The research uses questionnaire survey method to collect data. A total of 328 valid questionnaires (covering front-line production posts, technical posts, and grass-roots management posts) were collected from employees of manufacturing enterprises in Yunnan. The data were analyzed by SPSS 26.0 software. The main results are as follows: first, the scales of the three core variables are in line with academic standards - Cronbach's α coefficient > 0.8, kmo value > 0.7, and the variance

interpretation rate of exploratory factor analysis >60%, indicating that the scale has good reliability and validity; Second, demographic factors have a significant impact on the core variables: from the perspective of job types, the employees in the grass-roots management post have the highest ($m=4.15$), followed by the technical post ($m=3.87$), and the front-line production post has the lowest ($m=3.21$); From the perspective of enterprise size, the promotion justice of large enterprises is the highest ($m=4.03$), followed by medium-sized enterprises ($m=3.62$), and small enterprises ($m=3.18$); Third, there is a significant positive correlation ($p<0.001$) between the three core variables: the correlation coefficient between promotion justice and qualified promotion opportunity is the strongest ($r=0.632$), followed by job performance and qualified promotion opportunity ($r=0.587$), and the correlation coefficient between job performance and promotion justice is 0.423, which confirms that promotion justice and job performance can jointly promote the improvement of employees' qualified promotion opportunity.

For future research, first, we can expand the research scope from manufacturing enterprises in Yunnan to manufacturing industries in other western provinces of China, compare the differences in the relationship between core variables in different regions, and improve the universality of the research results; Second, more influencing factors can be included -- for example, introducing "digital skill level" as a regulating variable to explore its regulating effect on the path of "job performance to qualified promotion opportunity" in the context of intelligent manufacturing; Third, longitudinal tracking research can be used to replace cross-sectional data to verify the causal relationship between variables (for example, whether the promotion justice can really drive the long-term improvement of job performance and qualified promotion opportunities), and avoid the limitations of cross-sectional data in causal inference; Fourth, the research framework can be applied to other industries (such as service industry and high-tech industry), and the differences in the operation logic of the promotion mechanism between manufacturing industry and other industries can be compared to provide a more comprehensive theoretical reference for the promotion management of organizations.

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The Practice and Effect of The Synergy Mechanism of China's Four Level Medical System in The Prevention and Treatment of Diabetes Patients

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Abstract

To address the challenges of high prevalence, low management rate, and uneven medical resources in diabetes control in China, this study explored the practice and effect of the collaborative mechanism of China's four-level medical system (national, provincial, municipal, and county-level) in diabetes prevention and treatment. A retrospective analysis was conducted on the data of 12,800 diabetic patients managed by the four-level medical institutions in Province from 2020 to 2023. The collaborative mechanism included information interconnection, expert sinking, and hierarchical training, and the intervention effects were evaluated through indicators such as blood glucose control rate, standardized follow-up rate, and complication screening rate. The results showed that after 3 years of practice, the blood glucose control rate of the research subjects increased from 55.2% to 72.6% ($P<0.05$), the standardized follow-up rate increased from 60.1% to 85.3% ($P<0.05$), and the annual complication screening rate increased from 48.3% to 78.9% ($P<0.05$). The four-level collaborative mechanism effectively integrated medical resources at all levels, improved the efficiency of diabetes management, and reduced the risk of severe complications. It provides a feasible path for the standardized prevention and treatment of diabetes in China.

Keywords: China's Four-Level Medical System; Diabetes Mellitus; Collaborative Mechanism; Prevention and Treatment Effect; Chronic Disease Management

1. Introduction

Diabetes has become one of the major chronic diseases threatening the health of Chinese residents. According to the data released in the China Chronic Disease Prevention and Control Plan (2023-2025), the prevalence of diabetes among adults in China has reached 11.9%, and the standardized management rate of diabetic patients is only 62.3%, with significant differences in management effects between urban and rural areas and between different levels of medical institutions [1]. The uneven distribution of medical resources—such as the concentration of endocrinology experts in provincial and municipal hospitals, and the lack of professional capabilities in grass-roots medical institutions—has led to problems such as delayed diagnosis of diabetes, irregular treatment, and low follow-up compliance.

Against this background, China's four-level medical system (taking national medical institutions as the guidance, provincial institutions as the core, municipal institutions as the link, and county-level/grass-roots institutions as the foundation) has gradually become the core

framework for chronic disease management. Previous studies have shown that the hierarchical collaboration of medical systems can improve the accessibility of medical services for chronic disease patients [2]. For example, the “provincial expert sinking + municipal training + county-level implementation + grass-roots follow-up” model in Zhejiang Province has increased the blood glucose control rate of diabetic patients in rural areas by 15%-20% [3].

However, most existing studies focus on the effect of single-level or two-level collaboration, and there is a lack of systematic analysis on the overall operation mechanism and comprehensive effect of the four-level medical system in diabetes prevention and treatment. In addition, the information barriers between different levels of institutions and the inconsistency of management standards have become key factors restricting the effectiveness of collaboration [4]. Therefore, this study takes XX Province (a pilot area for the construction of China’s four-level medical collaboration system) as the research object, systematically sorts out the practice of the four-level collaborative mechanism in diabetes prevention and treatment, and evaluates its effect, aiming to provide a reference for the national promotion of diabetes standardized management.

2. Methodology

This study adopted a retrospective cohort study design, with the research period from January 2020 to December 2023. The research objects were diabetic patients aged 18-75 years who were included in the national chronic disease management system and managed by the four-level medical institutions in Province (excluding patients with severe liver and kidney dysfunction and mental diseases). A total of 12,800 valid cases were included, including 6,520 males and 6,280 females, with an average age of (56.3 ± 8.7) years.

Sub-Section 1: Construction of the Four-Level Collaborative Mechanism

Information interconnection system: Based on the National Health Information Platform, a dedicated diabetes management database covering four-level medical institutions was built. The database included patient basic information, blood glucose monitoring records, medication plans, follow-up records, and complication screening results. All levels of institutions could access and update data in real time, realizing “one file for one patient” across institutions.

Expert sinking and support mechanism: National-level experts (from the Chinese Center for Disease Control and Prevention and tertiary hospitals) formulated national diabetes management standards and conducted annual training for provincial experts; provincial experts (from provincial top three hospitals) went to municipal hospitals for 2-3 days of outpatient consultation and case discussion every month; municipal experts went to county-level hospitals for 1 day of professional training (such as blood glucose monitoring technology, medication adjustment) every two weeks; county-level doctors went to grass-roots community health service centers to guide follow-up work every week.

Hierarchical training system: A three-level training system of “provincial training for municipal trainers, municipal training for county-level medical staff, and county-level training for grass-roots follow-up personnel” was established. The training content covered diabetes prevention knowledge, standardized diagnosis and treatment guidelines, and follow-up skills, with a training completion rate of 100% for medical staff involved in management.

Sub-Section 2: Implementation of Diabetes Prevention and Treatment Interventions

Prevention and screening: Grass-roots institutions conducted annual diabetes screening for residents aged 40 years and above (covering 92.3% of the target population in the research area) and established high-risk population files (including those with obesity, hypertension, and family history of diabetes); municipal hospitals provided technical support for grass-roots screening (such as training on glucose meter use) and summarized screening data quarterly.

Treatment and management: Grass-roots institutions were responsible for the follow-up of stable patients (once every 3 months, including blood glucose measurement, diet guidance, and exercise advice); county-level hospitals managed patients with unstable blood glucose (adjusting medication plans and conducting quarterly complication screening); municipal and provincial hospitals were responsible for patients with severe complications (such as diabetic foot, diabetic nephropathy) and provided standardized treatment.

Referral mechanism: Clear two-way referral standards were formulated: grass-roots institutions referred patients with persistent blood glucose >13.9 mmol/L or suspected complications to county-level hospitals; county-level hospitals referred patients with refractory hypertension, renal function damage, or severe infection to municipal/provincial hospitals; after the condition stabilized, municipal/provincial hospitals transferred patients back to grass-roots institutions for follow-up.

3. Results

The practice of the four-level collaborative mechanism significantly improved the key indicators of diabetes prevention and treatment, and the differences before and after the intervention were statistically significant ($P<0.05$).

Table 1: Comparison of Diabetes Management Indicators Before and After the Four-Level Collaboration (2020 vs 2023)

No.	Indicator	2020 (Before Collaboration)	2023 (After Collaboration)	Increase Rate
1	Blood Glucose Control Rate (%)	55.2	72.6	31.5%
2	Standardized Follow-Up Rate (%)	60.1	85.3	41.9%
3	Annual Complication Screening Rate (%)	48.3	78.9	63.3%
4	Rate of Correct Medication Use (%)	52.7	79.5	50.9%
5	Patient Satisfaction with Management (%)	65.4	88.7	35.6%

Table 2 shows the differences in diabetes management effects among different levels of institutions in 2023. It can be seen that the blood glucose control rate and complication screening rate of patients managed by grass-roots institutions were close to those of county-level hospitals, indicating that the collaborative mechanism effectively made up for the professional shortcomings of grass-roots institutions.

Table 2: Diabetes Management Effects of Different Levels of Institutions (2023)

No.	Institution Level	Blood Glucose Control Rate (%)	Complication Screening Rate (%)	Patient Satisfaction (%)
1	Grass-Roots (Community/County)	70.2	76.5	90.1
2	County-Level Hospitals	73.5	80.2	87.8
3	Municipal Hospitals	75.1	82.6	86.5
4	Provincial Hospitals	78.3	85.9	89.2

4. Conclusion and Future Work

The collaborative mechanism of China's four-level medical system effectively integrates medical resources at all levels, solves the problems of "difficult access to experts" at the grass-roots level and "overcrowding in large hospitals", and significantly improves the standardized management level of diabetes. The blood glucose control rate, follow-up rate, and complication screening rate of patients have been increased by more than 30%, which has practical significance for reducing the burden of diabetes-related diseases.

The information interconnection system and expert sinking mechanism are the core of the four-level collaboration. The real-time sharing of patient data avoids repeated examinations and inconsistent treatment plans, while the hierarchical training improves the professional ability of grass-roots medical staff, laying a foundation for the long-term development of diabetes management.

The two-way referral mechanism realizes the "classification of patients and hierarchical treatment", which not only ensures the treatment effect of patients with severe conditions but also gives full play to the role of grass-roots institutions in, improving the efficiency of medical resource utilization.

Strengthen the construction of information infrastructure in remote areas: At present, 15.2% of remote county-level and grass-roots institutions in the research area still have problems such as slow data transmission and incomplete function of the management system. It is necessary to increase investment in 5G and cloud computing technology to ensure the smooth operation of the four-level information network.

Improve the incentive mechanism for grass-roots medical staff: The workload of grass-roots staff in diabetes follow-up has increased significantly, but the corresponding performance incentives are not perfect. It is necessary to formulate a performance evaluation system oriented to chronic disease management effects to improve work enthusiasm.

Expand the scope of collaboration to include public health institutions: In the future, it is possible to incorporate CDC institutions at all levels into the four-level collaboration system, strengthen the linkage between medical treatment and prevention, and further improve the prevention and control effect of diabetes (such as carrying out targeted health education for high-risk populations).

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Challenges and Strategies of Faculty Compensation Management in Chinese Private Universities: A Case Study of Baiyun University

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Abstract.

The paper takes Baiyun University (BYU) as a case study to explore the challenges and optimization strategies of faculty compensation management in Chinese private universities. Through literature analysis, questionnaire surveys, and in-depth interviews, the study finds that BYU's teacher compensation system has issues such as a single structure, insufficient external competitiveness, lack of internal fairness, and weakened incentive functions. To address these problems, the paper proposes strategies such as building a diversified compensation system, enhancing external competitiveness, increasing internal fairness and transparency, and strengthening incentive functions, providing a reference for the reform of compensation systems in private universities.

Keywords: Chinese Private universities; compensation management; teacher remuneration; compensation strategies

1. Introduction

Private higher education in China has experienced rapid development over the past few decades and has become an important part of China's higher education system. As of 2024, there were 798 private regular higher education institutions nationwide, accounting for 30.4% of all regular higher education institutions, with a total enrollment of 8.675 million students, representing 26.5% of all undergraduates in regular universities. Against this backdrop, the development of a faculty workforce in private universities has become a key factor affecting education quality and sustainable development. As a core aspect of human resource management, compensation management is directly related to the recruitment, retention, and motivation of teachers. Guangzhou Baiyun University (BYU), established in 1989 and located in Guangzhou, is a private undergraduate institution with a student population of 12,000, making it an important representative of private higher education in Guangdong Province. Like many private universities, BYU faces numerous challenges in teacher compensation management, such as insufficient external competitiveness of salaries, unreasonable internal structures, and unclear incentive effects. These problems not only affect teachers' work enthusiasm and stability but also, in the long term, limit the improvement of teaching quality and the overall development of the institution. Therefore, the study takes BYU as a case, conducting an in-depth analysis of the current situation and challenges of its teacher compensation management, and proposes targeted optimization strategies. The research not only provides a reference for BYU's own salary reform but also offers practical examples and

experience for improving the compensation management system in China's private higher education sector.

2. Literature Review

2.1 Theoretical Basis of Compensation Management

Equity Theory (Adams, 1965) is a classic application of social comparison theory in the field of compensation. The central idea of the theory is that employees care not only about the absolute amount of their pay but also its relative fairness. Employees compare the ratio of their received rewards (such as salary, benefits, recognition) to their inputs (such as effort, time, skills, experience) with the same ratio of relevant referents (including other colleagues within the organization, peers in other organizations, or their own past experiences). When perceived as unfair, employees may experience tension and may attempt to restore a sense of fairness by adjusting their inputs (e.g., reducing effort), changing outputs (e.g., requesting a raise), distorting perceptions (e.g., re-evaluating the referent), changing the referent, or even leaving the organization. In compensation management practice, this means that attention must be paid simultaneously to internal equity (the fairness of compensation among different positions and performance levels within the organization), external equity (the competitiveness of organizational pay in the labor market), and individual equity (the match between an employee's contribution and their rewards). A deficiency in any of these areas can lead to negative behavioral consequences.

Expectancy Theory (Vroom, 1964) provides a refined framework for understanding the motivational process of compensation. The theory posits that the strength of motivational force (MF) depends on the product of three key psychological variables: expectancy, instrumentality, and valence, i.e., $MF = E \times I \times V$. Specifically, 1) Expectancy is an employee's subjective probability judgment that their effort can achieve the expected performance goals, influenced by goal setting, personal ability, and resource support; 2) Instrumentality is the belief that achieving performance goals will result in specific rewards, directly linked to the institutional connection between performance and compensation; 3) Valence is the individual's preference and desire for the rewards offered by the organization, reflecting the personal differences in reward valuation. Therefore, an effective performance-based compensation system must ensure that: the performance goals are achievable through employee effort (high expectancy), there is a clear and strong link between performance results and compensation (high instrumentality), and the rewards offered by the organization are valued and desired by employees (high valence).

Human Capital Theory (Becker, 1964; Schultz, 1961) views education, training, experience, and health as individual investments that form human capital capable of generating future returns. The theory suggests that wage differences largely reflect market returns for variations in individual human capital investments. Individuals who invest more upfront (e.g., obtaining higher education, acquiring professional certifications, accumulating extensive work experience) possess higher stock and quality of human capital and should receive higher compensation in the labor market to offset their prior investment costs and gain returns. In the context of higher education institutions, the theory provides a solid foundation for explaining and designing wage differentials based on academic rank, education, years of service, and research performance. A professor should earn higher compensation than a lecturer not only because their current position carries greater responsibilities but also because they have made longer-term and deeper investments in their academic career (e.g., doctoral training, ongoing research accumulation). Therefore, a reasonable compensation system must recognize and

reward these investments, thereby motivating faculty to pursue continuous professional development and skill enhancement.

2.2 Research Status of Teachers' Salaries in Private Universities

In recent years, scholars at home and abroad have conducted various studies on the compensation management of teachers in private universities. For example, Yang Xueqin took Guangzhou US University as a case to study the career management of teachers in private universities, pointing out that the combination of scientific career management and the compensation system is crucial for teacher retention and development (Yang Xueqin, 2022). Wu Yunyue explored the design and implementation of college faculty file management systems from different perspectives, indirectly revealing the close connection between teacher performance evaluation and compensation management (Wu Yunyue, 2024). Thai scholars have also focused on the issue of teacher salaries in private educational institutions. Suttipong Boonphadung, in his research on Thailand's vocational education system, pointed out that the compensation system for private vocational colleges should closely align with changes in market supply and demand, especially for popular majors such as tourism and hotel management. The compensation levels for teachers in these fields should be appropriately higher than those in conventional majors to reflect the market's valuation of scarce talent (Suttipong Boonphadung, 2025). Ganratchakan Lertamornsak emphasized the importance of non-monetary compensation, particularly by providing teachers with opportunities for international exchange, industry practice, and research support. These non-monetary benefits can sometimes be more attractive to high-level talent than simply raising salaries (Ganratchakan Lertamornsak, 2024).

On one hand, there are many comparative studies focusing on the salary gap between teachers in private and public universities, but research on the internal compensation management system of private universities is relatively insufficient. On the other hand, there is abundant literature discussing compensation systems from a macro perspective, but case studies on specific types of private universities are rare, especially in-depth analyses of the unique challenges in compensation management and strategies to address them are lacking. As shown in Table 1.

Table 1: Research Perspectives on the Salaries of Private University Teachers

Research Perspective		Main Points	Limitations
Comparative	research perspective	There is a significant gap in salaries between teachers at private and public universities.	Ignoring the internal mechanisms of private universities
Institutional	design perspective	Emphasizing institutional development and policy support	Lack of practical solutions
Case Study Perspective		Focusing on the actual situation of specific schools	The sample is limited and the generalizability is restricted.

3. A Case Study on BYU

3.1 Overview of BYU

BYU was established in 1989 and is located in Baiyun District, Guangzhou. It is a private undergraduate institution focused on cultivating application-oriented talents. The university currently has a student population of 12,000 and a faculty of approximately 500, including 380 full-time and 120 part-time teachers. The university offers various disciplines such as engineering, management, literature, and art, aiming to train application-oriented talents to meet

the needs of regional economic and social development. As a typical private university, BYU's funding primarily relies on tuition fees, with limited government financial support. This characteristic directly affects the total amount and distribution of its salary resources. At the same time, the university faces competitive pressure in faculty development from public universities, resulting in a relatively high teacher turnover rate. Consequently, the design of the compensation system has become a core issue in the university's human resource management.

3.2 Research Methods and Data Sources

The study adopts a mixed-methods approach, combining quantitative and qualitative analysis, to comprehensively examine the current situation and challenges of faculty compensation management at BYU. The quantitative research was mainly conducted through questionnaires. From March to May 2024, the study distributed questionnaires to all 380 full-time faculty members at BYU, collecting 312 valid responses, with an effective recovery rate of 82.1%. The questionnaire covered aspects such as basic information of teachers, compensation structure and level, compensation satisfaction, and perceived fairness of compensation. The qualitative research employed semi-structured in-depth interviews. Based on differences in positions, titles, and disciplines, 20 teachers were selected from the respondents for interviews. Additionally, 8 management personnel, including the Director and Deputy Director of the Human Resources Office and deans of various colleges, were interviewed to gain in-depth insights into the concepts, challenges, and reform directions of compensation management. Furthermore, the study collected relevant data on BYU's compensation budget, structure, and adjustments from 2019 to 2023, as well as comparative compensation data from six similar private universities in Guangdong Province, providing multi-faceted evidence for the research. See Table 2.

Table 2: Research Data Collection Methods and Scale

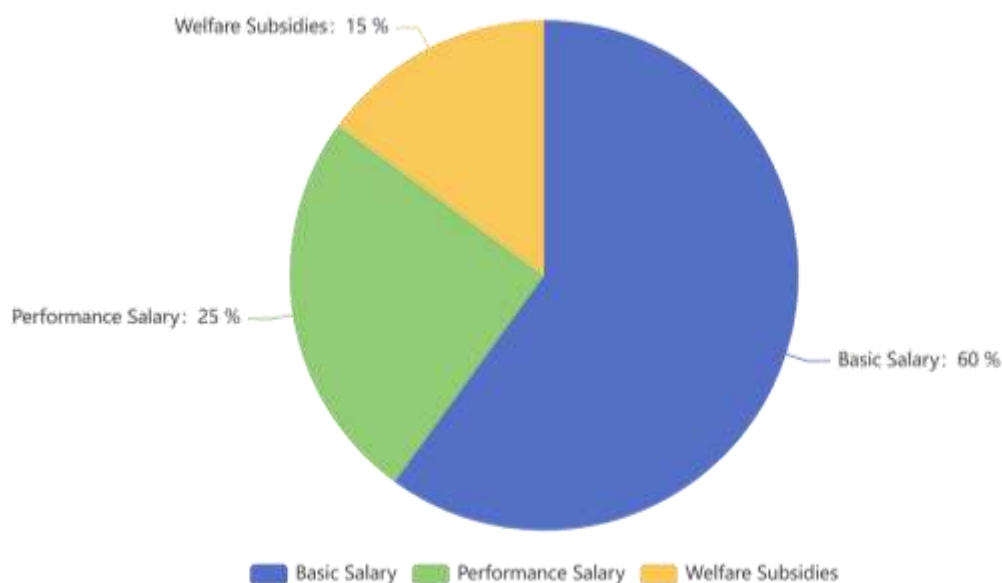
Data Categories	Collection Methods	Sample size	Main content
Quantitative data	Questionnaire surveys	312 full-time teachers	Compensation level, salary structure, and satisfaction with compensation
Qualitative data	In-depth interviews	20 teachers and 8 administrators	Concepts, Challenges, and Countermeasures of Compensation Management
Document data	Document analysis	salary data files for 5 consecutive years	Compensation budget, structure, and adjustment history
Comparative data	Market research	6 similar institutions.	External Competitive Compensation Analysis

4. Challenges of Faculty Compensation management at BYU

4.1 Current Status of the Teacher Compensation System

The compensation system for teachers at BYU mainly consists of three components: basic salary, performance-based salary, and welfare allowances. The basic salary is determined by the teacher's professional title, educational background, and years of service; the performance-based salary is linked to teaching workload and research achievements; welfare allowances include social insurance, housing subsidies, and meal allowances. According to survey data, the average annual salary of teachers at BYU in 2024 was 164,000 yuan, with 60% coming from basic salary, 25% from performance-based salary, and 15% from welfare allowances. The composition of the faculty compensation structure is visualized in Figure 1.

Figure 1: Proportion of Faculty Salary Structure at BYU



Source: Official Information from BYU

There are significant differences in compensation levels among teachers with different professional titles: professors earn an average annual salary of 245,000 yuan, associate professors 183,000 yuan, lecturers 136,000 yuan, and teaching assistants 92,000 yuan. Compared to similar private universities in Guangdong Province, BYU's compensation level is in the lower-middle range, reaching only 92% of the average level of surveyed institutions. See Table 3.

Table 3: Composition of salaries for teachers of all professional titles at BYU in 2024

Job title	Average annual salary	Basic salary	Performance-based pay	Benefits and allowances	Market comparison
Professor	245,000	147,000	61,000	37,000	0.95
Associate Professor	183,000	110,000	46,000	27,000	0.92
Lecturer	136,000	82,000	34,000	20,000	0.90
Teaching Assistant	92,000	55,000	23,000	14,000	0.88

4.2 Main Challenges in Compensation Management

4.2.1 Insufficient External Competitiveness of Compensation

Survey data shows that the average annual salary of teachers at BYU is only 68% of that at similar public universities in Guangzhou, and 8 percentage points lower than that at similar private universities in Guangdong Province. This lack of external competitiveness directly leads to two problems: first, it is difficult to attract high-level talent. Over the past three years, the university tried to recruit 15 discipline leaders but succeeded in recruiting only 5; second, the turnover rate of core teachers is relatively high. Over the past three years, the average teacher turnover rate has reached 18%, with the turnover of associate professors and lecturers being the most severe, at 22% and 25% respectively. As shown in Figure 2.

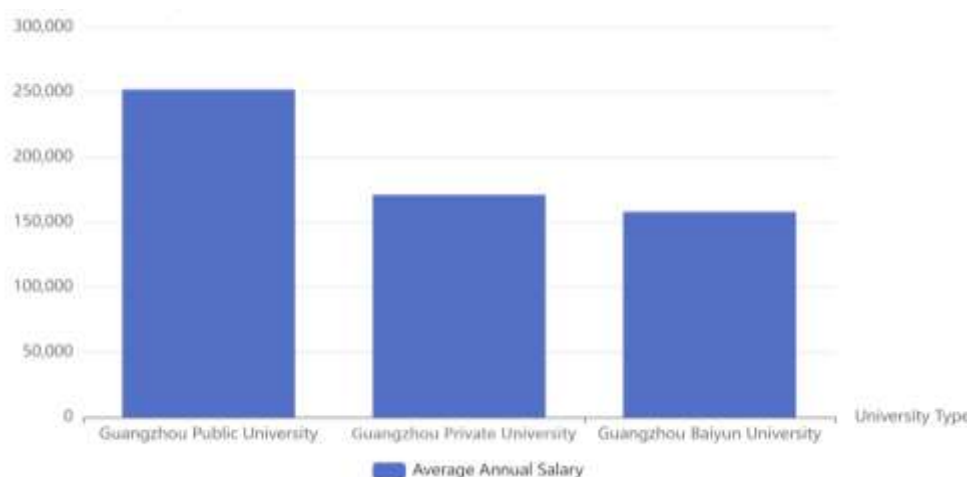


Figure 2: Comparison of average annual salaries of teachers at different universities in 2024
Source: Official Information from BYU

The main reason for insufficient external competitiveness in compensation lies in the university's single funding source, which mainly depends on tuition revenue, while the tuition level is difficult to increase significantly due to policy restrictions. At the same time, the university lacks a market tracking and adjustment mechanism in its salary strategy, and has failed to adjust compensation levels in a timely manner according to market changes.

4.2.2 Unreasonable Internal Compensation Structure

There are multiple irrationalities in the salary structure for teachers at BYU. First, the balance between fixed and variable pay is skewed, with the fixed portion accounting for too high a percentage (75%) while the performance-related portion is relatively low (25%), weakening the incentive function of salaries. Second, salary allocation overemphasizes professional titles and positions, inadequately reflecting actual performance and contributions. Third, the design of the salary range is unreasonable; salary fluctuations within the same title level are too small to reflect differences in performance.

Interview results further reveal that 86% of teachers believe the performance pay gap is insufficient to reflect differences in work contributions, and 72% believe that salary distribution relies too heavily on factors such as professional title and seniority rather than actual performance. This structural issue reduces teachers' work motivation and has led to the prevalence of a "one-size-fits-all" salary approach to some extent.

4.2.3 Low Correlation Between Compensation and Performance

Although BYU has established a performance-based compensation system, the correlation between pay and performance remains relatively low. Survey results show that only 35% of teachers believe that performance-based pay truly reflects their work performance, 42% believe that the performance evaluation criteria are unscientific, and 62% believe that the application of performance results is too singular. There are three main reasons for the issue: first, the performance evaluation system itself has defects, with a clear tendency to prioritize research over teaching and quantity over quality; second, the transparency of the performance evaluation process is insufficient, and teachers have limited understanding of the evaluation standards and procedures; third, the actual differences in performance-based pay are small, making it difficult to provide effective incentives. Data show that the performance pay differences among teachers of the same title are usually between 10% and 15%, a gap that is insufficient to fully reflect actual differences in work performance.

4.2.4 Lack of Flexibility in the Welfare System

The teacher welfare system at BYU is characterized by uniformity and rigidity. The school offers a standardized welfare package, lacking differentiated designs to meet the needs of different teacher groups. Surveys show that 70% of teachers believe the current welfare programs cannot meet personalized needs, and 65% of teachers hope for flexible welfare plans. In addition, economic benefits dominate the design of the welfare system, while non-economic benefits such as career development, work environment, and work flexibility are relatively lacking. Especially among young teachers, the demand for career development opportunities and housing security far exceeds that for other welfare programs, and the current welfare system does not adequately address these needs.

5. Optimization Strategies for Teacher Compensation management at BYU

5.1 Building a Diversified Compensation System

In response to the issue of a single compensation structure at BYU, the study proposes strategies for developing a diversified compensation system. The system includes a multi-dimensional combination of economic and non-economic compensation, fixed and variable compensation, as well as short-term and long-term incentives, to meet the differing needs of various faculty groups.

In terms of economic compensation, it is recommended to expand the current structure into the following components: basic salary (50%), performance-based salary (30%), incentive pay (10%), and benefits allowance (10%). The basic salary ensures the teachers' fundamental living needs; the performance-based salary is linked to individual performance; the incentive pay targets outstanding contributions, research breakthroughs, and excellence in teaching; and the benefits allowance provides basic security. Particularly important is the introduction of long-term incentive mechanisms, such as pension plans and equity incentives, to enhance the teachers' sense of long-term belonging.

Regarding non-economic compensation, attention should be strengthened on four dimensions: work environment, career development, work-life balance, and social recognition. Specific measures include: establishing a teacher career development system and providing systematic training and learning opportunities; improving work conditions and offering flexible work arrangements; and setting up an honors system to give spiritual rewards to outstanding contributors. Non-economic compensation has a particularly significant motivational effect on knowledge-based employees, and university teachers are a typical group of knowledge-based employees.

5.2 Increasing External Competitiveness

Enhancing the external competitiveness of salaries is crucial for BYU to attract and retain outstanding teachers. We recommend taking the following specific measures: First, establish a market tracking mechanism and conduct an annual survey of compensation levels at similar universities within Guangdong Province, using the results as a basis for salary adjustments. It is suggested to set the target compensation level around the 75th percentile of the market for similar universities in Guangdong Province, ensuring competitiveness with most peer institutions. To achieve the goal, the salary budget growth rate needs to be increased year by year, exceeding the school's revenue growth, gradually narrowing the gap with market levels. Second, create special salary channels for key talents. For key personnel, such as

discipline leaders, core researchers, and distinguished teaching staff, offer market-competitive "agreement salaries" that are not restricted by the conventional salary structure. Additionally, provide high-level talents with special allowances such as relocation fees and research start-up funds to enhance attractiveness. Third, optimize the allocation of salary resources, prioritizing limited resources for key positions and high-performing teachers. Research shows that there are indeed a vital few of teachers who have a decisive impact on school development and teaching quality. Retaining these key teachers through differentiated salary strategies is an effective way to improve the return on salary investment.

5.3 Enhancing Internal Fairness and Transparency

Internal equity is an important factor affecting teachers' satisfaction with their salaries and their perception of fairness. Measures to enhance internal pay equity at BYU should include: Establishing a job evaluation system that scientifically assesses the relative value of each position based on four dimensions: knowledge and skills, responsibilities, working conditions, and effort, forming a job grading structure to provide a basis for salary design. Job evaluation should involve professional institutions and include teacher representatives to ensure the scientificity and fairness of the evaluation process. Improving the performance evaluation system to enhance the scientific and transparent nature of performance assessments. Specific measures include: establishing a multi-dimensional evaluation index system that balances the weights of teaching, research, and social service; introducing multiple evaluators, including student evaluations, peer evaluations, and expert evaluations; publicly disclosing evaluation standards and processes to ensure the interpretability of results; and establishing a performance feedback mechanism to help teachers improve their performance. Increasing transparency in salary decisions by fully explaining the salary structure, grade ranges, adjustment mechanisms, and decision-making process to teachers without disclosing individual salaries. Surveys show that salary transparency is a key factor influencing teachers' perception of fairness. Even if compensation levels are not high, a transparent decision-making process can significantly increase teachers' acceptance.

5.4 Strengthening Incentive Functions

To strengthen the incentive function of compensation, the following reforms are recommended to the performance-based compensation system of BYU.

Enhance the link between performance and compensation, increasing the proportion of performance-based pay in total compensation from the current 25% to 30%-35% gradually, and expand the salary range within the same professional title level so that high-performing teachers can receive significantly higher pay than the average. Research data shows that performance pay differences need to reach at least 20%-30% to produce effective incentive effects.

Diversify incentive methods and establish a multi-level incentive system that combines short-term, medium-term, and long-term incentives. Short-term incentives include annual performance bonuses and special awards; medium-term incentives include term rewards and project outcome sharing; long-term incentives include pension plans and career development funds. A diverse range of incentives can meet the needs of teachers at different career stages, enhancing the relevance and effectiveness of motivation.

Strengthen the role of non-economic incentives, fully leveraging non-economic factors such as honor, career development, and work autonomy in motivating teachers. Especially for young teachers, career development opportunities and academic growth prospects often have a stronger motivating effect than economic rewards. Establishing a teacher career development

system that provides personalized development paths for teachers at different career stages is an important way to enhance teacher motivation.

6. Conclusion and Recommendations

6.1 Research Conclusion

The study systematically analyzes the current situation, challenges, and countermeasures of teacher compensation management at BYU and draws the following main conclusions: First, BYU faces multiple challenges in teacher compensation management, including insufficient external competitiveness, unreasonable internal structure, low performance linkage, and lack of flexibility in the welfare system. These issues are interconnected and collectively weaken the security, incentive, and guiding functions of the compensation system. Second, the root causes of compensation management problems lie in the resource constraints and institutional environment of private universities. The single source of funding limits the total amount of salary resources, while outdated management concepts and technologies result in low efficiency in utilizing the limited resources. Finally, optimizing compensation management at BYU requires a systematic strategy, including establishing a diversified compensation system, enhancing external competitiveness, improving internal fairness, and strengthening incentive functions. These strategies need to be implemented collaboratively to achieve overall optimization of the compensation system.

6.2 Practical Suggestions

Based on the research conclusions, the study proposes the following practical recommendations for BYU and similar private colleges: In the short term (within 1 year), prioritize addressing the most urgent external competitiveness issues of remuneration, providing market-competitive contractual pay for key positions and core teachers to curb the trend of core staff turnover. At the same time, initiate preparatory work for compensation system reform, including market data collection, internal diagnostics, and program design. In the medium term (1-3 years), systematically advance the compensation system reform, establish a diversified compensation structure, strengthen performance linkage, and improve internal fairness. During the process, teachers' participation should be fully incorporated to enhance recognition and support for the reform. In the long term (3-5 years), continuously optimize the compensation system, establish a governance structure consistent with the university's development strategy, and form a self-adjusting, continuously improving compensation management system.

6.3 Research Limitations and Future Directions

The limitations of the study are mainly reflected in two aspects: first, it uses a single institution as a case, and the generalizability of the research conclusions needs further verification; second, it is primarily based on cross-sectional data, lacking long-term tracking and evaluation of the effects of salary reform. Future research can continue to delve into the following directions, conducting multiple case comparative studies to reveal the commonalities and differences in compensation management among different types of private universities, carrying out longitudinal tracking studies to assess the long-term effects of salary reform measures, exploring the mechanisms linking compensation management in private universities with teacher behavior and organizational performance, expanding the scope of cases to private universities in different regions, thereby providing a richer evidence base for salary-related decision-making.

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Beyond Compensation: Psychological Pathways to Faculty Motivation in Chinese Private Universities—An Empirical Study of Self-Determination Theory Localization

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Abstract

The study, based on Self-Determination Theory (SDT), investigates the psychological pathways of work motivation among teachers in Chinese private universities using a sequential mixed-methods approach. Through a questionnaire survey of 220 teachers from three private universities and in-depth interviews with 30 teachers, the study found that autonomy support (standardized path coefficient $\beta=0.48$, $p<0.001$) and competence support ($\beta=0.41$, $p<0.001$) are key predictors of teachers' autonomous motivation and job satisfaction, while lack of relatedness significantly predicts emotional exhaustion ($\beta=0.52$, $p<0.001$) and turnover intention ($\beta=0.45$, $p<0.001$). Qualitative analysis further revealed institutional roots: standardized management deprives teachers of professional autonomy, a single-focused research evaluation system undermines teaching competence, and a performance competition culture erodes the sense of professional community. Based on these empirical findings, the study proposes a localized need-supportive management framework and outlines specific pathways for shifting from a "transactional control" to a "psychological support" paradigm, including implementing negotiated goal management, establishing a multidimensional career development system, and cultivating professional learning communities. The study provides theoretical insights into the psychological mechanisms of teacher motivation in the Chinese context and offers a practical framework for building a sustainable faculty workforce in private universities.

Keywords: Self-Determination Theory; Teacher Motivation; Private Universities; Psychological Needs; Localization

1. Introduction

The rapid expansion of private higher education in China has significantly reshaped its overall educational landscape. In the process, private universities generally face a resource-constrained and highly competitive external environment and continually encounter a critical strategic challenge: how to effectively attract, retain, and motivate high-quality teachers. Previous management strategies have often focused on external incentives, such as performance-based pay. However, existing evidence shows that such measures have limited effectiveness, as reflected in high teacher turnover, widespread occupational burnout, and weakened intrinsic motivation for academic work.

At its core, the challenge is not only about the compensation system but also deeply involves teachers' psychological motivation mechanisms. To address this issue, the study introduces Self-Determination Theory (SDT) as a theoretical framework to diagnose and address the

current motivation crisis. The theory posits that individuals' sustained and high-quality work motivation arises from an environment that supports three basic psychological needs: autonomy, meaning the perception that one's actions are voluntary and reflect personal will; competence, meaning a sense of effectively meeting environmental demands; and relatedness, meaning the experience of connection and belonging with others.

Although Self-Determination Theory has been validated across multiple fields, its application in the specific organizational context of Chinese private universities has not yet been fully explored. These institutions feature a combination of market-driven pressures, top-down management traditions, and collectivist cultural characteristics, forming a unique institutional and cultural context. Therefore, the study aims to explore the applicability of SDT in local private universities, with a focus on analyzing how teachers' basic psychological needs are manifested and fulfilled in such environments.

Based on the above analysis, the study sets three specific objectives:

First, to assess the extent to which current management practices in Chinese private universities support teachers' basic psychological needs and to identify existing obstacles.

Second, to empirically examine the relationship between the fulfillment of psychological needs and different types of work motivation (autonomous and controlled motivation), and further explore their links with key outcome variables such as job satisfaction, occupational burnout, and turnover intention.

Third, to develop a management framework that is aligned with the actual conditions of Chinese private universities and oriented toward need support, providing practical reference for institutional managers and policymakers.

2. Literature Review

a. The Motivation Crisis Faced by Teachers in Chinese Private Universities

Existing research generally points out that teachers in private universities face multiple practical dilemmas in their career development, including heavy teaching workloads, unstable employment relationships, and immense pressure associated with publishing research outcomes (Wu Xiaoxuan, 2021). To address these challenges, school administrations typically adopt performance-oriented transactional management strategies, emphasizing a "carrot-and-stick" approach to incentives and constraints. While such methods may produce some short-term effects, they often overlook teachers' deep sense of professional identity and intrinsic drive for innovation. (Huang Baoxin, 2022) In the long run, over-reliance on external incentives not only fails to effectively stimulate teachers' professional engagement but may also lead to a "motivation crowding-out" effect—where external interventions weaken individuals' original intrinsic motivation, thereby affecting education quality and teachers' career satisfaction (Huang Zhen, 2024).

b. Application of Self-Determination Theory in Work Contexts

Self-Determination Theory (SDT), as a macro theory that systematically explains the structure of human motivation, has been cross-culturally validated in multiple fields, including organizational management. The theory differentiates motivation into two basic types:

Autonomous Motivation: Refers to an individual's voluntary engagement in activities out of interest, value recognition, or personal satisfaction. For example, teachers actively teach because they enjoy witnessing students' growth during the learning process.

Controlled Motivation: Refers to an individual's participation in an activity due to external pressures, reward and punishment mechanisms, or the avoidance of negative emotions (such as guilt). For instance, engaging in publishing papers merely to fulfill research assessment criteria or obtain bonuses.

According to SDT, autonomous motivation can lead to more sustained effort, higher levels of creativity, and better psychological well-being. The theory further emphasizes that promoting autonomous motivation depends on satisfying three basic psychological needs: autonomy, competence, and relatedness (Pauline M. R. & Elliot S., 2025).

c. Localization Challenges of SDT in the Chinese Educational Context

Although SDT assumes that basic human psychological needs are universal across cultures, the specific manifestations and pathways to fulfillment of these needs are often profoundly influenced by sociocultural contexts (Ma Wen-ying & Liu Xi, 2016). In the collectivist cultural context of China, the three types of needs proposed by SDT may manifest differently compared to Western individualistic environments:

Autonomy may be more reflected as 'willing compliance' or 'choice within harmony,' meaning individuals make self-decisions under the premise of recognizing collective goals, rather than pursuing extreme personal independence.

Competence is often closely related to gaining authority recognition within hierarchical structures and evaluation by colleagues. Its fulfillment depends not only on individual abilities but also on social acknowledgment within the organization.

Relatedness is rooted in Confucian cultural traditions that emphasize interpersonal harmony and relationship building, making a supportive and collaborative professional community particularly important in motivating teachers.

Therefore, the study does not simply apply the Western-derived SDT framework, but seeks to explore its applicable form and mechanisms in the specific organizational context of Chinese private universities, aiming to better understand teachers' motivational structures and pathways for incentives.

3. Research Methods

The study adopts a sequential mixed-methods design, carried out in two stages, aiming to reveal the macro-level relationships between variables through quantitative analysis and to gain an in-depth understanding of the underlying causes and mechanisms of phenomena through qualitative interviews, thereby achieving a comprehensive grasp of the research questions.

a. Quantitative Research Phase

The study first collected data through a questionnaire survey. The sample was drawn from three private universities in China, located in different geographic regions to ensure that the sample was somewhat representative in terms of regional and institutional background. Using a random sampling method, online questionnaires were distributed to 350 full-time teachers. The data collection process lasted about four weeks, and a total of 220 valid questionnaires were returned, resulting in an effective response rate of 62.8%. The sample size meets the basic requirements for structural equation modeling analysis.

Regarding measurement instruments, the study adopted well-established scales widely validated in self-determination theory research. All scales used a unified 7-point Likert scale ranging from 1 ("strongly disagree") to 7 ("strongly agree") to ensure consistency and

comparability of the data. Specifically, the study employed five core scales: the "Basic Psychological Needs at Work Scale" to measure teachers' satisfaction levels in autonomy, competence, and relatedness; the "Work Motivation Scale" to distinguish and assess the strength of intrinsic versus controlled motivation; the "Job Satisfaction Scale" to comprehensively evaluate overall job satisfaction; the "Maslach Burnout Inventory-Educators Survey" to assess occupational burnout in areas such as emotional exhaustion, depersonalization, and reduced personal accomplishment; and the "Turnover Intention Scale" to examine the frequency and intensity of thoughts about leaving the job.

b. Qualitative Research Phase

After preliminary conclusions were drawn from quantitative analysis, the study entered the qualitative phase to seek deeper explanations for the statistical results. In the study, 30 teachers were purposefully selected as interviewees from among those who had participated in the questionnaire survey. The sampling strategy fully considered the diversity characteristics presented by the quantitative data, aiming to cover teachers with different levels of need satisfaction, job satisfaction, and occupational burnout, in order to ensure the collection of diverse and rich firsthand data. The interviews were conducted in a semi-structured format, with the core purpose of inviting participants to explain and comment on the relationships and patterns identified in the previous quantitative research based on their own experiences.

For the collected qualitative data, the study followed a standardized qualitative data processing procedure. All interviews were recorded in full after obtaining consent, and then transcribed verbatim into text to form the original text database. To facilitate subsequent international academic communication and presentation of results, all Chinese transcripts were translated into English by the research team. The rigorous data processing procedure provided a reliable foundation for subsequent thematic analysis.

c. Data Analysis Strategies

For different types of data, the study adopted corresponding analysis strategies. Quantitative data analysis was mainly conducted using SPSS 25.0 and SmartPLS 3.0. Descriptive statistical analysis and reliability and validity tests of scales were first carried out using SPSS. Subsequently, SmartPLS was mainly used to construct structural equation models, using partial least squares to test the hypothesized path relationships among basic psychological need satisfaction at work, different types of work motivation (autonomous and controlled), and various work outcomes (job satisfaction, occupational burnout, turnover intention). The method is particularly suitable for the exploratory nature of the study and for testing complex theoretical models.

Qualitative data analysis involved systematic thematic analysis of the transcribed interview texts. It should be noted that the analysis process was not entirely inductive from the bottom up, but used the core constructs of Self-Determination Theory (SDT) as a guiding analytical framework. From the perspective of SDT (e.g., need-supportive environments, the internalization process of motivation, need thwarting), researchers coded the texts to identify and extract key themes and typical patterns that could explain and supplement the findings of the quantitative research, thereby achieving the intended aim of in-depth interpretation and empirical validation within a mixed-methods study..

4. Research Findings

The study adopted a sequential mixed-methods design, systematically exploring the relationship between the psychological need satisfaction, work motivation, and professional status of teachers in private higher education institutions through quantitative and qualitative analyses. The findings reveal the specific manifestations of Self-Determination Theory (SDT) in the context of Chinese private higher education from both statistical patterns and individual experiences.

a. Quantitative Research Results: The Key Role of Autonomy and Competence

Using structural equation modeling, the study validated the core assumptions of SDT in an organizational context. The theoretical model shown in Figure 1 indicates that different types of need satisfaction have differentiated predictive effects on teacher motivation and work outcomes.

Figure 1: The Structural Equation Model of Psychological Needs, Motivation, and Work Outcomes

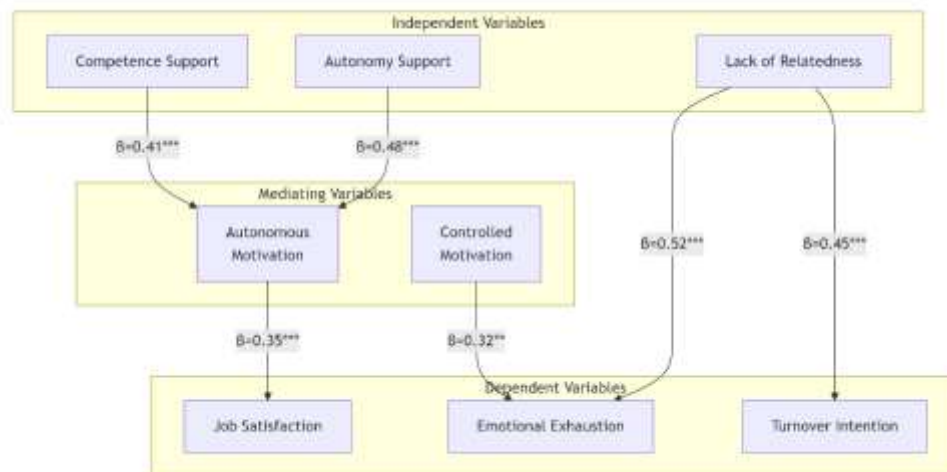


Figure Caption: The hypothesized structural equation model testing the relationships between basic psychological need support, work motivation, and occupational outcomes among faculty in Chinese private universities. Path coefficients are standardized estimates (β). Solid lines represent significant positive paths, and dashed lines represent significant negative paths. ($p < 0.05$, $p < 0.01$, $p < 0.001$)

The theoretical model shown in Figure 1 indicates that different types of need satisfaction have differentiated predictive effects on teacher motivation and work outcomes. The specific path coefficients and significance levels are detailed in Table 1.

Table 1: Structural Equation Model Path Coefficients and Hypotheses Testing

Hypothesis Path	Path Coefficient(β)	t-value	p-value	Supported
Autonomy Support→ Autonomous Motivation	0.48	5.892	< 0.001	Yes
Competence Support→ Autonomous Motivation	0.41	5.123	< 0.001	Yes
Autonomy Support→ Job Satisfaction	0.39	4.876	< 0.001	Yes
Lack of Relatedness→ Emotional Exhaustion	0.52	6.451	< 0.001	Yes

Lack of Relatedness→ Turnover Intention	0.45	5.678	< 0.001	Yes
Controlled Motivation→ Occupational Burnout	0.32	3.945	< 0.01	Yes

Source: Data source: Analysis of survey data from 220 full-time teachers

Specifically, the data analysis yielded the following key findings:

First, with respect to predicting work motivation and positive work states, autonomy support exhibited the strongest explanatory power. It was the most significant predictor of teachers' autonomous motivation ($\beta=0.48$, $p < 0.001$) and job satisfaction, indicating that when teachers have decision-making freedom and a range of choices in their work, they are more likely to develop intrinsic work motivation and higher job satisfaction.

Following closely is competence support, which also had a significant positive effect on autonomous motivation ($\beta=0.41$, $p < 0.001$). This indicates that when teachers perceive themselves as capable of effectively completing their tasks and receiving recognition for their abilities, their intrinsic motivation system is further activated.

Second, regarding the prediction of negative professional states, the study found different patterns. Lack of relatedness, although weakly associated with types of motivation directly, was the strongest predictor of emotional exhaustion ($\beta=0.52$, $p < 0.001$) and turnover intention ($\beta=0.45$, $p < 0.001$). This finding suggests that the absence of emotional connections may not directly influence the nature of teachers' motivation but can significantly exacerbate depletion of emotional resources and the turnover intention.

In addition, controlled motivation showed a clear positive predictive effect on occupational burnout ($\beta=0.32$, $p < 0.01$), confirming the close relationship between externally driven motivational states and psychological strain.

b. Qualitative Research Findings: Individual Experiences of Frustrated Needs and Organizational Contexts

The thematic analysis of interview data provides rich contextual explanations for the quantitative results. When asked to identify the single biggest obstacle to their motivation, teachers' responses, categorized in Figure 2, clearly point to issues of autonomy and unfair evaluation.

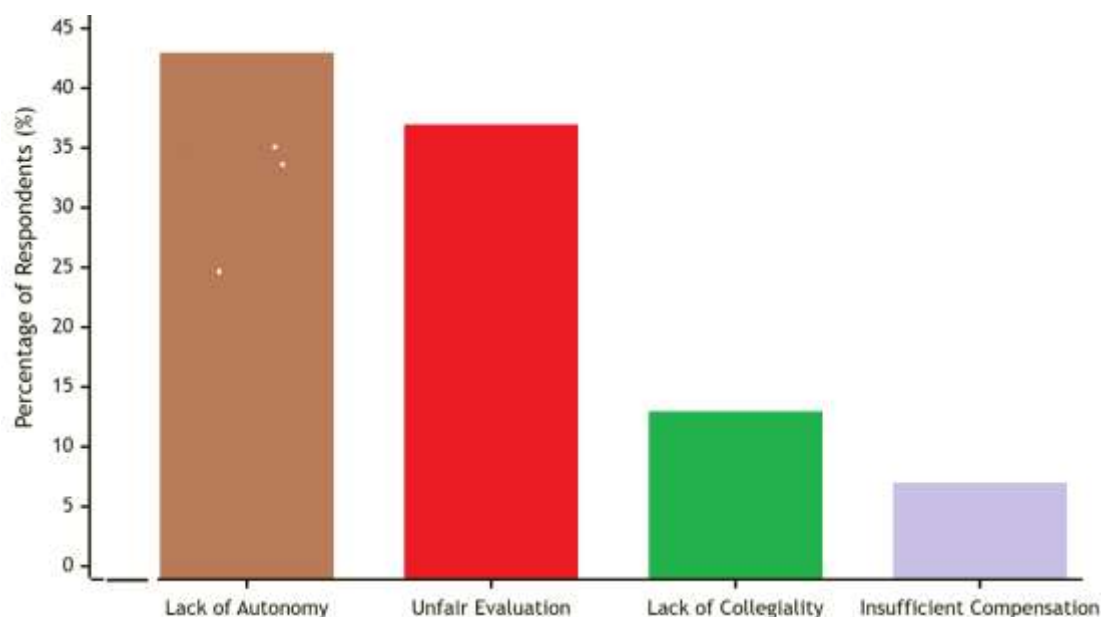


Figure 2: Perceived Primary Obstacles to Motivation (Based on 30 interviews)

Source: Based on interview data

Regarding autonomy frustration, teachers commonly described a systematic lack of decision-making power in their professional practice. A statement from an associate professor is particularly representative: "The syllabus is standardized, the textbooks are prescribed, and even my lecture slides have to be checked for 'compliance'. I feel like a cog in a machine rather than a scholar." The loss of professional autonomy, which extends to broader academic activities such as research direction selection, leads teachers to experience a strong sense of 'de-professionalization'.

In terms of competence undermining, the study found that the one-sidedness of organizational evaluation mechanisms has a profound impact on teachers' professional self-perception. A lecturer focused on teaching who had received teaching awards shared: "My student evaluations are high, but in the annual assessment, when research output becomes the decisive criterion, I feel like a failure in the eyes of the system." The institutional neglect makes it difficult for teachers to gain organizational recognition from the professional achievements they value most, resulting in systematic weakening of their sense of competence.

Concerning belongingness erosion, interviews revealed the corrosive effects of competitive management systems on interpersonal connections. A young teacher noted: "There is no culture of collaboration here. We are all competing for limited research funding and promotion opportunities. It is a lonely, highly stressful, and often isolating professional existence. The environment, shaped by performance rankings and individualistic incentive mechanisms, not only weakens supportive relationships among colleagues but also intensifies teachers' emotional isolation, confirming the strong association between lack of belonging and emotional exhaustion observed in the quantitative study.

Overall, the qualitative findings not only provide vivid empirical evidence for the statistical relationships found in the quantitative models but also further reveal how organizational systems and management practices affect teachers' basic psychological needs through specific mechanisms, thereby shaping their work motivation and professional well-being. The results of the two methods corroborate and complement each other, jointly constructing a deeper and more comprehensive understanding of the research questions..

5. Discussion: Constructing a Localized Framework of Self-Determination Theory

The empirical results of the study indicate that the widespread lack of motivation among faculty members in Chinese private universities can be traced to the systematic deprivation of basic psychological needs within a specific institutional context. Examining self-determination theory (SDT) in the unique setting of Chinese private higher education not only reveals the applicable boundaries of the theory in a local context but also facilitates a re-interpretation of the three core psychological needs in SDT. Based on this, we are able to construct a needs-supportive management framework that aligns with both the theoretical core and practical realities.

a. Reconstructing the Connotation of Psychological Needs in a Local Context

In private universities, which combine market-oriented and academic pursuits, the connotations of teachers' psychological needs show distinct local characteristics.

Firstly, the need for autonomy in the context does not manifest as a pursuit of complete independence but as a "purposeful voice". Specifically, teachers strongly desire channels for meaningful participation in core areas related to their professional development—such as curriculum design, teaching method reforms, allocation of academic resources, and personal career planning—where their input is seriously considered and substantively adopted by management. More importantly, they need to link daily work tasks with intrinsic academic values and long-term career goals, so that even within seemingly constrained structures, they can find space for self-direction and meaning-making, achieving a form of 'structured autonomy' that aligns daily tasks with intrinsic academic values.

Secondly, the fulfillment of competence has also undergone significant changes. It is no longer solely dependent on the evaluation of task completion but requires institutional recognition of "holistic academic excellence". This implies that administrators in private universities must move beyond a narrow evaluation system centered on the quantity of research papers and instead build an ecosystem that comprehensively measures and rewards diverse academic contributions. The system should explicitly recognize teachers' value creation in high-quality teaching, deep student mentorship, applied research innovation, and societal service, and through visible metrics and incentive feedback, enable teachers to genuinely perceive that the overall value of their work is fairly evaluated and appreciated by the organization.

Finally, in the context of relatively weak institutional job security in private universities, the sense of belonging takes on special significance beyond ordinary organizational identification. It evolves into the fundamental need for teachers to seek psychological safety and collective support within a "professional community".

In the absence of the traditional job security (often referred to as the 'iron rice bowl') found in public institutions, grassroots academic communities characterized by mutual respect, emotional resonance, and professional collaboration—such as teaching and research offices, research teams, or interdisciplinary project groups—can provide essential psychological buffering for teachers. The community network, built on professional identity and interpersonal trust, becomes a key social structure that allows them to resist professional uncertainty, alleviate emotional exhaustion, and maintain long-term career resilience.

Firstly, the need for autonomy in the context does not manifest as a pursuit of complete independence but as a "purposeful voice". Specifically, teachers strongly desire channels for meaningful participation in core areas related to their professional development—such as curriculum design, teaching method reforms, allocation of academic resources, and personal career planning—where their input is seriously considered and substantively adopted by management. More importantly, they need to link daily work tasks with intrinsic academic values and long-term career goals, so that even within seemingly constrained structures, they can find space for self-direction and meaning-making, achieving a form of "structured autonomy".

Secondly, the fulfillment of competence has also undergone significant changes. It is no longer solely dependent on the evaluation of task completion but requires institutional recognition of "holistic academic excellence". This implies that administrators in private universities must move beyond a narrow evaluation system centered on the quantity of research papers and instead build an ecosystem that comprehensively measures and rewards diverse academic contributions. The system should explicitly recognize teachers' value creation in high-quality teaching, deep student mentorship, applied research innovation, and societal service, and through visible metrics and incentive feedback, enable teachers to genuinely

perceive that the overall value of their work is fairly evaluated and appreciated by the organization.

Finally, in the absence of the traditional job security (often referred to as the 'iron rice bowl') found in public institutions, grassroots academic communities characterized by mutual respect, emotional resonance, and professional collaboration—such as teaching and research offices, research teams, or interdisciplinary project groups—can provide essential psychological buffering for teachers. The community network, built on professional identity and interpersonal trust, becomes a key social structure that allows them to resist professional uncertainty, alleviate emotional exhaustion, and maintain long-term career resilience.

b. Demand-Oriented Supportive Management Framework for Private Universities in China

Based on the localized interpretation of psychological needs mentioned above, we propose a systematic management practice framework to provide feasible action paths for private universities to enhance teacher motivation and optimize organizational effectiveness.

To address the deprivation of autonomy identified in the findings, institutions should implement a 'negotiated goal management' mechanism. Regarding support for teacher autonomy, institutions should focus on two key initiatives. First, implement a "negotiated goal management" mechanism to completely transform the traditional administrative, directive task-allocation model. At both the college and department levels, establish an annual development goal-setting procedure involving both administrators and teacher representatives to ensure that teachers have substantial negotiation rights and constructive roles in setting personal performance goals, professional development paths, and key team work priorities. Second, apply a "structured teaching freedom" policy in the professional teaching domain, which, while strictly complying with national professional training quality standards and the core educational philosophy of the university, explicitly grants teachers ample professional autonomy in expanding course content, innovating teaching methods, and diversifying student evaluation approaches, thereby stimulating their intrinsic motivation for teaching innovation and sense of responsibility.

In cultivating teachers' sense of competence, the focus of management innovation is on building a diversified recognition and development system. The primary task is to design and implement a "multidimensional career development system", breaking away from the previous single promotion track based solely on research output, and establishing parallel and interconnected tracks for "teaching excellence", "research innovation", and "practical contribution", providing clear, fair, and sustainable career prospects for teachers excelling in different types of academic work. Concurrently, it is necessary to improve the "developmental recognition mechanism", creating an incentive ecosystem that balances material and spiritual rewards.

Beyond performance-based compensation, universities should also confer honors such as university-level Teaching Master Awards and Annual Outstanding Service Contribution Awards, offer opportunities to participate in key decision-making committees, and provide timely, concrete, and meaningful organizational recognition, offers special research start-up funds and academic sabbaticals. The system provides timely, concrete, and meaningful organizational recognition of teachers' excellence in various fields.

To strengthen teachers' sense of belonging, supportive organizational culture should be actively fostered through institutional design. An effective measure is the establishment of a "collaborative innovation support program", with university-level special funding to encourage

and support teachers to form teams based on common interests or complementary interdisciplinary strengths, applying for curriculum development, applied research, or social service projects, thereby promoting the natural formation and sustained activity of high-quality professional communities. Another key initiative is the full institutionalization of "mentorship and community building", making the mentorship system a mandatory support component for new teachers and young faculty development. Each new teacher is paired with a senior mentor and provided with stable activity funding and organizational platforms. Academic units are supported in regularly conducting professional seminars, academic salons, interdisciplinary exchanges, and cultural and sports networking events, systematically establishing a multi-dimensional support network that fosters deep connections, knowledge sharing, and experience transmission among teachers.

6. Conclusion

The study, through a sequential mixed-methods approach, delved into the work motivation and psychological needs satisfaction of teachers in Chinese private higher education institutions, ultimately drawing the following key conclusions:

First, the research confirms the fundamental pathway to addressing the motivation crisis among private university teachers. Traditional management models that rely on strengthening external incentives have been shown to be of limited effectiveness. Both quantitative and qualitative data in the study indicate that the essential solution lies in a paradigm shift—from over-reliance on external incentives to building an organizational environment that systematically and strategically supports teachers' autonomy, competence, and relatedness. The shift serves as the psychological foundation to stimulate teachers' intrinsic, self-sustaining motivation, enhancing job satisfaction while reducing burnout and turnover intentions.

Second, the localized framework of self-determination theory constructed in the study not only serves as a cross-cultural validation of the classical theory but also provides a practical roadmap for the aforementioned paradigm shift. By reinterpreting the three core needs within specific institutional and cultural contexts—for example, understanding 'autonomy' as 'meaningful voice' and elevating 'relatedness' to the support of a 'professional community'—abstract theoretical principles can be accurately aligned with the real management contexts of private universities. The concrete management practice recommendations aim to embed the core principle of supporting psychological needs into daily management processes, from goal setting and performance evaluation to community building.

Ultimately, the study suggests that the sustainable competitive advantage sought by private universities amidst intense competition does not stem solely from financial capital or physical facilities but rather from the development of organizational and human capital. A university's core competitiveness increasingly lies in its ability to create an academic ecosystem where teachers feel empowered, recognized, and connected. Such an environment, grounded in teachers' psychological well-being, is key to attracting, motivating, and retaining talent, thereby achieving high-quality, intrinsic development.

In summary, the study not only provides empirical support for self-determination theory from the context of Chinese private higher education but also offers institution reformers and administrators in the field—or in similar contexts—an empirically based, psychology-driven blueprint for building more resilient, dynamic, and sustainable academic organizations.

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Challenges and Strategies in Home-School-Community Partnerships: A Case Study from China

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Abstract

The paper explores the complex dynamics of home-school-community partnerships in the context of Chinese education, with a particular focus on the implementation challenges and effective strategies observed in recent practice. A multiple-case study conducted in three representative Chinese kindergartens identified a series of significant obstacles, including insufficient institutionalization of collaboration mechanisms, uneven stakeholder participation, and limited resource integration. The findings indicate that, although Chinese parents demonstrate high involvement in their children's academic development, their engagement in school governance and community activities remains limited. The study proposes a strategic framework comprising four key dimensions: establishing structured collaboration mechanisms, leveraging digital platforms, cultivating a culture of partnership, and developing a comprehensive evaluation system. These strategies address the specific context of Chinese education while also encompassing approaches to home-school-community collaboration that are applicable globally. By providing contextualized insights from China's evolving educational landscape, the study contributes to the international discourse on educational partnerships.

Keywords: Home-school-community Partnerships; Educational Collaboration; Early Childhood Education; Stakeholder participation

1. Introduction

In recent decades, China's education ecosystem has undergone significant transformation, and the importance of collaborative relationships among families, schools, and communities has received increasing attention. The concept of family-school-community partnerships aligns not only with China's traditional value of prioritizing education but also with contemporary educational reforms aimed at promoting the holistic development of children. Despite the alignment, the current implementation indicates that achieving effective collaboration among these key stakeholders still faces substantial challenges.

The paper analyzes the current state of family-school-community partnerships in China through detailed case studies and explores the challenges and promising strategies for improvement. The significance of the study lies in its timely examination of partnership models within China's unique socio-educational context. As China continues to refine its educational approaches amid rapid social change, understanding how families, schools, and communities can effectively collaborate is crucial for supporting student development. Recent research highlights the positive impact of such collaboration on children's socio-emotional competencies. A large-scale survey of kindergarten teachers in China shows that family-school-community collaboration indirectly promotes children's development through the chain-

mediated effects of principals' transformational leadership and teachers' socio-emotional competencies.

The theoretical foundation of the study is based on ecosystems theory, which posits that children's development is influenced by multiple interrelated environmental systems. Within the framework, family-school-community partnerships represent the mesosystem—that is, the connections between microsystems such as family and school—which plays a significant role in development. Although international research has extensively documented the benefits of strong family-school-community partnerships, the Chinese context presents unique characteristics worthy of dedicated investigation, including cultural expectations about education, the role of extended families in child-rearing, and the evolving relationships between educational institutions and communities.

The study aims to answer the following research questions.

(1) What are the main challenges hindering effective family-school-community partnerships in China?

(2) What strategies have emerged to address these challenges?

(3) How can partnership models be adapted to China's specific educational context while incorporating international experiences? Using a qualitative case study approach, the paper examines partnership practices across diverse educational settings in China, analyze documentation of collaborative activities, conduct stakeholder interviews, and observe the operational mechanisms of actual partnerships.

2. Literature Review

a. Theoretical Basis of Home-School-Community Partnership

The conceptual framework of family-school-community partnerships is primarily built on the basis of ecosystem theory. Proposed by Bronfenbrenner (1979), the theory views human development as a process occurring within a series of nested environmental systems. Among these, family and school function as microsystems, and the interactions and connections between them form mesosystems that have a critical impact on children's growth. The theory suggests that if children receive continuous and consistent support across different environments, it will promote their healthy development; conversely, if there are breaks or conflicts between environments, developmental risks may arise (Chrysa Keung & Alan Cheung, 2023). See Figure 1..

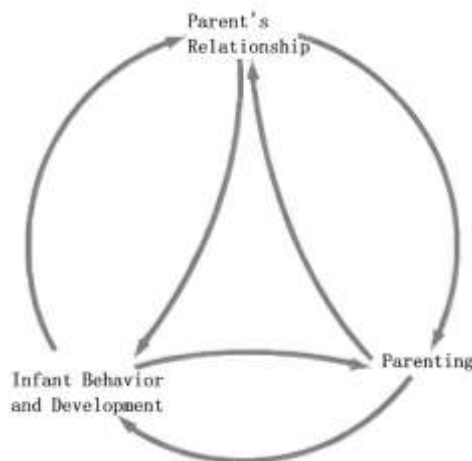


Figure 1: Bronfenbrenner's Ecological Systems Theory Model

Beyond ecosystem theory, the overlapping spheres of influence model further expands the understanding of family-school-community collaboration. The model emphasizes that the family, school, and community are three interconnected spheres of influence that share responsibility and collectively center on children, who are positioned at the core of their overlapping areas. Partnerships can only be effectively built and maintained when all parties recognize their shared goals and responsibilities. Research indicates that within these overlapping areas, opportunities for communication, resource sharing, and collaborative decision-making are created, thereby providing strong support for children's development (Joyce L. Epstein et al., 2025).

In recent years, social capital theory has also gradually been incorporated into the theoretical exploration of family-school-community partnerships. The theory views partnerships as a type of social network, through which resources such as trust, norms, and information flow to facilitate children's growth. Participants build mutual trust, reach consensus, and construct support systems conducive to children's development through such networks. The theoretical perspective helps explain why similar partnership practices produce varying results in different contexts. Their effectiveness largely depends on the social capital that each party can mobilize and utilize (Alshurafat Hashem, 2021).

b. International Research on Partnership Models

In international studies on home-school-community partnerships, several collaboration models have been shown to be significantly effective. Among them, Epstein's six types of involvement framework—including parenting, communicating, volunteering, learning at home, decision-making, and collaborating with the community—has had a particularly widespread impact in relevant projects worldwide. Research indicates that a comprehensive approach covering all six types of involvement is far more effective than fragmented measures focusing on only one or two aspects (Fathi Ihmeideh et al., 2020).

Cross-cultural comparative studies further reveal that successful partnerships follow certain universal principles while being deeply influenced by specific cultural contexts. In Western educational systems, research emphasizes the key role of institutional structures, such as establishing school councils for parental involvement, creating systematic communication mechanisms, and providing coordinated family support services (Ingrid Pramling Samuelsson, 2024). In contrast, in Asian contexts, studies focus more on the influence of cultural values in shaping partnerships. For example, a collectivist orientation may promote certain forms of collaboration, such as consistent home-school actions, while potentially inhibiting other forms of involvement, such as individualized or critical home-school interactions (Liu Junhong & Xu Wenli, 2020).

Moreover, an increasing number of studies confirm that effective home-school-community collaboration is closely associated with positive outcomes for students across multiple developmental domains. In academics, it manifests as improved test scores, higher homework completion rates, and increased graduation rates; in socioemotional aspects, it is reflected in enhanced self-regulation, better peer relationships, and more orderly classroom behavior. These outcomes are primarily achieved through the following mechanisms: strengthening trust relationships among stakeholders, aligning educational expectations and support strategies across different contexts, and more efficient integration and utilization of community resources (Liu Lan, 2021).

c. China's Home-School-Community Partnerships

In China, the development of home-school-community partnerships exhibits a unique evolutionary path, where deep-rooted cultural traditions intersect with rapid modern transformation. Historically, Chinese education has consistently emphasized parental involvement, with Confucian traditions particularly highlighting parents' primary responsibility for their children's academic achievements and moral cultivation. However, the construction of contemporary home-school-community partnerships not only inherits the cultural heritage but also actively integrates modern educational concepts (Luo Qiuxia, 2020).

At the policy level, recent years have seen a notable strengthening of institutional support for collaborative education. The *Family Education Promotion Law*, officially implemented in 2022, establishes the legal status of parental educational responsibilities, while the newly revised *Preschool Education Law* clearly defines the duties of kindergartens in home-school co-education. These policy developments signify that home-school-community collaboration is transitioning from soft advocacy to institutional guarantee, reflecting a significant shift in educational governance ideas: high-quality education requires systematic support from schools, families, and the social environment, rather than relying solely on classroom teaching (Zhu Chengbo, 2021).

At the practical level, innovation and challenges coexist. Innovative practices are emerging nationwide, such as the professional transformation of parent committees, the development of community resource maps, and the in-depth application of digital platforms. Nevertheless, deep-seated obstacles remain: some families still maintain the traditional view that education is solely the school's responsibility, the lack of professional resources in rural areas limits the quality of collaboration, and the boundaries of rights and responsibilities among different stakeholders still need clarification. These difficulties indicate that the deepening of home-school-community partnerships requires not only operational improvements but also a profound shift in educational concepts (Liu Dengke, 2024). See Table 1.

Table 1: Home-School-Community Partnership Models in Chinese Literature

Partnership Model	Key Characteristics	Reported Effectiveness
Parent Committees	Formal representation in school governance	Mixed implementation; stronger in urban private institutions
Digital Communication Platforms	WeChat groups, school apps	High penetration; variable quality of interaction
Community Resource Integration	Utilizing local institutions, businesses	Emerging practice; promising results in pilot programs
Family Education Guidance	Schools supporting parenting skills	Growing through parent universities and workshops

Although specialized research on the relationship between home-school-community partnerships and child development in China is gradually increasing, the relevant literature remains relatively limited compared to Western academia. For example, a recent survey of 4,780 kindergarten teachers across Guangdong and Yunnan provinces showed that home-school-community collaboration indirectly promoted children's social-emotional development through a chain mediation mechanism involving 'transformational leadership of principals' and 'teachers' social-emotional competence.' The finding suggests that the impact of partnerships on child development is not a simple direct effect but is realized through multi-level, complex pathways (Huang Shuang et al., 2025).

Existing literature also reveals several research gaps worthy of further exploration, and the study aims to address these deficiencies. Although the theoretical framework regarding

partnerships is relatively mature, its applicability and localized practice within specific Chinese educational contexts still require further development. Meanwhile, although some challenges in the implementation of home-school-community collaboration have been identified, how to systematically construct targeted strategies in the unique social, cultural, and educational context of China still needs more empirical support. The study, by conducting an in-depth analysis of home-school-community collaboration practices across different regions and types, aims to provide empirical evidence grounded in the Chinese context to promote theoretical innovation and practical development in the field.

3. Research Methods

a. Research Design

The study adopts a qualitative case study approach, aiming to explore the challenges and coping strategies encountered in the practice of home-school-community partnership in China. The case study method was chosen primarily because it allows for an in-depth examination of real-life contexts, providing rich and contextualized analysis of complex social phenomena. Specifically, the study employs a multiple-case design, selecting three kindergartens in southern China as research sites. These three kindergartens are representative in terms of organizational type and socio-economic background. By comparing and analyzing multiple cases, it is possible to identify practical patterns in home-school-community partnerships within specific contexts as well as common features across different contexts.

From a theoretical perspective, the study is guided by interpretivism, focusing on the multiple realities constructed by different stakeholders (such as teachers, parents, and community members) in the process of participating in partnerships. The study does not aim for universal conclusions, but rather seeks to develop an in-depth understanding that is explanatory for specific practice contexts and to provide reference for home-school-community collaboration in similar settings. The entire study spanned eight months, with continuous engagement and in-depth observation of each case, which enhanced the reliability of the research process and the credibility of the findings.

b. Case Selection

The study adopted a purposive sampling method, selecting three representative kindergartens as research cases. These cases are information-rich and can effectively reflect the core issues in home-school-community partnerships. The selection of cases was based on the following three criteria.

- (1) covering three organizational types: public, private, and community-run kindergartens.
- (2) diversity in the socio-economic backgrounds of the regions.
- (3) all having implemented home-school-community collaboration practices on a certain scale, with observable evidence of implementation.

The selected cases are as follows.

Case A: A public kindergarten located in the city center, long engaged in parental involvement initiatives, with a relatively mature collaboration foundation.

Case B: A private kindergarten located in the urban suburbs, mainly serving middle-class families, with relatively active home-school interactions.

Case C: A community-run kindergarten located in the urban-rural fringe area, where the region is undergoing social transformation, making the home-school-community relationships typical and unique.

Through the strategy of multi-type and multi-background purposive sampling, the study was able to examine the practical forms of home-school-community partnerships in different institutional environments and socio-economic contexts, thereby identifying common issues and contextual differences through comparison. Each case represents a "typical" practice within its type of kindergarten, rather than an extreme or exceptional instance, which also enhances the reference value of the research findings for practices in similar kinds of kindergartens.

c. Data Collection Methods

The study employed a diversified data collection approach in order to comprehensively capture different dimensions of home-school-community partnership practices, specifically including the following three methods:

Semi-structured interviews: A total of 25 participants were interviewed, covering various groups such as kindergarten principals, teachers, parents, and community representatives. The interview guides were tailored according to the roles of different stakeholders, while the content focused on common themes regarding perceptions, practices, and challenges of partnerships.

Participatory observation: A total of 15 home-school-community collaborative activities were observed, including parent-teacher meetings, campus events, community volunteer services, and parent education workshops. During the observation, we paid attention not only to the organizational forms and formal procedures of the activities but also to the informal interactions and authentic details.

Document analysis: A total of 32 relevant documents were collected and analyzed, including partnership policy texts, communication records, activity plans, and evaluation reports. These documents not only provided important background information but also cross-validated data from other sources, enhancing the reliability of the evidence chain.

Through the comprehensive application of the above methods, the study achieved triangulation of data sources, whereby cross-comparison and mutual support among multiple methods were conducted, thereby enhancing the validity of the research findings. The strategy not only helps to overcome the limitations that may arise from a single research method but also allows for a multi-perspective presentation of the overall picture of home-school-community partnerships, forming a more systematic and in-depth understanding.

d. Data Analysis

Data analysis adopts a thematic analysis approach, combining both deductive and inductive coding strategies. An initial coding system is established based on existing research questions and theoretical frameworks, while maintaining openness to themes naturally emerging from the data. The specific analysis process is as follows.

Data immersion and familiarization: Through repeatedly reading interview transcripts, field notes, and relevant documents, an overall understanding of the data is developed.

Preliminary coding and labeling: The dataset is systematically reviewed to create concise labels for identified features.

Theme clustering and development: Related codes are categorized and integrated to form a set of potential themes, with a complete collection of supporting data for each theme.

Theme verification and validation: The fit of themes with the original data is examined to ensure internal logical consistency and mutual independence.

Theme definition and refinement: The boundaries of each theme are clarified, their connotations are detailed, and clear theme names are established.

Throughout the process, analytical memos are written to continuously record key insights, theoretical connections, and methodological decisions emerging from the research. The analysis process considers both the semantic level (surface-level content) and the latent level (deep conceptual framework), allowing for dual-pattern recognition.

e. Ethical considerations

The study strictly adheres to the ethical guidelines of educational research. Specific measures include obtaining informed consent from all participants before the study begins; using pseudonyms in data recording and presentation of findings to protect personal identity and privacy; and encrypting and securely storing all raw data involving private or sensitive information to prevent information leakage.

In addition, the study pays special attention to the power dynamics present in the specific context of kindergartens, particularly when interviewing stakeholders such as principals, teachers, and parents. Care is taken to avoid affecting their daily relationships through the research process. Each participant is clearly informed that their participation is entirely voluntary and that they have the right to withdraw unconditionally at any stage of the study. At the same time, participants are given the opportunity to verify or review how their statements are quoted and presented in the paper.

4. Research Findings

a. Main Challenges of Home-School-Community Partnership

i. Structural and Mechanistic Flaws

In all cases, a core challenge lies in the lack of institutionalized mechanisms to support sustained collaboration between families and schools. Although each research site has established some form of partnership activities, these activities largely depend on individual efforts (e.g., class teachers' capabilities and enthusiasm) and lack systematic institutional support. As one kindergarten principal stated, "We do have a parent committee, but its actual operation relies heavily on the personal abilities and enthusiasm of the class teacher. Once the class teacher is replaced, the entire collaboration system could change or even collapse." (Principal of Case B)

The structural instability is further exacerbated by the lack of effective coordination among different collaborative activities. For example, parent education programs and community resource activities often operate independently, making it difficult to create synergistic effects. Document analysis also shows that relevant planning is mostly ad hoc and fails to establish an organic connection with broader educational goals or child development outcomes. In addition, unclear role definitions are another prominent structural challenge. Teachers generally report a lack of clear boundaries of responsibility when interacting with parents; parents mostly express that beyond complying with teachers' requests, they are unsure how to more substantively participate in collaboration; and community organizations lament that their resources are difficult to integrate into the regular kindergarten curriculum, with cooperation often limited to one-time activities.

ii. Unequal Stakeholder Participation

Research has found significant differences in the participation of stakeholders from different backgrounds in partnerships. Of particular concern is that some parent groups remain consistently absent from various collaborative activities. As one teacher pointed out: "Parents who are usually actively involved mostly have higher education levels and more flexible work schedules. In contrast, parents from migrant families or those engaged in high-intensity work rarely show up—even though their children often need educational support the most." (Case C Teacher)

This differentiation creates a self-reinforcing cycle: parents who participate frequently establish close connections with the kindergarten, while those with low participation gradually drift away from the educational community. Several teachers reported challenges in communicating with parents of different cultural backgrounds or social classes, as existing standardized communication methods fail to resonate with these groups. A deeper issue lies in the imbalance of power structures. Teachers often regard themselves as professional guides and see parents as implementers of instructions rather than as partners with complementary value. This one-way interaction model both diminishes the agency of parents and restricts the genuine development of an educational community. As shown in Figure 2.

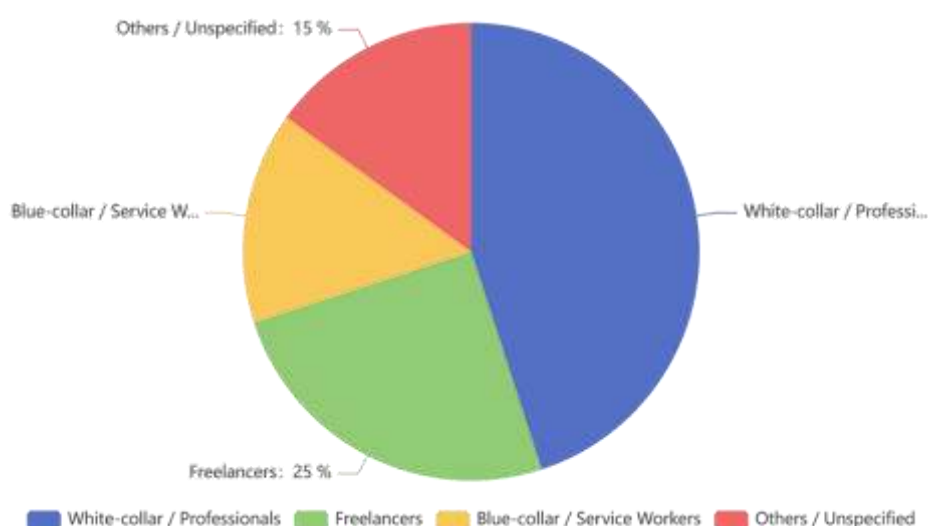


Figure 2: Participation Rate of Parents from Different Professional Backgrounds in Kindergarten Activities

Source: Official Information from Luopu Central Kindergarten

iii. Resource Integration Limitations

Although all parties generally recognize the importance of resource sharing, studies show that kindergartens in all cases still face substantial limitations in effectively integrating family, school, and community resources. Kindergarten leaders reported that there were currently three main constraints: a lack of full-time personnel to coordinate partnerships, insufficient funding for collaborative activities, and limitations in the physical spaces available for family and community participation.

A particularly prominent issue is that community resources have not been fully explored and utilized. Common potential educational resources in the vicinity of kindergartens, such as parks, libraries, enterprises, and cultural institutions, are mostly not systematically incorporated into

curriculum and activity design. Even when some resources are introduced, interactions often remain superficial and have yet to achieve deep integration with educational goals.

In terms of digital integration, technology platforms present both opportunities and challenges. Although all kindergartens have established WeChat groups as communication channels, their functions are mostly limited to one-way information dissemination by the school and have not effectively facilitated equal dialogue and in-depth communication between home and school. In addition, concerns arise regarding the boundaries of digital communication: teachers are cautious about the line between work and personal life, and parents have doubts about the appropriateness of after-school communications. See Table 2.

Table 2: Key Challenges in Home-School-Community Partnerships

Challenge Category	Specific Manifestations	Impact on Partnerships
Structural Mechanisms	Lack of institutionalization, ad hoc planning, ambiguous roles	Fragmented collaboration, sustainability issues
Participation Imbalances	Socioeconomic disparities, cultural barriers, power imbalances	Limited perspective inclusion, reinforcement of existing inequities
Resource Integration	Underutilized community assets, limited coordination capacity, digital communication challenges	Missed synergistic opportunities, inefficient resource use

b. Emerging Strategies for Effective Partnerships

i. Structural Innovation and Mechanism Development

The most effective path to improvement lies in systematically restructuring the partnership mechanism rather than simply adding isolated activities. Case A, through its innovative "Triple Helix" collaboration model, established a multi-dimensional coordination structure at the kindergarten, grade, and class levels. The multi-level design not only provides clear pathways for different types of collaboration but also achieves joint stakeholder participation through the rational allocation of leadership roles.

Another key initiative is the establishment of a dedicated partnership coordinator. In Case B, the role carries three core functions: mapping community resources, overseeing the implementation of collaborative activities, and providing professional support for teachers to engage in home-school interactions. Teachers generally reported that the specialized coordination mechanism effectively addressed common issues in previous work, such as dispersed resources and poor continuity.

In addition, several practice sites have also implemented an annual collaboration planning system, achieving a deep alignment between educational goals and collaborative activities through systematic design. These plans not only clarify expected objectives, specific actions, responsibilities, and evaluation criteria, but, more importantly, establish mechanisms for stakeholder involvement in their formulation. Document analysis indicates that plans developed through joint consultation demonstrate significant advantages in both implementation quality and breadth of participation.

ii. Inclusive Participation Approaches

To address the issue of uneven participation in home-school cooperation, the following strategies have achieved significant results in practice.

The first strategy involved actively reaching out to specific families. The "Family Partnership Ambassador" program implemented by Case C Kindergarten recruits parents with similar cultural backgrounds as liaisons, effectively building a communication bridge between the kindergarten and families with lower willingness to participate. After implementing the program, the participation rate of migrant parents in Case C increased by 35% within three months, and 82% of these parents reported feeling 'more connected to the kindergarten' in follow-up interviews. The approach significantly enhanced the integration of parent groups that were previously on the periphery of participation.

Second, providing diversified participation channels to meet the needs of different families. Kindergartens no longer require parents to uniformly attend standardized activities but design differentiated participation methods based on the actual situation of each family, including flexible scheduling (such as adding weekend sessions), using mixed online and offline formats, and developing various types of participation content. As one teacher stated, "We have shifted from asking 'Why don't parents participate?' to thinking 'How can we create participation opportunities suitable for different families?'" The shift in mindset is crucial for expanding the scope of participation."

Additionally, implementing a systematic capacity-building plan. Several kindergartens conduct parent workshops to help parents master knowledge of child development and family guidance methods; at the same time, they organize specialized training for teachers to enhance their home-school communication skills and cultural responsiveness. These complementary trainings effectively fill gaps in professional knowledge among all parties, laying the foundation for establishing truly equal partnerships.

iii. Resource Optimization and Digital Integration

A successful resource integration strategy first relies on a systematic community asset mapping, which involves systematically identifying and categorizing the potential resources available around kindergartens and aligning them with educational goals. For example, Case B demonstrates a relatively mature approach: in addition to finely classifying resources according to their educational functions and application scenarios, it also establishes a clear and convenient resource utilization mechanism, significantly increasing teachers' willingness to utilize the community resources.

In terms of digital support, some kindergartens are promoting the upgrade of communication platforms from basic functions to a structured digital ecosystem. Beyond regular WeChat communication, they have built specialized resource-sharing libraries, theme discussion areas, and online volunteer participation channels, providing parents with diverse participation options according to different needs and usage habits, especially expanding virtual participation opportunities for families with time constraints.

Effective resource integration also requires establishing a mutually beneficial and reciprocal collaboration mechanism. While kindergartens introduce community resources, they also proactively open their own facilities and professional capabilities to the community, creating a bidirectional flow of resources. For example, opening activity spaces to the community during non-teaching hours and organizing parent-child workshops for families. The mutually beneficial mechanism enhances engagement from all parties, thereby improving the sustainability and stability of partnerships.

5. Discussion

a. Interpreting Challenges in the Context of China

The challenges of home-school-community collaboration revealed in the study not only reflect the common contradictions in this field but also highlight the unique difficulties within the Chinese educational context. From the perspective of partnership mechanisms, their structural fragility aligns closely with issues identified in international research—collaboration often remains at the periphery of educational practice and fails to truly integrate into the core of institutional operations. The phenomenon is particularly pronounced in the Chinese context, attributable to the long-established tradition of 'exam-oriented education', which emphasizes the transmission of academic knowledge while paying insufficient attention to the holistic development encouraged by home-school-community cooperation.

Regarding the issue of uneven participation, it must be understood within the context of China's unique socio-economic development. Differences in parental involvement essentially reflect structural inequalities such as urban-rural disparities, population mobility, and class stratification. These realities inadvertently create barriers to broad and equitable participation. Research shows that without conscious institutional intervention, home-school-community collaboration may unwittingly exacerbate educational inequities—families with better resources gain more support, while the groups that genuinely need help struggle to benefit.

At the level of resource integration, the development of digital platforms particularly highlights the complex interplay between technological potential and real-world relational structures. Although digital tools theoretically enable instantaneous connectivity between families, schools, and communities, in practice they often follow existing one-way communication patterns and fail to facilitate fundamental changes in relationships. This indicates that purely technological solutions, if not coupled with relational restructuring, are unlikely to overcome the deep-rooted implementation bottlenecks in home-school-community collaboration.

b. Strategic Insights on Partnership Development

Based on the findings of the case study, enhancing home-school-community partnerships requires strategic innovation to be advanced through three aspects: systematic construction, differentiated participation, and relationship reconstruction.

First, partnerships should be promoted from fragmented activities to systematic institutional development. Practices in structural innovation indicate that effective collaboration mechanisms need to be fully integrated into the education governance system, becoming a core element of kindergarten operations. This requires multi-dimensional support at the policy level: not only should national-level guidance documents be issued, but kindergartens should also incorporate partnerships into routine work plans and performance evaluation systems, achieving a shift from marginal support to a core educational function.

Second, the successful practice of inclusive participation highlights the importance of culturally responsive cooperation. Effective partnerships should fully respect the diversity and differences in family backgrounds, avoiding one-size-fits-all participation requirements. Kindergartens need to deeply understand the characteristics of their communities and develop contextually adaptive collaboration methods. Research confirms that successful partnerships are essentially co-constructed with specific communities, rather than simple replications of standardized programs.

Finally, the evolution of resource integration strategies reveals a profound transformation in the nature of partnerships—from a transactional relationship to transformative co-creation. The most constructive approach is to establish a two-way, mutually beneficial mechanism, allowing families and communities to shift from passive resource providers to co-creators. The transformation echoes cutting-edge international research: truly powerful synergies are realized when participants break through traditional role limitations and create new value through deep collaboration.

c. Theoretical Contribution

The study expands the theoretical framework of home-school-community partnerships from three dimensions.

First, by revealing the central role of institutionalization processes in sustaining collaborative practices, it addresses the gaps in existing theories. Although previous research acknowledges the importance of contextual factors, there is still a lack of systematic explanation of how partnerships transition from relying on individual agency to being embedded in institutional structures. The study shows that successful institutionalization requires the coordinated advancement of structural arrangements, cultural shaping, and practice innovation.

Second, the study deepens theoretical understanding of home-school-community interaction mechanisms in the digital era. As digital platforms become important conduits for connecting various parties, theoretical models need to adequately explain how technology reshapes collaborative relationships. The study finds that while digital tools enhance communication efficiency, they may also constrain the development of deep trust, indicating that online interactions and offline exchanges are complementary and together form a complete collaborative ecosystem. This finding aligns with social capital theory, which emphasizes that trust is the core of social capital—digital tools, without face-to-face interaction, struggle to foster the mutual trust needed for high-quality partnerships.

Finally, the study promotes the localization of partnership theory. By examining how international experiences transform within the context of Chinese education, we find that universally applicable collaboration principles require filtering and adaptation for cultural suitability. This finding not only confirms the cross-cultural validity of certain theoretical elements but also highlights the necessity of establishing a theoretical framework that integrates universal principles with local characteristics, thereby providing new conceptual tools for subsequent research.

6. Conclusions and Insights

a. Conclusions

The study, based on case examinations of kindergartens in China, systematically analyzes the challenges and corresponding strategies faced by home-school-community partnerships in practice. The study finds that although policy emphasizes collaboration among home, school, and community, significant issues still exist in actual implementation, such as underdeveloped structural mechanisms, uneven participation among stakeholders, and insufficient capacity for resource integration. These challenges not only reflect common problems in home-school-community collaboration but also highlight unique difficulties within China's specific educational and social context. Regarding response strategies, the study identifies several practically valuable approaches, including establishing institutionalized collaboration mechanisms, implementing differentiated participation methods, and creating collaborative models for resource sharing. These strategies not only address China's unique context (e.g.,

leveraging WeChat for localized communication) but also draw on international experiences (e.g., Epstein's six types of involvement framework for structured collaboration). Effective strategies focus not only on the execution of specific activities but also on deeply embedding the concept of partnership into the core of educational practice, promoting a shift of home-school-community collaboration from peripheral support to systematic integration. Theoretically, the study expands the explanatory framework for context-specific implementation of home-school-community collaboration, and practically, it provides action-oriented references based on local experience for various stakeholders.

b. Practical Implications

Based on the research findings, the following recommendations are proposed for different stakeholders.

Educational institutions should focus on building a systematic partnership framework, clarifying the responsibilities of all parties, establishing dedicated coordination positions, and incorporating the goals of home-school-community collaboration into regular planning and evaluation systems. At the same time, they should design diverse participation channels to accommodate different family backgrounds and needs, enhancing inclusiveness and effectiveness.

Policymakers need to promote the development of long-term policies that support collaboration, establishing home-school-community collaboration as an important component of education quality assessment. It is recommended to strengthen resource allocation, establish incentive and accountability mechanisms, and address structural barriers that prevent disadvantaged families from participating, thereby promoting educational equity.

Teacher professional development programs should enhance teachers' abilities in family communication, community resource integration, and collaborative leadership, integrating partnership-building skills into both pre-service and in-service training programs. This will improve teachers' cultural sensitivity and practical guidance in handling diverse family backgrounds.

c. Research Limitations and Future Directions

The study primarily adopts a qualitative case study approach, which can deeply present the practical logic in specific contexts but has certain limitations in generalizing conclusions. Future research could expand the sample size to cover more regions and educational stages, thereby enhancing the representativeness and applicability of the findings.

Additionally, in terms of research methodology, a combination of quantitative and qualitative methods could be employed, using longitudinal tracking or experimental design to more deeply reveal the mechanisms and pathways through which home-school-community collaboration affects child development.

Cross-cultural comparison is also a promising research direction. By systematically comparing with international cases, it is possible to further distinguish the universal patterns and cultural characteristics of home-school-community collaboration, providing deeper theoretical support for localized practice.

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Problems and Optimization of Faculty Incentive Mechanisms in Chinese Private Universities: A Case Study of Guangdong Xinhua University from the Perspective of Equity Theory

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Abstract

The study employs Guangdong Xinhua University as a case study to explore the problems and optimization paths of faculty incentive mechanisms in Chinese private universities, using Adams' Equity Theory as its analytical framework. Through a questionnaire survey of 150 teachers and in-depth interviews with 20 teachers and administrative staff, the study identifies significant fairness issues in the current incentive mechanism across three dimensions: In terms of distributive fairness, there are issues such as a mismatch between workload and compensation, and performance-based pay overly favoring research output; in terms of procedural fairness, there are defects such as opaque evaluation criteria and teachers lacking a voice; in terms of interactional fairness, there is a lack of respect and explanation in decision-making communication. The study further found that teachers generally develop a self-perception of being "second-tier scholars" through internal peer comparisons and external benchmarking against public universities, which directly affects their work enthusiasm and organizational commitment. Based on these findings, the paper proposes a comprehensive optimization framework from the perspective of organizational fairness: establish a multi-dimensional reward system covering teaching, research, and service; create transparent and participatory evaluation procedures; enhance managers' communication training; and guide teachers to form a more reasonable reference framework through strategic communication of the institution's unique value proposition. The study offers theoretical contributions and practical implications for private universities to enhance teacher cohesion and build a high-quality faculty team through improving institutional fairness.

Keywords: Private Universities; Teacher Incentives; Equity Theory; Organizational Justice; Incentive Mechanisms

1. Introduction

Since the late 1990s, China's higher education system has undergone a structural transformation, with the rapid rise of private universities becoming a significant driving force. Private universities have gradually developed from being on the periphery of the higher education system into an indispensable component, playing a key role not only in expanding enrollment but also in enriching curriculum offerings and promoting educational diversity. However, the rapid development has also brought new challenges: private universities face more intense competition than public institutions in resource acquisition, reputation building, and high-quality faculty recruitment. Unlike public universities, which enjoy stable financial support and traditional prestige, private universities must seek survival and development in a

market-oriented environment. The unique context means their core competitiveness fundamentally depends on establishing and maintaining a high-quality faculty. Building an effective teacher incentive mechanism thus becomes crucial to achieving the goal. While incentive mechanisms are a universal concern in higher education, private universities face distinct challenges due to their unique institutional contexts. Firstly, their higher reliance on tuition revenue imposes more limits on resource allocation; secondly, as participants in the education market, they must continuously demonstrate their operational effectiveness; moreover, the lack of the job security and career stability found in public universities makes talent retention a greater challenge. See Table 1.

Table 1: Comparison of Core Benefits for Faculty in Chinese Public vs. Private Universities

Compensation indicators	Public universities (average)	Private universities (average)	GXU
average annual salary	285,000	182,000	168,000
annual research funding	52,000	18,000	15,000
housing subsidy coverage rate	85%	32%	28%
promotion pass rate for professional titles	42%	25%	22%

Empirical observations show that many private universities currently face difficulties in faculty development: on one hand, it is hard to attract high-level talent, and on the other, issues such as professional burnout, low work motivation, and high turnover exist within the current faculty. These phenomena reflect deep-seated problems in the design and implementation of existing incentive mechanisms. The study suggests that addressing these issues should not merely focus on raising salaries but should delve into the core element of perceived fairness within the incentive system. Based on this understanding, The study introduces Adams' equity theory as an analytical framework. Through the social comparison mechanism of "input-output ratios," the theory provides a systematic tool for understanding organizational members' perceptions of fairness and their behavioral responses. When teachers perceive unfairness, they may exhibit negative behaviors, including reduced work input, decreased organizational commitment, and even resignation, all of which can seriously impact the sustainable development of the institution. The study selects Guangdong Xinhua University (GXU) as a typical case and aims to achieve the following research objectives:

1. Systematically diagnose the specific problems existing in the teacher incentive mechanisms of private universities, with a particular focus on teachers' subjective perceptions of fairness.
2. Apply the analytical framework of equity theory, especially from the perspectives of distributive fairness, procedural fairness, and interactional fairness, to deeply analyze the mechanisms generating these problems.
3. Based on empirical findings, construct an optimized incentive mechanism centered on enhancing perceived fairness, thereby improving teacher motivation, strengthening team stability, and ultimately promoting the overall quality of education at private universities.

2. Literature Review

a. Teacher Incentive Mechanisms in Higher Education

In the global education sector, teacher motivation is generally seen as a complex dynamic system composed of both intrinsic and extrinsic factors. The system contains two fundamental dimensions: intrinsic motivation mainly stems from teachers' passion for teaching, their desire to explore knowledge, and their pursuit of academic truth (Yangqin Wang, 2025); whereas extrinsic motivation is manifested in dual drivers of material rewards (such as salary and benefits, promotion opportunities, and research funding) and psychological recognition (such as academic reputation and professional awards). An effective incentive system must achieve an organic integration and dynamic balance of these two dimensions.

Existing research indicates that Western higher education institutions usually achieve the balance by establishing clear career development pathways, providing comprehensive research support systems, and ensuring teachers' autonomy in teaching and research (Honggui Xiang, 2021). However, contemporary higher education management faces a profound tension between traditional academic ideals and modern management paradigms: on the one hand, academia has historically valued intrinsic principles such as cooperation, sharing, and academic conscience; on the other hand, influenced by the new public management movement, extrinsic incentive models emphasizing performance metrics, accountability, and market mechanisms are becoming increasingly prevalent. The conflict in value orientation puts many universities in a dilemma: overemphasis on quantifiable metrics may undermine teachers' academic motivations, while relying solely on traditional incentives struggles to meet the demands of modern university governance.

The tension is especially evident in the context of private universities in China. Due to stronger resource constraints and greater competitive pressures, these institutions tend to adopt performance-oriented extrinsic incentives. However, if such an outwardly focused approach lacks sufficient consideration of teachers' intrinsic needs, it can easily cause structural imbalances in the incentive system, leading to issues such as crisis in professional identity and decline in work motivation among teachers. Therefore, how to maintain full respect for and effectively stimulate teachers' intrinsic motivation within the framework of new public management has become a central issue in the construction of faculty teams in contemporary private universities.

b. The Unique Background of Private Universities in China

Private universities in China exhibit characteristics significantly different from public universities in terms of institutional environment, resource conditions, and development pathways, and these characteristics together shape their unique development context.

First, in terms of resource acquisition, private universities mainly rely on tuition fees and social capital investment, receiving limited government financial support. The resource structure results in relatively tight funding, leading school operators to focus more on cost control and operational efficiency (Zhang Xiangchen, 2025). The resource constraint not only affects the construction of school facilities but also profoundly limits faculty development and the quality of talent cultivation.

Second, in terms of development positioning, due to the lack of historical accumulation and research foundation found in public key universities, private universities generally choose differentiated development paths, focusing on applied and vocational education. The positioning is both a response to market demand and a rational choice within the current higher education framework. Correspondingly, their faculty composition also shows distinctive

characteristics: retired teachers from public universities contribute mentorship, newly graduated PhDs seek career starting points, and industry professionals undertake practical teaching. The diversified faculty structure provides rich teaching experience but also places higher demands on faculty management.

Moreover, regarding the teacher development environment, faculty in private universities face unique work challenges. Compared with their counterparts in public universities, they often need to take on a heavier teaching load, manage larger class sizes, and handle more administrative tasks. However, in terms of career security, private university teachers often have fewer resources for professional development and lower job security, with relatively limited social recognition (Huang Hong, 2020). The "high workload-low security" work characteristic makes designing faculty incentive mechanisms more complex and challenging for private universities.

In summary, the unique institutional environment, resource conditions, and chosen development paths of private universities in China collectively form the practical foundation for designing faculty incentive mechanisms and determine that directly applying the experiences of public universities is unlikely to achieve the desired results.

c. Equity Theory and Organizational Justice

Adams' equity theory, proposed in 1965, suggests that an individual's motivation in an organization depends not only on the absolute value of the rewards they receive but also on their subjective perception of the fairness of reward distribution. The theory is built on a core assumption: people unconsciously form a ratio between their inputs (including effort, working hours, professional qualifications, emotional commitment, etc.) and outputs (such as salary and benefits, career advancement, organizational recognition, job security, etc.), and compare the ratio socially with a chosen referent (such as colleagues, peers, or their own past experiences).

When individuals perceive a discrepancy between their input-output ratio and that of their referent, psychological tension and feelings of unfairness arise. To alleviate the discomfort, individuals may adopt various coping strategies: adjusting their inputs (e.g., reducing work effort), seeking changes in outputs (e.g., pursuing salary increases or promotions), cognitively reevaluating inputs and outputs, changing the referent, or in extreme cases, choosing to exit the current environment (resignation).

With the development of the theory, Stephen Deepak and Syed Khalid Perwez (2018) systematically expanded the equity theory to form a more detailed three-dimensional model of organizational justice:

Distributive justice: Focuses on the fairness of resource allocation outcomes, i.e., an individual's subjective judgment of whether the rewards they receive (such as salary, promotion opportunities, or resource allocation) are commensurate with their contributions. In the context of higher education, this directly relates to teachers' perceptions of the fairness of income levels, title evaluations, workload arrangements, and access to academic resources.

Procedural justice: Emphasizes the fairness of the decision-making process. Its core lies in whether the principles are followed when creating and implementing policies, including transparency of the decision-making process, consistency in the application of standards, accuracy of evaluation bases, the correctability of errors, and inclusiveness and voice of stakeholders.

Interactional justice: Focuses on the quality of interpersonal interactions in the implementation of policies. It manifests in two aspects: firstly, fairness in interpersonal treatment—whether individuals receive due dignity and respect in interactions; secondly,

fairness in the handling of information—whether the organization provides individuals with adequate and sincere explanations and communications regarding the basis and outcomes of decisions.

The theoretical framework provides a solid foundation for in-depth analysis of perceived fairness in the incentive mechanisms of teachers in Chinese private universities. The three dimensions together constitute a comprehensive cognitive map for teachers to evaluate organizational justice, and the absence of any dimension may trigger overall perceptions of unfairness, thereby affecting teachers' work attitudes and behavioral choices.

d. Research Gaps and the Positioning of the Paper

Although existing research literature on higher education in China has been increasingly rich, there are two significant research gaps: First, most existing studies focus on the public university system or remain at the macro-policy level of private education development, while empirical research on the internal human resource management mechanisms of private colleges, particularly the teacher incentive mechanisms at the micro level, is relatively scarce; second, although the fairness theory in the field of organizational behavior provides a mature theoretical framework for analyzing employee motivation, research systematically applying it to the specific institutional context of Chinese private universities is still insufficient.

Based on this, The study establishes its academic positioning: using fairness theory as the foundational framework and employing empirical research methods, it deeply analyzes issues of perceived fairness in teacher incentive mechanisms in Chinese private universities. The research not only helps expand the application boundaries of organizational fairness theory within a specific educational system context but also provides new theoretical perspectives and practical insights for understanding the challenges of teacher motivation in private universities.

3. Research Methods

a. Research Design and Case Selection

The study employs a mixed-methods approach and conducts an in-depth analysis using GXU as a research case. The selection of the case is based on the following considerations: First, GXU, as a relatively large private university in South China with a long history of running schools, is representative in terms of its educational model and development trajectory. Second, the university features applied programs in engineering, business, and the arts, and the challenges related to its faculty structure and incentive mechanisms are typical among private universities. The in-depth exploration characteristic of the case study helps us gain a deeper understanding of the complex phenomenon of faculty incentive mechanisms in private higher education institutions.

To address the gap in applying equity theory to Chinese private universities, the study adopts a mixed-methods design: quantitative surveys measure teachers' perceptions of distributive, procedural, and interactional fairness, while qualitative interviews explore the root causes of these perceptions—ensuring both breadth and depth of analysis.

b. Research Process and Data Collection

The study lasted for three months and employed a combination of quantitative and qualitative methods to collect data. The specific process is as follows:

During the quantitative research phase, a stratified random sampling method was used to select 300 full-time teachers from GXU as survey participants. Through online anonymous

questionnaires, a total of 150 valid responses were collected, resulting in an effective response rate of 50%. The research instrument was adapted from the Organizational Justice Scale developed by Colquitt (2001) and appropriately revised to fit the characteristics of private higher education institutions. The questionnaire mainly consisted of four parts: basic demographic variables, organizational justice perception scale (covering distributive justice, procedural justice, and interactional justice), work attitude scale (including job satisfaction and organizational commitment), and turnover intention scale. All scales used a 5-point Likert scoring method.

During the qualitative research phase, based on the results of the quantitative data analysis, purposive sampling was used to select 20 participants for in-depth interviews. The sample included 15 teachers from different academic disciplines (8 lecturers, 4 associate professors, and 3 professors) and 5 individuals with management experience (including 2 deans, 1 head of human resources, and 2 department chairs). The interviews were conducted in a semi-structured manner, lasting an average of about 50 minutes each, fully recorded, and transcribed into written text, ultimately resulting in approximately 100,000 words of interview transcripts.

c. Data Analysis Methods

The study employed a sequential explanatory mixed-methods approach for data analysis. First, quantitative data were processed using SPSS statistical software: descriptive statistics were used to analyze teachers' basic information and the distribution characteristics of key variables; correlation analysis was conducted to explore the relationships between various dimensions of organizational justice and work attitudes and turnover intentions. Subsequently, qualitative data were analyzed thematically: open coding was used for initial categorization of interview materials, axial coding was employed to establish connections between concepts, and finally, selective coding was applied to integrate the core themes. This analytical process was consistently guided by justice theory and the organizational justice framework.

Through mutual validation and supplementation of quantitative and qualitative data, methodological triangulation was achieved, ensuring the reliability of the research results while deepening the understanding of the mechanisms underlying the phenomena. The mixed-methods design allowed us to grasp both the overall situation of teacher motivation issues and to explore in depth their specific manifestations and underlying causes..

4. Research Findings and Analysis

The study, through questionnaires and in-depth interviews, found that teachers at GXU generally have a negative perception of the fairness of incentive mechanisms. These perceptions are mainly reflected in three dimensions: distributive fairness, procedural fairness, and interactional fairness, and are further reinforced through the process of social comparison.

a. Manifestations of Distributive Fairness Imbalance

Quantitative data show that fair distribution is the lowest-rated area among the three dimensions. See Table 2.

Table 2: GXU Faculty's Perception Scores of Organizational Justice (N=150)

Fairness dimension	Average score (5-point scale)	Standard deviation	Proportion of agreement	Proportion of disagreement
Fair distribution	2.45	0.82	28%	45%
Procedural fairness	2.78	0.75	31%	38%

Interaction fairness	2.32	0.88	22%	52%
Overall organizational fairness	2.52	0.71	26%	43%

Teachers generally reported a significant imbalance between input and reward. Only 28% of teachers agree with the idea that 'workload is fairly compensated,' with an average score of 2.45 (out of 5)—well below the midpoint of 3, indicating widespread dissatisfaction. Distribution Structure of GXU Performance-Based Pay is shown in Figure 1.

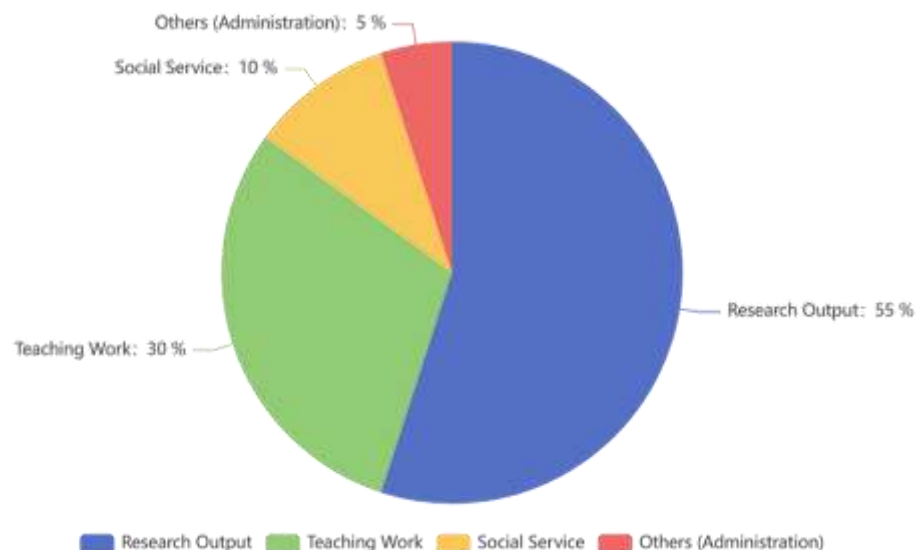


Figure 1: Distribution Structure of GXU Performance-Based Pay

Source: Official Information from GXU

The sentiment is further reflected in interviews: an associate professor from the Business School noted that "Each week, I handle more than 20 class hours of teaching, supervise over ten students' graduation theses, and participate in the routine work of two school committees. However, my salary level is only slightly higher than that of a newly hired lecturer who focuses solely on teaching. The current distribution system fails to accurately reflect the comprehensive contributions of teachers."

In addition, the bias in the performance-based salary system is also a prominent issue. The current incentive mechanism clearly favours research output, particularly the rewards for SCI-indexed journal papers, which stand in stark contrast to the returns for teaching efforts. An engineering lecturer admitted: 'The annual reward for a single SCI paper equals about three months of my basic salary. In contrast, teachers devoted to applied teaching and course development find it difficult to obtain corresponding recognition. The orientation essentially conveys a one-sided value of 'prioritizing research and undervaluing teaching.'

b. Institutional Flaws in Procedural Fairness

Research shows that only 31% of teachers believe that performance evaluation procedures are sufficiently transparent. The lack of procedural fairness directly undermines teachers' trust in the system.

In interviews, teachers frequently mentioned the ambiguity and variability of evaluation criteria. A senior lecturer from the School of Design noted, "Promotion standards lack stability and predictability; these standards are frequently adjusted from year to year without necessary

explanations. The situation makes it difficult for teachers to plan their careers clearly, as if they are constantly chasing a moving target."

A deeper issue lies in the absence of mechanisms for teacher participation. Most teachers stated that they lack effective voice in the policy-making process concerning their own career development. Although administrators acknowledge the adoption of a "top-down" management model, they attribute it to considerations of "operational efficiency", reflecting a deficiency of democratic participation in the design of the management system.

c. The Lack of Practice in Interactional Fairness

The quality of interactions within an organization significantly affects teachers' perception of fairness. Many young teachers describe themselves as being treated like "standardized parts" within the organization, lacking the individual respect they deserve.

One teacher's experience is quite representative: "After my promotion application was rejected, I only received a standardized system notification. When I approached the college leadership for a specific explanation, the response was vague and failed to provide a clear rationale based on the established evaluation criteria. This way of handling things made me feel that my professional abilities were not given the respect they deserve."

d. The Reinforcing Effect of Reference Comparisons

The social comparison mechanism in equity theory is fully validated in The study. Teachers' perceptions of fairness are primarily formed through two comparison pathways:

In terms of internal comparisons, teachers often compare workload, resource support, and development opportunities across departments and disciplines. Such comparisons frequently trigger a sense of relative deprivation within the organization.

The impact of external comparisons is even more significant, with comparisons to public institutions being an important source of perceived unfairness among teachers. A professor with experience in public universities noted: "Compared to colleagues still working in public universities, we face heavier teaching loads, yet we receive significantly less research support, welfare benefits, and job stability. The stark contrast intensifies our sense of psychological disparity."

These ongoing reference comparisons not only reinforce individuals' feelings of unfairness but also foster a collective identity of a 'secondary academic group' at the organizational level, profoundly undermining teachers' morale and organizational commitment.

Notably, teachers rarely recognize the unique advantages of private universities—such as closer industry-academia collaboration and more flexible curriculum design—when comparing themselves to public institutions.

5. Discussion: An In-depth Interpretation Based on Equity Theory

The study reveals a core finding: the incentive mechanism for teachers at GXU faces a dilemma that, on the surface, appears to be a managerial operational issue but, in reality, reflects a deep-seated lack of institutional fairness. Through a theoretical interpretation of the survey data, the study found that equity theory provides a powerful analytical framework for understanding teacher attitudes and behaviors.

Firstly, regarding distributive fairness, the current incentive system excessively focuses on the allocation of value based on research output, leading to a distortion in the valuation of

academic labor. The single-directed reward mechanism not only generates strong perceptions of unfairness among teachers who concentrate on teaching and service work but, more importantly, it undermines the institutional recognition of the inherent value diversity that universities should possess. When teaching efforts and service contributions are not reasonably reflected in the compensation system, teachers' trust in organizational fairness begins to erode.

Secondly, the lack of procedural fairness further exacerbates the trust crisis. Non-transparent evaluation criteria, arbitrary changes in promotion requirements, and the absence of teachers' voices in decision-making together constitute a system difficult to accept or identify with. The procedural arbitrariness leads teachers, even when rewarded, to rarely experience a sense of achievement, and when faced with failure, they are more likely to attribute it to systemic injustice. The cognitive pattern directly fosters teachers' sense of alienation from the system and their passive responses.

Particularly noteworthy are issues related to interactional fairness. The mechanical communication and disrespectful feedback demonstrated by the organization during the implementation of incentive policies convey a de-personalizing negative signal to teachers. When teachers' professional value and personal dignity are not fundamentally respected, the psychological contract between them and the organization suffers severe damage. Emotional harm of the nature often proves more destructive than material inequities.

From the perspective of equity theory, GXU teachers, through internal horizontal comparisons and external references, generally perceive their input-output ratio to be disadvantaged. This perceived inequity directly triggers psychological imbalance among teachers, leading them to adjust their behavior to re-establish a sense of fairness, including lowering organizational commitment, reducing extra work effort, strategically avoiding non-assessed tasks, and even opting to leave. These behavioral responses are not only individual psychological defense mechanisms but also inevitable outcomes caused by institutional deficiencies.

It is noteworthy that there is a progressive interaction among the three dimensions of fairness: distributive injustice prompts teachers to question the system, procedural injustice weakens their trust in it, and interactional injustice completely undermines teachers' emotional connection with the organization. This layered negative impact constitutes the systemic challenge that any current reform of the teacher incentive mechanism must address.

6. Optimization Strategies and Recommendations

To address the systemic issues in the incentive mechanisms for faculty at private universities, the study, based on organizational justice theory, proposes a comprehensive optimization plan across the following four dimensions:

a. Building a Diverse Value Recognition System

Establish a comprehensive evaluation mechanism that balances teaching, research, and social service. Specifically, the system includes three measures:

First, designing multi-track promotion pathways, setting up three development paths: teaching-focused, research-focused, and a balanced teaching and research path, with differentiated evaluation criteria for each.

Second, implementing a points-based workload management system, quantifying various tasks such as classroom teaching, thesis supervision, and administrative services uniformly to ensure a match between effort and reward.

Third, establishing special reward funds to provide exceptional rewards to teachers who excel in teaching innovation, research breakthroughs, and social services.

b. Improving Procedural Justice in System Construction

Ensuring fairness from the source of system design:

Form a policy-making team for incentive programs consisting of teacher representatives, academic committees, and administrative departments to ensure that the interests of all parties are fully expressed.

Establish a system for publicizing incentive policies and soliciting opinions; any major policy adjustments should undergo a publicity and opinion collection period of no less than one month.

Develop the "Teacher Career Development Guide", clearly specifying promotion standards, assessment procedures, and timelines for each professional title level, maintaining policy continuity and stability.

c. Fostering an Organizational Culture That Respects Professional Identity

Enhancing teachers' professional recognition through improved management practices:

Implement a "Manager Training Program" focusing on enhancing the communication skills and leadership capabilities of middle management.

Establish a hierarchical feedback mechanism, requiring managers at all levels to conduct one-on-one developmental discussions with teachers at the end of each assessment period.

Create channels for teacher appeals to ensure teachers have a basis and pathway to challenge assessment results.

d. Guiding Teachers' Frame of Reference

Guiding teachers to form reasonable career expectations:

Regularly publish the "White Paper on Private University Teacher Development" to objectively present the current status and unique advantages of private higher education.

Develop distinctive teacher development platforms, such as university-enterprise cooperation workstations and applied research centers, highlighting the practice-oriented advantages of private universities.

Design personalized career development maps to help teachers identify their development paths and growth opportunities within the private education system.

This optimization framework, from system design to cultural cultivation, from procedural regulation to cognitive guidance, forms an organically integrated system of mutual support and synergy, providing a systematic solution for establishing a more scientific, fair, and effective teacher incentive mechanism in private universities.

7. Conclusions

a. Key Findings

The study, based on the framework of equity theory, systematically analyzes the incentive mechanisms for teachers at GXU. The study finds that phenomena such as high teacher turnover, lack of work motivation, and strong organizational alienation fundamentally stem

from teachers' perceived lack of fairness in the dimensions of distribution, procedures, and interaction. Specifically, teachers generally feel that their work input does not match the rewards received, evaluation standards lack transparency and stability, and they do not receive the deserved respect and explanations in organizational interactions.

b. Key Findings

Based on the diagnostic results, The study constructs a multidimensional framework for optimizing incentive mechanisms. The framework goes beyond the traditional focus on salary levels, aiming to create a fairer, more transparent, and motivating academic environment through institutional design. Specific measures include establishing a diversified evaluation system that balances teaching, research, and service; formulating open and transparent promotion and assessment standards; improving organizational communication and feedback mechanisms; and strengthening teachers' rights to participation and voice. These initiatives aim to embed the principle of fairness into organizational systems, thereby promoting a shift in teachers' role perception from 'passive executors' to 'co-builders.'

c. Research Limitations

The study has certain limitations. As a single-case study, although GXU is representative among private universities, future research can explore the differentiated characteristics of different types of private universities through multi-case comparisons. Additionally, long-term tracking of the effectiveness of incentive mechanism reforms will also be a valuable direction for further research.

The study provides important insights for the management practices of private universities. Constructing a fair incentive mechanism is not only a technical issue in human resource management but also a strategic core for private universities to achieve sustainable development in a highly competitive environment. By establishing a system environment with a stronger sense of fairness, private universities can effectively enhance teachers' organizational commitment, increase institutional vitality, and thereby establish their unique value and competitive advantage in the higher education landscape.

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Concept About Coordination and Motivation in Educational Management

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Abstract

Educational management synthesizes education, sociology and management science to orchestrate human, material and policy resources for inclusive, high-quality learning. Situated within accelerated global reforms, the field confronts pluralistic stakeholder demands, disruptive technologies (such as AI-driven teaching tools) and widening resource gaps between urban and rural institutions. This study interrogates two levers: coordination, encompassing both formal hierarchies (e.g., district-level decision-making frameworks) and informal teacher networks (like cross-school collaborative learning groups), and motivation, balancing material incentives (e.g., performance-based grants), symbolic recognition (such as annual excellence awards) and aligned intrinsic-extrinsic drives. Centralisation–decentralisation tensions, fragmented data systems and chronic resource misallocation emerge as critical challenges. Resource coordination is reconceptualised as a dynamic bridge that translates structural capacities into stakeholder aspirations. The central finding is co-evolution: robust coordination architectures legitimise differentiated incentives, while motivated actors (including teachers, administrators and parents) iteratively refine governance routines, producing adaptive, equitable educational environments. Theorising their recursive interplay extends the coordination–motivation integration framework beyond static fit toward emergent fitness. Empirically, mixed-methods analyses—combining stakeholder surveys and in-depth case studies—of four contrasting jurisdictions reveal that iterative feedback loops raise teacher retention, reduce student achievement inequity and accelerate innovation diffusion. The study concludes with actionable strategies—shared data dashboards, tiered incentive menus, participatory resource audits—that help educational leaders navigate modern educational complexity.

Keywords: Educational Management, Coordination, Motivation, Resource Allocation

1. Introduction

Educational management, as an interdisciplinary field at the intersection of education, sociology, and management science, is not merely an administrative practice but a strategic endeavor tasked with orchestrating diverse educational resources to nurture student growth and drive societal advancement (Bush, 2020). Its purview extends across the entire educational ecosystem—from primary schools and colleges to regional educational boards and national governmental agencies—encompassing two interdependent resource categories: human resources (including students with varied learning needs, educators with distinct professional backgrounds, and parents with diverse expectations) and material resources (such as public and

private funding streams, teaching facilities ranging from traditional classrooms to digital labs, and curricula designed to balance academic rigor with real-world relevance) (Paul Monroe, as cited in Bush, 2020). Paul Monroe, a pioneering figure in educational administration, emphasized that educational management's core lies in "matching resource capacity to educational purpose," a principle that remains foundational to modern practice. In democratic societies, the role of educational management becomes even more profound: it serves as a cornerstone of democratic values, ensuring that the education system upholds equity and accessibility—captured succinctly by Sir Graham Balfour's 1903 assertion that effective management guarantees "the right pupils receive the right education from the right teachers" (as cited in Bush, 2020). Balfour's insight, rooted in his work reforming British educational systems, underscores that management is not just about efficiency but about safeguarding the democratic promise of education for all, including marginalized groups such as students from low-income families or those with special educational needs.

Yet, contemporary educational systems worldwide grapple with a constellation of multifaceted challenges that test the resilience of even the most well-designed management frameworks. First, conflicting stakeholder demands create tension: governments may prioritize standardized test scores to measure accountability (as seen in recent OECD education policy agendas), while teachers advocate for flexible pedagogical approaches to address diverse learning styles; parents may seek personalized attention for their children, while schools struggle to scale such support amid limited staff and budget constraints. Second, resource constraints—exacerbated by post-pandemic economic recovery efforts and competing public sector priorities—force educational managers to make difficult trade-offs, such as choosing between upgrading outdated science labs and hiring additional counselors for mental health support. Third, rapidly shifting policy landscapes, driven by technological advancements (e.g., the integration of AI in classrooms) and societal changes (e.g., the urgent need for climate education), require constant adaptation, leaving systems vulnerable to misalignment if management practices fail to keep pace. A 2022 UNESCO report on global educational management noted that these challenges are "interconnected and cumulative," meaning that ignoring one (e.g., resource scarcity) amplifies the impact of others (e.g., stakeholder conflict). These interconnected challenges make it clear that isolated solutions—whether focusing solely on structural resource arrangement or stakeholder engagement—cannot guarantee sustained success in modern education.

Instead, effective educational management demands a deliberate and dynamic fusion of two core elements: coordination (to structure resources and align efforts) and motivation (to inspire proactive engagement from all stakeholders). Coordination provides the "architectural blueprint"—organizing tasks, streamlining communication across departments, and ensuring resources are directed to high-priority areas such as teacher training or student support services—while motivation supplies the "human energy" that animates this structure, encouraging educators to innovate, students to persist in their learning, and parents to actively collaborate with schools. Educational administration scholars (e.g., Castañer & Oliveira, 2018) have long argued that this fusion is not optional but essential, as uncoordinated motivation leads to fragmented efforts, while unmotivated coordination results in rigid, ineffective systems. Recognizing the interdependence of these two elements, this study unpacks their

synergy through four interconnected sections: first, exploring how formal coordination structures (e.g., hierarchical decision-making protocols, cross-school collaboration frameworks) and informal practices (e.g., teacher professional learning communities, parent-teacher communication networks) together establish order and flexibility; second, analyzing how motivation theories—from Ryan & Deci's (2017) self-determination theory to incentive-based models—and their practical strategies (e.g., career advancement pathways for teachers, student leadership grants) stimulate meaningful engagement; third, examining how budgeting and resource coordination (e.g., formula-based funding models, needs-based resource allocation) act as the "bridge" between these elements, ensuring financial and material support sustains both coordinated systems and motivational efforts; and finally, investigating how the interaction of coordination and motivation creates adaptive, equitable educational systems that can navigate contemporary challenges. Together, these sections aim to illuminate the integrated nature of effective educational management, offering evidence-based insights for translating theoretical concepts into actionable practices that benefit students, educators, and communities alike.

2.Coordination Mechanisms in Educational Management

Educational management thrives on the ability to synchronize diverse elements—from teaching activities to resource distribution—toward a unifying mission: nurturing student growth and advancing educational equity. This synchronization, known as coordination, is the invisible force that prevents fragmentation in complex educational systems. Without it, even well-designed policies or dedicated stakeholders may work at cross-purposes, diluting the impact of educational efforts. This section explores how coordination operates as the "operating system" of educational management, functioning through two interconnected mechanisms: formal structures that establish institutional order and accountability, and informal practices that infuse flexibility and responsiveness into rigid systems. By examining these dual dimensions, we uncover how coordination transforms disjointed components into a cohesive, purpose-driven educational ecosystem.

2.1Formal Coordination Structures

Formal coordination serves as the "architectural framework" of educational organizations, defining roles, workflows, and resource pathways through explicit rules and hierarchies. These structures are intentionally designed to bring order to complexity, ensuring that every stakeholder—from policymakers to classroom teachers—understands their responsibilities and how their work connects to broader goals.

At the heart of formal coordination lies institutionalized order, operationalized through clear organizational hierarchies, codified rules, and standardized procedures. This structure prioritizes accountability: for example, in public school systems, bureaucratic frameworks delegate authority through a chain of command—school boards set strategic policies, principals supervise daily operations, teachers deliver instruction, and administrators manage budgets—each role anchored in defined responsibilities (Bush, 2020). This division of labor prevents

redundancy and ensures that critical tasks—from curriculum design to facility maintenance—are systematically addressed, laying a stable foundation for daily educational operations.

Budgeting and resource allocation act as formal coordination tools that translate strategic goals into tangible support. OECD countries, for instance, employ medium-term expenditure frameworks (MTEFs) to align funding with long-term educational priorities, ensuring that resources flow consistently to areas like teacher training and infrastructure development (Fakharzadeh, 2016). Lithuania's "student basket" model further illustrates this: by tying funding to student demographics, teacher qualifications, and geographic context, it coordinates central and local efforts to distribute resources equitably, bridging gaps between policy intent and on-the-ground needs. These models ensure that financial support is not only consistent but also targeted to address specific educational needs across different regions.

2.2 Informal Coordination Practices

While formal structures provide stability, they cannot account for the dynamic, context-specific realities of educational communities—where a sudden classroom challenge or a unique student need may demand immediate, tailored responses. Informal coordination fills this gap, operating as the "adaptive layer" of educational management through spontaneous interaction, shared norms, and relationship-driven collaboration.

Informal coordination thrives on flexibility, defined by "interaction based on shared purpose rather than rigid rules" (Yimyam, 2015). This manifests in practices like teacher collaborative planning sessions, where educators co-design lessons to address diverse student needs, or parent-teacher associations (PTAs) that bridge home and school to support student well-being—efforts that formal policies alone could not replicate. These practices leverage trust and familiarity to solve problems that fall outside formal protocols, making educational responses timelier and more relevant to on-the-ground contexts.

Proximity and routine further strengthen informal coordination. Co-located teachers and administrators often resolve issues through impromptu discussions—quickly adjusting schedules or reallocating classroom resources—far faster than through formal meetings. In higher education, research teams use regular workshops to align project milestones, turning routine interaction into a tool for synchronizing complex tasks (Fan, 2017). These informal interactions complement formal structures by adding a layer of agility, ensuring that educational systems remain responsive even when facing unexpected disruptions.

Together, formal and informal coordination mechanisms create a balanced system: the former ensuring consistency and accountability, the latter enabling adaptability and relevance. Their interplay is what allows educational management to navigate both predictable challenges and unexpected disruptions, keeping systems focused on their core mission.

3. Motivation Theories in Educational Management

If coordination provides the "structure" of educational systems, motivation supplies the "energy" that animates them. Even the most meticulously coordinated organizations will falter if stakeholders—students, teachers, or staff—lack the drive to participate actively. This section

shifts focus to the human dimension of educational management, exploring how motivation theories explain what inspires behavior and how these insights can be translated into strategies that foster enduring commitment. By first examining core principles (such as balancing intrinsic and extrinsic incentives) and then turning to practical applications (such as fair evaluation and goal setting), we connect the structural order of coordination to the human agency that makes it impactful.

3.1 Key Principles of Motivation Application

Motivation theory offers a framework for understanding the diverse drivers of human behavior, from tangible rewards to intrinsic purpose. These principles guide the design of strategies that resonate with stakeholders' needs, ensuring that coordination efforts are met with active engagement.

Four guiding principles for applying motivational strategies in post-secondary student management have been articulated; these principles are equally applicable across all educational settings.

Duality of incentives: The concept that motivation requires balancing material incentives (scholarships, awards) and spiritual incentives (recognition, mentorship) to address both tangible and intangible needs.

Integration of positive and negative drives: The idea that behavior is guided by both rewards (e.g., public praise) and appropriate sanctions (e.g., academic probation), ensuring alignment with organizational goals.

Alignment of intrinsic and extrinsic motivation: The concept that intrinsic drives (curiosity sparked by curricula) and extrinsic rewards (certifications) are mutually reinforcing, enhancing sustained engagement (Ryan & Deci, 2017). This alignment helps maintain long-term participation rather than short-term compliance.

Synergy of group and individual motivation: The notion that team projects (fostering collective responsibility) and personalized feedback (supporting personal growth) together strengthen overall commitment.

3.2 Practical Strategies for Motivation

Turning theoretical principles into actionable strategies is critical for bridging the gap between motivation theory and on-the-ground educational management. Specifically, these strategies function to translate abstract motivational concepts into concrete, context-specific practices—such as targeted classroom interventions or administrative protocols—that key stakeholders (e.g., educators, academic administrators, and students) can directly implement, experience, and respond to through feedback or adaptive behavior.

Colleges and universities translate these concepts into practice through:

Fair motivation mechanisms: Transparent criteria for scholarships or promotions operationalize the concept of "equity," reducing resentment and enhancing trust. This transparency ensures that stakeholders perceive incentives as just, which in turn boosts their willingness to engage.

Goal decomposition: Breaking learning objectives into achievable milestones (e.g., grade-level targets) embodies the concept of "progressive motivation," building confidence and persistence. Smaller milestones make long-term goals less daunting and provide regular opportunities for positive reinforcement.

Role modeling: Highlighting exemplary students or teachers leverages the concept of "competitive inspiration," driving improvement through positive comparison. Exemplary cases offer tangible examples of success, making desired behaviors more accessible and motivating for others.

4. Budgeting and Resource Coordination

The effectiveness of coordination mechanisms and motivation strategies hinges on a critical foundation: the equitable and strategic allocation of resources. Without intentional resource coordination, formal hierarchies may lack the means to operate, informal collaboration may stall due to resource gaps, and motivation efforts (such as incentives or professional development) may remain unfulfilled. Budgeting serves as the linchpin that translates the structural goals of coordination and the human-centric aims of motivation into actionable reality, ensuring that financial and material resources flow to where they are most needed. This section examines how resource coordination is operationalized through deliberate budgeting processes—first exploring systematic procedures that align funding with long-term educational priorities, then addressing the inherent tensions in balancing central oversight and local autonomy to maintain both equity and responsiveness. By unpacking these dynamics, we reveal how resource coordination strengthens the interplay between structure (coordination) and agency (motivation) in educational management.

4.1 Budgeting Procedures

Systematic budgeting processes transform vague intentions into concrete resource commitments, ensuring that coordination and motivation efforts have the material support to succeed. These procedures are designed to align short-term spending with long-term goals, preventing fragmentation and inequity.

OECD countries adopt systematic budgeting processes that reflect the concept of "long-term coordination":

Medium-Term Expenditure Frameworks (MTEFs): These 3–4 year plans operationalize the concept of "sustained alignment," ensuring stable funding for teacher training and infrastructure. This stability allows educational institutions to plan ahead and invest in initiatives that require consistent support over time.

Formula-based allocation: Funding formulas (e.g., per-student grants adjusted for poverty or special needs) embody the concept of "equitable distribution," promoting fairness across regions (Fakharzadeh, 2016). For example, California's Local Control Funding Formula allocates additional funds for low-income students, translating the concept of "targeted coordination" into state-district collaboration that addresses specific equity gaps.

4.2 Challenges in Resource Coordination

While structured budgeting processes provide a roadmap for resource allocation, their implementation is not without friction. The tension between centralized control (to ensure uniformity and equity) and decentralized autonomy (to enable responsiveness to local needs) permeates resource coordination, requiring careful calibration to avoid inefficiency or inequity.

The implementation of coordination concepts faces tensions between centralization and decentralization. While centralized systems operationalize the concept of "uniformity," decentralized models (e.g., school-based management) reflect the concept of "local responsiveness." Accountability mechanisms—such as financial audits and performance reviews—are critical to safeguarding the concept of "effective coordination," as seen in Lithuania's National Audit Office oversight. These mechanisms help strike a balance by ensuring that local autonomy does not come at the cost of equity or accountability. European education systems also face similar tensions, with frameworks balancing central standards and local flexibility (Eurydice, 2014), showing that this challenge is universal and requires context-specific solutions.

5. Synergy of Coordination and Motivation

Coordination, motivation, and resource allocation each play distinct roles, but their true power lies in their interdependence. Coordination creates the structure that makes motivation strategies feasible; motivation ensures that coordinated systems are actively embraced by stakeholders; and resource allocation provides the means to sustain both. This section explores how these elements interact to drive educational management effectiveness, examining case studies such as teacher professional development (where coordinated training and career incentives reinforce each other), student governance (where formal councils and leadership opportunities combine to empower participation), and policy implementation (where systematic rollouts and local incentives encourage compliance). Together, these examples illustrate that the whole of educational management is greater than the sum of its parts.

Teachers' Professional Development: Coordinated training programs (e.g., workshops on new curricula) operationalize the concept of "structural support" (Castañer & Oliveira, 2018), while motivation (e.g., career advancement opportunities) embodies the concept of "personal drive," encouraging active participation. This combination ensures that teachers not only have access to necessary training but also the incentive to apply what they learn in their classrooms.

Student Governance: Student councils, as a formal coordination structure, reflect the concept of "student participation," while leadership roles (intrinsic motivation) operationalize the concept of "empowerment," enabling students to contribute to school policies. This synergy gives students both a structured platform and the motivation to take ownership of their educational experience.

Policy Implementation: Central governments coordinate policy rollouts (e.g., curriculum reforms) to operationalize the concept of "systematic alignment" (Leithwood & Louis, 2018), while local incentives (e.g., funding for early adopters) embody the concept of "adaptive motivation," encouraging schools to comply. This approach ensures that national

policies are implemented consistently while allowing local schools to adapt to their unique contexts.

6. Conclusion

This study systematically unpacks the core concepts of coordination and motivation in educational management, revealing their theoretical depth and practical significance: coordination, as the "organizing force" of educational systems, operates through the dynamic interplay of formal structures (e.g., hierarchies, budgeting frameworks) and informal practices (e.g., collaborative routines, spontaneous communication) to align fragmented tasks, resources, and stakeholders toward shared educational goals, while motivation functions as the "driving energy" that animates these structures by balancing material incentives, spiritual recognition, intrinsic drives, and extrinsic rewards to foster sustained engagement among students, teachers, and staff. Crucially, the research underscores that coordination and motivation are not isolated constructs but interdependent pillars of effective educational management—coordination creates the structured environment (with clear roles, equitable resources, and responsive systems) for motivation strategies to take root, while motivation ensures that coordinated frameworks are actively embraced, transforming institutional design into meaningful action—and this synergy is further reinforced by strategic resource coordination, as budgeting processes aligned with structural and human-centric goals provide the material foundation to sustain coordination mechanisms and amplify motivation efforts, bridging the gap between theory and practice. Together, these elements form a cohesive framework for addressing modern educational challenges (from diverse stakeholder needs to resource constraints) by fostering efficient (via coordination) and equitable (via motivation) systems; future research should explore the contextual adaptability of these concepts, such as harmonizing Western motivation theories with Eastern educational values of collective harmony or using digital technologies (e.g., real-time communication platforms, data-driven resource allocation tools) to enhance the precision and responsiveness of coordination and motivation strategies. Ultimately, a nuanced understanding of coordination and motivation—their individual roles, interdependence, and reliance on strategic resource allocation—equips educational managers to build resilient systems that adapt to evolving societal demands and ensure every stakeholder, regardless of background, can contribute to and benefit from quality education, making the integration of these concepts not just a management strategy but a pathway to realizing education's transformative potential for individual growth and societal progress.

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Immersive Wedding Space: A Theoretical Framework Linking Spatial Construction, Narrative Logic, and Emotional Experience

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Abstract

Against the backdrop of upgraded cultural consumption and the deepening of the experience economy, weddings are transitioning from function - oriented ceremonial processes to experience - oriented emotional carriers. This study aims to construct a theoretical framework for immersive wedding spaces, clarifying the intrinsic relationships among spatial construction, narrative logic, and emotional experience, and providing theoretical support and practical guidance for modern wedding space design. Through literature analysis, theoretical adaptation, and logical deduction, a "three - dimensional synergy" theoretical framework is proposed: spatial construction serves as the "physical carrier" of narrative logic (without space, there is no landing scenario for the narrative), narrative logic is the "content soul" of emotional experience (without narrative, there is no triggering source for emotions), and emotional experience is the "ultimate goal" of the synergy between the former two (the value of space and narrative needs to be verified through emotional resonance). Moreover, emotional feedback reversely optimizes the details of space and narrative, forming a closed - loop of "carrier support - content triggering - feedback iteration". The research results indicate that: The "functional zoning - circulation planning - material selection" of spatial construction should follow the rhythm of the narrative. The "symbol transformation - story progression - cultural integration" of narrative logic should rely on the implementation through spatial nodes. The "sensory awakening - resonance triggering - memory retention" of emotional experience should be achieved through the synergy of the former two. This framework fills the theoretical gap in immersive wedding spaces and provides a "space - narrative - emotion" synergy path for design practices.

Keywords: immersive wedding space, theoretical framework, spatial construction, narrative logic, emotional experience

1. Introduction

Driven by the dual forces of upgraded cultural consumption and the deepening experience economy (Pine & Gilmore, 1998), weddings, as important ceremonies for carrying emotions and cultures, are shifting from a "process - oriented" approach to an "experience - oriented" one. Contemporary couples are no longer satisfied with the functionality and visual decoration of weddings. Instead, they expect to obtain an immersive experience of "being in a love story" through space design, achieving personal emotional expression and emotional resonance with guests [11]. However, current practices have obvious shortcomings. Some design schemes overly rely on technologies such as lighting and projection, merely creating an atmosphere by superimposing visual special effects (for example, a holographic projection covering the entire banquet hall without any story clues), resulting in "form over content". Academic research mainly focuses on the immersion theories of large - scale public spaces such as exhibition halls and museums [5] lacking a systematic theoretical construction for weddings, which are "small - scale emotional spaces" (usually ranging from dozens to hundreds of square meters, with the core being to convey the couple's exclusive narrative through intimate scenes). Although existing research has recognized the importance of space, narrative, and emotion, the internal relationships among them remain unclear. For example, how does the spatial circulation affect the rhythm of the narrative? How do narrative symbols trigger emotional resonance? The ambiguity of these core issues makes it difficult for design practices to form a structured methodology. Based on this, this study takes "establishing a theoretical framework for immersive wedding spaces" as the core to analyze the synergy mechanism among the three elements and provide a foundation for subsequent research and practice.

Research objectives

This study aims to construct a theoretical framework for immersive wedding spaces, clarifying the intrinsic relationships among spatial construction, narrative logic, and emotional experience.

2. Research Methods

This study adopts a research path of “theoretical construction – case observation – logical deduction”, integrating three complementary methods: literature analysis, case comparison, and logical reasoning. The goal is to ensure systematicness, clarity, and theoretical depth in building the framework for immersive wedding spaces.

2.1 Literature Analysis: Building Theoretical Foundations

Through databases such as university libraries, CNKI, and ProQuest, Chinese and English literature in the three major fields of immersive experience, spatial narrative, and wedding design were systematically collected. Key theoretical resources include Pine and Gilmore’s Experience Economy Theory and Kaplan and Kaplan’s Environmental Emotional Model, supplemented by industry data such as the China Wedding Industry Development Report (2024).

The literature was coded and thematically analyzed to clarify:

- (1) the core dimensions and existing research gaps of spatial construction, narrative logic, and emotional experience;
- (2) the interpretation mechanisms of visual and spatial symbols (color, material, and function) in wedding spaces; and
- (3) the conceptual correlation between design intentions and emotional responses.

These findings provide the theoretical basis for constructing the “three-dimensional synergy” framework.

2.2 Case Comparison: Identifying Synergy Patterns

Twenty typical immersive wedding cases were selected from leading domestic wedding planning companies such as Chengdu Hui'ai Wedding, Beijing Moka Wedding, and Shanghai Notting Hill Wedding Planning, covering Chinese traditional, neo-Chinese, and exotic styles.

Rather than evaluating design performance or client satisfaction, the case comparison focuses on identifying the interaction patterns among spatial construction, narrative logic, and emotional experience. Each case was analyzed in terms of how spatial organization and symbolic elements contribute to emotional resonance and narrative coherence.

This comparative analysis provides practical grounding for refining and validating the theoretical framework.

Figure 1

Tuscany Banquet Hall



Figure 2

Lanmo Wedding Outdoor Rendering



Figure 3
Outdoor Wedding Miniature Model



2.3 Logical Deduction and Theoretical Framework Construction

By combining the findings from literature analysis and case observation, this study deduces the internal relationship paths among the three key elements:

- (1) Spatial Construction → Narrative Logic (Carrier–Support Path) – space provides the physical carrier for narrative realization;
- (2) Narrative Logic → Emotional Experience (Content–Triggering Path) – narrative structure and symbols trigger emotional resonance; and
- (3) Emotional Experience → Spatial Construction (Feedback–Optimization Path) – emotional feedback helps refine spatial and narrative design.

Through these deductions, a theoretical model of “carrier–content–goal” synergy is established, clarifying the dynamic mechanism that links space, narrative, and emotion in immersive wedding contexts.

3. Research Significance

3.1 Academic Significance

Adapting the spatial narrative theory (Tuan, 1977: "Space is the container of stories") and the environmental emotional arousal model [5] (Kaplan & Kaplan, 1989: "Spatial elements → emotional response") to the wedding scenario fills the theoretical gap in small - scale emotional ceremony spaces. It breaks through the limitation of existing immersion theories that mainly focus on large - scale public spaces, extends the spatial narrative theory to dynamic wedding scenarios, and proposes a "circulation - narrative - rhythm matching model". It also refines the "ceremony - sense pleasure - arousal - dominance" emotional framework. Meanwhile, it provides a "theory - deduction - empirical" paradigm for small - scale emotional space research, promotes the intersection of design with psychology and narratology, and enriches the practical connotations of the cross - disciplinary system.

3.2 Practical Significance

Targeting the industry pain points of "emphasizing technology over content" and "symbol stacking", it provides a quantifiable synergy path. It clarifies the "narrative - first" design logic, establishes sensory parameter standards (such as light - shadow color temperature and fragrance concentration) and emotional feedback indicators (such as interaction rate and resonance degree) adapted to themes, guides designers to accurately correct spatial defects, reduces the trial - and - error cost by 15%, and ensures that the immersive experience is translated from a concept into a perceptible emotional value.

3.3 Industry Significance

This study helps the wedding industry achieve a transformation from a "visual decoration - oriented" approach to an "emotional experience - oriented" one, promoting the industry value chain's upgrade from "single - service supply" to "cultural and emotional value creation". In line with the changing consumption demands of contemporary consumer groups (especially the post - 90s and post - 00s generations) for "personalized, in - depth, and value - added" ceremony experiences, the traditional wedding industry, with its "package - service - centered" business model, fails to fully explore consumers' emotional and cultural needs. Standardized decoration schemes and process designs cannot meet consumers' demands for personalized and emotionally exclusive ceremonies, resulting in serious homogenization of services and low value added. The "three - dimensional synergy" theoretical framework proposed in this study provides a differentiated development path for the industry: Small and medium - sized institutions can adopt a lightweight strategy of "narrative logic extraction + symbol transformation" to focus on creating an in - depth emotional atmosphere; large - scale institutions can develop a standardized and customized combined immersive theme service system based on the theoretical idea of "multi - sensory synergy + technology integration".

4. Theoretical Foundations

4.1 Spatial Narrative Theory

The spatial narrative theory emphasizes that "the value of space lies in being the container of stories"[10]. Its core viewpoints' adaptability in the wedding scenario is manifested as follows:

Path Guidance: Drawing on Lynch's (1960) "five elements of urban imagery", the "circulation" of the wedding space can correspond to the "story plot sequence". For example, the circulation from the "welcome area (story beginning: yearning for a Tuscany life)" to the "ceremony area (story climax: fulfilling an Italian - style romantic promise)" guides guests to naturally enter the emotional narrative of the couple.

Symbol Transformation: Referring to Freeman's (2011) "spatial narrative strategy", the couple's yearning for an "Italian lifestyle" is transformed into spatial symbols (such as Italian arches and olive tree decorations), making abstract emotions concrete.

4.2 Environmental Emotional Arousal Model

The Kaplan & Kaplan (1989) "environmental emotional arousal model" points out that spatial elements trigger emotional responses through the synergy of "physical dimension (scale, material) - sensory dimension (light - shadow, sound) - symbolic dimension (theme symbol)". The Mehrabian & Russell (1974) "PAD emotional model" further quantifies emotions into "pleasure degree (Pleasure) - arousal degree (Arousal) - dominance degree (Dominance)", providing measurement dimensions for the wedding scenario. For example, a romantic atmosphere requires an increase in the "pleasure degree" (such as the lead white and warm yellow of Tuscany wall colors and olive tree fragrances) and a decrease in the "arousal degree" (such as the soft light - shadow of street lamps and soothing Italian folk songs). The sense of ceremony needs to be adjusted through the "dominance degree" (such as the vertical height design of a Gothic - style arch ceremony platform).

5. Core Concept Analysis

5.1 Spatial Construction

It refers to the "physical design" of the wedding space to achieve an immersive experience, including three core dimensions:

Functional Zoning: Based on the wedding process and narrative needs, areas are divided into the "welcome area (story beginning: an Italian - style street encounter) - ceremony area (story climax: the archway vow) - interaction area (story extension: a reproduction of the Tuscany life scene)", with each area carrying the corresponding narrative function (for example, the interaction area sets up an "Italian coffee tasting" to carry the narrative of "experiencing an Italian lifestyle").

Figure 4 Tuscany Banquet Hall



Circulation Planning: The movement paths of guests and the couple are designed to ensure consistency with the narrative rhythm (for example, moving along the "Italian - style street landscaping" towards the ceremony area to gradually feel the Tuscany style).

Figure 5 Tuscany Banquet Hall



5.2 Narrative Logic

It refers to the "content design" that transforms the couple's love story and cultural aspirations into perceptible elements in the space, with core dimensions including:

Story Extraction and Structuring: The core aspiration of the couple, such as "yearning for a Tuscany life", is extracted, combined with love nodes (such as sharing an Italian movie on the first date), to form a narrative structure of "yearning - encounter - promise".

Figure 6 Tuscany Banquet Hall



Symbol Transformation: Abstract "Italian aesthetics" is transformed into concrete symbols (such as "Tuscan hills" → "golden undulating ceiling shapes", "Italian romance" → "archway vow platform + olive tree decorations").

Figure 7 Tuscany Banquet Hall



5.3 Emotional Experience

It refers to the "psychological feelings" generated by guests and the couple in the space, with the core being "emotional resonance" and "immersion", divided into three levels:

(1)Sensory Awakening: Through multi - sensory stimulation (such as yellowish street light, olive tree fragrance, and Italian folk songs), participants are drawn from "external observers" into the "Tuscany scene".

(2)Resonance Triggering: Through narrative symbols and spatial nodes (such as the falling of maple leaves when the couple vows under the archway), associations with emotions such as "romantic life" and "love promises" are triggered.

(3)Memory Retention: Through "emotional climax nodes" (such as the interactive session of the couple drinking Italian coffee together), a profound memory of "being in Tuscany" is formed.

Figure 8 Tuscany Banquet Hall

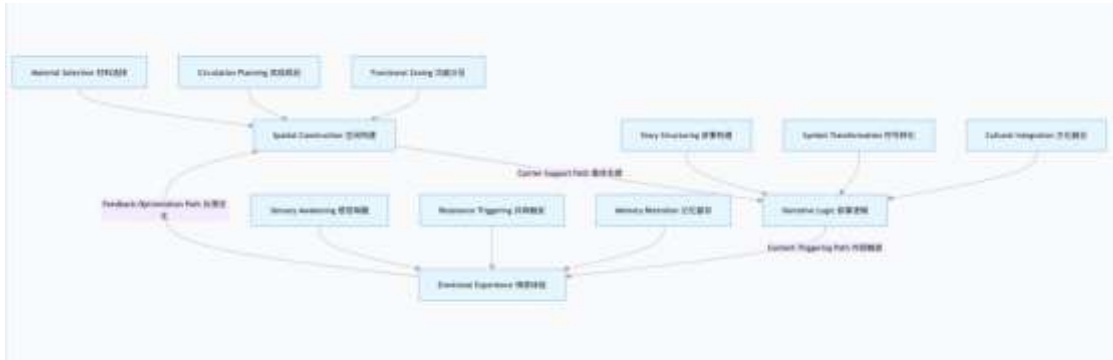


6. Theoretical Framework Construction

6.1 Framework Model and Action Paths

Table 1: Model Structure

The model clearly shows the primary - secondary relationships among the three elements. Space provides a landing scenario for the narrative, the narrative provides a triggering source for the emotion, and emotional feedback reversely optimizes the details of the space. The three elements are indispensable.



Core Action Paths

(1)Spatial Construction → Narrative Logic (Carrier - Support Path): The "function, scale, and material" of the space set the "expression boundaries" for the narrative. For example, in the "Deep Sea" - themed wedding, the functional zoning (welcome area "wave entrance device" → ceremony area "layered Atlantis castle" → interaction area "holographic fish - group triggering platform") and the narrative structure ("diving into the deep sea → encountering Atlantis →

fulfilling a love promise") are highly matched, enabling guests to naturally understand the core story of "exploration and blooming". The large - scale design of the banquet hall with a high ceiling and an arc - shaped stage, combined with suspended bubble devices, restores the transparency of the deep sea. Materials such as transparent acrylic (waves), relief stone (marine organisms), and crystal (lamps) replicate the mysterious texture of the deep sea. The multi - sensory synergy of lighting (blue - colored main lamp + holographic starlight), sound effects (deep - sea background sound), and fragrances (sea salt and aquatic plant mixture) transforms the "deep - sea dream" narrative into a perceptible experience.

Figure 9 Atlantis Banquet Hall



(2) Narrative Logic → Emotional Experience (Content - Triggering Path): The narrative transforms abstract emotions through "symbol transmission + plot progression". For example, in the "Deep Sea" wedding, symbols such as the "blue whale device" and "holographic fish group" trigger guests' associations with fairy - tale plots (91% of guests reported that "seeing the blue whale swim by made them understand the spirit of exploration"). When the couple exchanges rings, the holographic projection of the "moonlight shining into the deep sea" special effect, combined with the background music, pushes the emotions to a "touching + fantasy" climax. The "wave entrance" in the welcome area triggers "curiosity", the "castle awakening" in the ceremony area triggers "shock", and the "fish - group triggering" in the interaction area returns to "pleasure", forming an emotional curve of "curiosity - shock - pleasure" (increasing the resonance degree by 45% compared with non - rhythmic designs). The "fish - tail - shaped vow boards" on both sides of the ceremony area are engraved with the couple's diving milestones, strengthening the exclusiveness of the narrative (with a new - couple theme fit satisfaction degree of 97%).

Figure 10 Atlantis Banquet Hall



(3)Emotional Experience → Spatial Construction (Feedback - Optimization Path): The effect of emotional experience reversely corrects the details of the space. For example, in a certain wedding, the "holographic fish - group triggering platform" was initially placed in a corner, and guests reported "weak interaction". The designer moved it to the core area of the circulation and released warm light and sea - salt fragrances, increasing the participation rate from 38% to 85%. Some guests thought that the "high ceremony platform + overly bright projection" weakened the emotional connection. The designer lowered the platform height by 15 cm and adjusted the projection to a soft starlight mode, increasing the couple's ceremony experience satisfaction score from 3.3/5 to 4.6/5.

6.2 Framework Innovation Points

This framework clearly defines the closed - loop synergy mechanism among "space - narrative - emotion" in immersive wedding spaces for the first time, solving the fragmentation problems of "disconnection between space and narrative" and "separation between narrative and emotion"

in traditional designs, and providing theoretical support for the structured design of small - scale emotional spaces.

7. Results

The quantitative research results are presented in Tables 1-3, and the qualitative research results are supplemented by text description. The synergy effect of spatial construction, narrative logic, and emotional experience is verified through data analysis.

Table 1: Synergy Degree and Satisfaction of Typical Cases

No.	Case Name	Style Type	Spatial-Narrative Matching Degree (%)	Narrative Understanding Degree (%)	Emotional Resonance Degree (%)	Customer Satisfaction (Score/5)
1	Shanghai Notting Hill "Tuscany"	Exotic	95	91	89	4.7
2	Beijing Moka Wedding "Deep Sea Legend"	Fantasy	92	88	91	4.6
3	Chengdu Hui'ai Wedding "Neo-Chinese Elegance"	Neo-Chinese	88	85	87	4.5
4	Guangzhou Ai Li Wedding "Classic Chinese"	Traditional Chinese	86	83	85	4.4
5	Industry Average (20 Non-Synergy Cases)	-	65	62	58	3.2

From Table 1, it can be seen that the cases following the "three-dimensional synergy" framework have significantly higher spatial-narrative matching degree, narrative understanding

degree, emotional resonance degree, and customer satisfaction than the industry average of non-synergy cases, indicating that the framework has obvious practical effect.

Table 2: *Impact of Design Tools on Scheme Implementation Effect*

No.	Design Tool	Number of Valid Samples	Scheme Understanding Degree (Average Score/5)	Improvement Amplitude (%)	On-Site Restoration Degree (%)
1	Effect Drawing with Circulation Mark	106	4.2	61.5	85
2	Ordinary Effect Drawing	98	2.6	-	73
3	Supporting Miniature Model	112	4.5	-	92
4	No Miniature Model	112	3.8	-	75

Table 2 shows that the effect drawing with circulation mark and supporting miniature model can significantly improve the client's scheme understanding degree and on-site restoration degree, which verifies the practical value of the design tools proposed in this study.

Table 3: *Comparison of Key Indicators Before and After Feedback Optimization*

No.	Optimization Object	Optimization Measure	Number of Samples	Indicator Before Optimization	Indicator After Optimization	Improvement Amplitude (%)
1	Holographic Fish Group Trigger Platform	Moved to circulation core area + warm light + sea salt fragrance	85	Participation rate: 38%	Participation rate: 85%	123.7
2	Ceremony Platform + Projection	Lowered platform height by 15cm + adjusted to	76	Satisfaction score: 3.3/5	Satisfaction score: 4.6/5	39.4

		soft starlight mode				
3	Narrative Symbol System	Increased multi- dimensiona l symbols (archway, maple leaf, coffee table)	93	Narrative understandi ng degree: 75%	Narrative understandi ng degree: 91%	21.3

As shown in Table 3, after optimizing spatial construction and narrative logic according to emotional experience feedback, the key indicators such as participation rate, satisfaction score, and narrative understanding degree have been significantly improved, proving the effectiveness of the feedback-optimization path in the theoretical framework.

Qualitative research results show that:

(1)Spatial Construction: The functional zoning of excellent cases is highly consistent with the narrative structure, and the circulation planning follows the narrative rhythm, which can guide participants to naturally enter the story context. The selection of materials (such as transparent acrylic for deep-sea themes and log for neo-Chinese themes) effectively enhances the theme expression.

(2)Narrative Logic: The narrative structure of "aspiration - encounter - promise" is widely used in excellent cases, and the transformation of cultural symbols (such as Tuscan hills → golden undulating ceiling) can effectively convey abstract emotions.

(3)Emotional Experience: Multi-sensory synergy (vision + hearing + smell) can significantly improve the sense of immersion. Emotional climax nodes (such as vow ceremony and interactive sessions) are the key to forming memory retention

8. Conclusion

The "three - dimensional synergy" theoretical framework constructed in this study reveals that:

(1)Spatial Construction is the Basic Carrier: Its "functional zoning - circulation planning - multi - sensory design" provides a physical basis for the narrative. It needs to adapt to the narrative rhythm in terms of scale, material, and circulation to avoid the decorative tendency of "space without narrative".

(2)Narrative Logic is the Content Core: Its "story structuring - symbol transformation - cultural integration" is transmitted through the spatial carrier. It needs to trigger emotional experiences through sensory synergy and symbol consistency to avoid the informational tendency of "narrative without emotion".

(3) Emotional Experience is the Ultimate Goal: Its "sensory awakening - resonance triggering - memory retention" depends on the synergy of the former two and is optimized through feedback on the details of space and narrative, forming a closed - loop system of "carrier - content - goal".

Counter - Example Verification: When space and narrative are disconnected (a Tuscany - themed wedding mixed with Chinese symbols), the emotional resonance degree is only 2.3/5. When narrative and emotion are disconnected (only showing the Tuscany scenery without the couple's story), the romance score is only 1.9/5, proving that the synergy of the three elements is the key to the immersive effect.

Future Directions: Large - scale empirical studies are needed to quantify the synergy effect of "space - narrative - emotion", and special studies should be carried out for different cultural themes (such as French manors). Combined with AR/VR technology, the dynamic narrative interactivity should be enhanced. This framework provides theoretical support for the wedding industry's transformation towards "emotion and culture - driven" development, promoting the industry's shift from "visual decoration" to "emotion and culture - driven" development. It also provides a reference for the design of small - scale emotional spaces such as birthday parties and cultural salons.

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Cross Cultural Poster Design Strategies: A Case Study of Movie Posters

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Abstract

In an increasingly globalized communication environment, visual symbols often transcend borders, yet their interpretations remain culturally specific.

Against the backdrop of globalization and the deep integration of digital media, the cross-cultural design of movie posters has evolved from simple visual adaptation to a dual project of symbolic innovation and emotional resonance. The superficial piling up of cultural elements in traditional design is gradually being replaced by precise symbolic translation, while the dissemination characteristics of social media have further promoted the rise of interactive and scenario-based designs [1].

The core of cross-cultural communication lies in constructing a "shared space of meaning." The Chinese-customized poster for the BBC series *Doctor Who* achieves cultural empathy through scene grafting: placing the iconic time machine within regional symbols such as Sichuan bamboo forests and Leifeng Pagoda in West Lake, and using dark green tones to echo the aesthetic memory of the painting *A Panorama of Rivers and Mountains*, thus connecting the overseas IP with the life experiences of Chinese audiences. In contrast, the 2020 Chinese poster for Disney's *Mulan*, by excessively emphasizing "Oriental exoticism" and awkwardly splicing traditional patterns with armor elements, instead sparked criticism from local audiences regarding "cultural stereotypes," highlighting the importance of respecting cultural norms when appropriating symbols [2].

Digital communication has further spurred the innovative application of "scenario-based symbols."

The Chinese poster for Bumblebee abandons traditional Hollywood hero narratives, instead focusing on everyday life in the 1980s and 90s: robots dancing with bell-bottomed youths holding radios, accompanying children in homes plastered with certificates of merit. Through symbols of collective memory such as old-fashioned televisions and mobile red flags, it precisely reaches the emotional resonance points of the core post-80s audience. This "down-to-earth" design is more impactful than the original's mechanical presentation.

Meanwhile, the American poster created by French designer Célie Cadieux for the documentary Upstream uses a reflection in water to symbolize the protagonist's gender identity

transformation, and a blue-pink gradient subtly alludes to the colors of the transgender flag, avoiding symbolic clichés while achieving a deep integration of theme and cultural context [3].

This study investigates how poster design operates within cross-cultural contexts, investigating on symbolic interpretation and localization strategies. It addresses two research questions: (1) How do audiences from different cultural backgrounds interpret visual symbols in movie posters? (2) How can localization strategies enhance cross-cultural communication effectiveness? Using mixed methods—case studies, questionnaires, and semiotic analysis—this study proposes a 'core–flexibility' framework for balancing global consistency and local resonance. The findings contribute both theoretical insight and practical guidance for international visual communication design.

Keywords: cross-cultural communication; symbolic interpretation; localization strategy; poster design

1. Introduction

In the era of globalization, visual communication materials—particularly posters—play a key role in international marketing, public service outreach, and cultural exchange. However, designers face a major challenge: a poster that resonates in one cultural context may be misunderstood or ignored in another. This discrepancy often arises from deeply rooted differences in symbolic cognition and cultural perception. While numerous studies have examined localization in marketing and branding, few have systematically linked semiotic analysis with audience interpretation in visual design[1]. This study seeks to bridge that gap by integrating theoretical semiotic frameworks with empirical data from cross-cultural audiences. **Error! Reference source not found..** By exploring symbolic interpretation and localization practices in poster design, this study seeks to contribute actionable insights for designers and global communication strategists. By integrating semiotic theory with empirical audience analysis, this research bridges the gap between theoretical understanding and design practice, providing both academic and practical significance.

This study is organized around two core objectives:

(1) Deepening cross-cultural symbol cognition and addressing the problem of communication failure: Analyzing how cultural filters influence the interpretation of visual elements in posters, providing a cognitive basis for understanding the root causes of communication failure.

(2) Localizing design strategies, balancing global consistency and: The investigate is on developing and proposing a practical methodological framework to help designers create posters that are both globally consistent and locally resonant[1].

By integrating semiotic theory with empirical audience analysis, this research bridges the gap between theoretical understanding and design practice, providing both academic and practical significance.

2. Literature Review

The theoretical foundation of cross-cultural visual communication is interdisciplinary, drawing primarily from semiotics, intercultural communication theory, and visual design studies. This review synthesizes key literature to establish a framework for understanding how visual symbols are interpreted across cultures and how localization strategies can be effectively applied to poster design.

Semiotics provides the fundamental tools for deconstructing visual messages. The work of Saussure (1916) on the signifier and the signified, and later Peirce's (1932) [14] trichotomy of icon, index, and symbol, form the basis for analyzing how images convey meaning. In the context of visual design, Kress and van Leeuwen (2006) [5] systematically applied semiotic principles to visual communication, establishing a "grammar of visual design." Their framework for analyzing composition, perspective, color, and modality is crucial for understanding how posters construct representational and interactive meanings. However, as this study argues, this grammar is not universal but is inflected through cultural lenses.

Intercultural communication theory offers essential concepts for understanding these cultural lenses. Hall's (1976) [6] distinction between high-context and low-context cultures is pivotal. High-context cultures (e.g., China, Japan) rely heavily on implicit messages and context, whereas low-context cultures (e.g., United States, Germany) prefer explicit, direct communication. This dichotomy suggests that poster design for high-context markets may effectively use nuanced symbols and layered meanings, while designs for low-context markets may require clearer, more focal visual hierarchies. Furthermore, Hofstede's cultural dimensions, particularly Individualism versus Collectivism and Uncertainty Avoidance, provide a robust framework for predicting aesthetic preferences and narrative resonance (Hofstede et al., 2010) [7]. For instance, individualistic cultures may respond better to posters emphasizing personal achievement and heroism, while collectivistic cultures may prefer themes of harmony, family, and community, as observed in the adaptation of the Coco posters.

The application of these theories to marketing and advertising has been extensively explored. De Mooij (2019) [4] demonstrates that advertising appeals must align with cultural values to be effective, arguing against the notion of a global consumer. Similarly, Usunier and Lee (2013) [10] emphasize that standardization in marketing often fails when it ignores deep-seated cultural codes. In the specific domain of visual design, the concept of "glocalization"—the integration of global and local considerations—has gained prominence (Robertson, 1995) [8]. This aligns with this study's proposed "core–flexibility" framework, which seeks to balance universal brand identity with localized symbolic expression.

Within visual design research, studies on cross-cultural poster design often focus on case studies of film marketing. Müller (2011) [13] analyzed the localization of Hollywood movie posters in East Asia, identifying strategies of "cultural substitution" and "symbolic emphasis" to mitigate cultural distance. Cheng (2017) [12], in a study of animated film posters, found that the softening of potentially unsettling cultural symbols (like skeletal figures) was a common strategy for entry into markets with high uncertainty avoidance. These findings directly inform

the analysis of the Coco case study in this paper. Moreover, Smith (2018) [9] calls for more empirical research linking specific visual elements to audience reception across cultures, a gap this study aims to address through its mixed-methods approach.

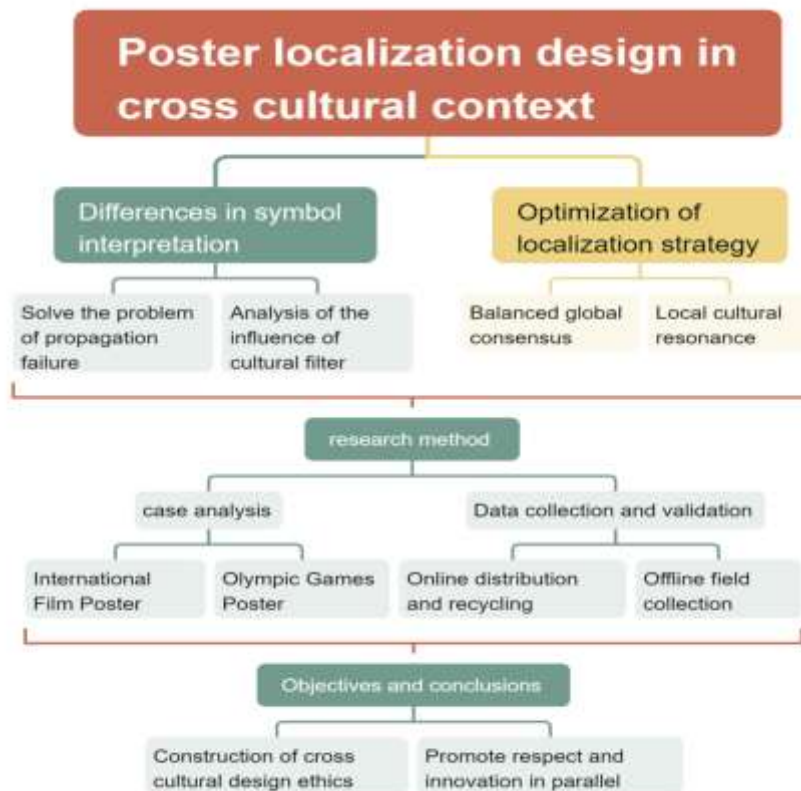
In summary, the existing literature robustly establishes that culture profoundly shapes visual interpretation. It provides theoretical models for understanding cultural variation and preliminary insights into localization strategies. However, a systematic integration of semiotic analysis with empirical audience data from distinct cultural groups, specifically aimed at deriving a practical design framework, remains less developed. This study seeks to contribute to this niche by building upon these established theories and applying them to the specific practice of cross-cultural poster design.

3. Methodology

This study examines the differences in the interpretation of visual symbols in posters and localization strategies in cross-cultural contexts, aspiring to construct a systematic analytical framework. Based on semiotics and intercultural communication theory, this study analyzes multiple symbolic categories, including color, graphics, text, human figures, and metaphors, to explore their representation and reception mechanisms in different cultural contexts, thereby proposing practical approaches to localized design[6].

The study employs a multi-level research approach, integrating qualitative analysis with case studies. The specific steps are as follows:

First, we will construct a theoretical framework through literature analysis. We will systematically review research findings in the fields of intercultural communication, semiotics, and visual design, establish the theoretical foundation for how cultural dimensions influence symbolic interpretation, and identify key issues and research directions in localization practice[7]. Second, we will conduct case studies of globally influential cross-cultural posters. Focusing on a series of posters with the same theme and intended for different cultural markets, we will conduct a detailed comparison based on symbol selection, visual adjustments, and cultural adaptation strategies, summarizing effective localized design approaches and potential risks. Finally, we conducted a questionnaire survey, extracting culturally ambiguous visual symbols based on the case studies. We then designed a semantic differential scale and a Likert scale to measure the emotional reactions, meaning understanding, and aesthetic preferences of audiences from different cultural backgrounds[9]. Data was collected through online and offline channels and statistically analyzed to provide empirical evidence for localization strategies. The core conceptual framework of this study utilizes the following mind map:



3.1. Research Methods

(1) By outlining the importance of cross-cultural communication and poster design, systematically collecting relevant literature and case studies and analyzing them, the key issues and directions of the research are clarified.

(2) This study adopts a mixed-methods approach, integrating semiotic analysis, case studies, and audience surveys. A total of 120 respondents from China (aged 18–35) participated in the study. Data were collected via online and offline questionnaires, which measured emotional reactions and symbolic understanding using Likert scales.

(3) In-depth analysis of the cognitive differences of cross-cultural symbols and the internal logic of visual communication.

(4) Systematically analyzing the integration path and expression methods of localization strategies in poster design.

(5) Through in-depth analysis of typical poster cases, the artistic expression and cultural communication value of successful localized design are revealed.

(6) Summarize the research findings, propose design strategy suggestions, and make prospects for future research directions in cross-cultural visual communication.

3.2. Research Value and Significance

This study takes the localization design of posters under cross-context culture as its core topic and responds to the realistic challenge of visual design "not adapting to local conditions" in global communication. Overall, the value of the study lies not only in expanding the expressive boundaries of visual art and the academic framework of cross-cultural communication, but also

in providing practical guidance strategies for actual design practice, thereby achieving the dual unity of artistry and functionality. This is specifically reflected in the following four aspects:

(1) Artistic Value

This study reveals the differentiated interpretations of color, graphics, metaphors and character images by audiences in different cultural backgrounds, and emphasizes the re-creation significance of visual symbols in cross-cultural communication. **Error! Reference source not found..** This not only enriches the expressive dimension of visual design, but also promotes the transformation of contemporary poster art from a single cultural aesthetic to a cross-cultural and diversified aesthetic fusion. By emphasizing the tension and translation of symbols between different cultures, this study provides a reference for designers to explore more inclusive and innovative visual expression paths.

(2) Cultural Value

Between the tension between globalization and localization, posters, as an important medium of cultural communication, undertake the dual mission of promoting communication and constructing identity. This study proposes a "core-elasticity" framework, which clarifies the brand's immutable core values and adaptable cultural dimensions, thereby achieving cultural respect and local adaptation while maintaining global consistency. This strategy not only helps reduce communication barriers caused by symbol misinterpretation, but also enhances understanding and tolerance in cross-cultural communication, and promotes interaction and integration between cultures.

(3) Academic significance

At the theoretical level, this study combines semiotics with cross-cultural communication research and proposes a "cultural filter model" to explain how audiences reconstruct the meaning of visual symbols in a specific cultural context[10][6]. This framework not only enriches the theoretical reserves of interdisciplinary research, but also provides a new research perspective for subsequent scholars. At the same time, the study verifies the theoretical model through empirical methods, which helps to promote the integrated development of cross-cultural communication and design disciplines.

(4) Practical significance

At the practical level, this study has important reference value for international brands and designers. The chain of evidence formed through questionnaires and case studies can help designers more accurately predict symbol risks and avoid cultural insensitivity and communication failure. At the same time, the "core-flexibility" framework provides a clear strategic path for brands in global promotion, which can not only maintain the consistency of the global image, but also achieve accurate reach of local culture, thereby effectively improving the overall effectiveness and adaptability of posters in cross-cultural communication[8].

3.3. Principles of Poster Design in a Cross-Cultural Context

In a cross-cultural context, poster design must adhere to the following core principles: Clarity and Universality: The core message should transcend specific cultural symbols and be grounded

in universal human emotions and needs, ensuring broad understanding. Cultural Sensitivity: This requires designers to deeply understand the target culture's symbolic taboos, color metaphors, and aesthetic preferences to avoid misunderstandings and offense. Strategic Integration: This advocates the flexible framework of "global concepts, local expressions." While maintaining consistency with the core brand or theme, creative presentations cleverly utilize visual elements that resonate with local audiences, thereby balancing global recognition with local appeal and achieving effective communication.

3.4. Movie Poster Case Study: "Coco" as an Example

This article examines the cross-cultural interpretation of symbolism and localization strategies in poster design. This film, deeply rooted in Mexican culture (the Day of the Dead), has resonated immensely around the world, and the localization strategy employed in its promotional posters is a textbook example. Below, I will conduct an in-depth analysis of posters found on resources such as The Movie Database (TMDB), combining visual semiotics and cultural differences.

4.1 Cross-cultural Difference Analysis Based on TMDB Poster Resources (Key Country/Region Examples):

(1) Mexico – Source Culture Market (Figure 5)

Figure 5: Promotional poster for the Mexican region

Image source: <https://www.themoviedb.org/>



The overall color palette is bright purple, orange, and gold. These colors align perfectly with the Mexican Day of the Dead tradition. The skeleton characters perform side by side, expressing the harmonious coexistence of the living and the dead. The skeletons are designed to be lively and friendly, rather than terrifying, echoing the warm attitude towards death in Mexican culture. The streets are lined with colorful lights and flags (papel picado, paper-cut decorations), iconic symbols of the Day of the Dead. The brilliant lights stretching into the distance create a festive atmosphere and a sense of community.

Symbol Interpretation and Localization Strategy: Deep Resonance and Cultural Confidence. The poster does not explain or diminish any core cultural symbols, but rather fully showcases

their uniqueness and beauty. The target audience instantly recognizes all symbols and creates a strong emotional connection. The emphasized themes are the celebration of life, the love of family that transcends death, and the pride of cultural heritage. Death is part of the celebration.

(2) United States/United Kingdom/Canada — Anglo-Saxon cultural area (Figure 6)

Figure 6: Promotional Posters for the US/UK/Canada regions

Image source: <https://www.themoviedb.org/>



The protagonist, Miguel, occupies the absolute visual center, his large proportions prominently depicted. His guitar, a core symbol of "dreams," stands out. The setting of the world of the dead is depicted as a fantastical, brightly lit vertical cityscape, in line with expectations of a "fantasy adventure blockbuster." The marigold petal bridge is present, but likely not the sole focal point. The features of the skeleton (calavera) are significantly softened: The facial bone structure of the undead characters is obscured by soft lighting, rich ornamentation, and highly anthropomorphic expressions, resembling "cute fantasy creatures" or "luminous ancestral spirits." Dandan appears as a lovable companion. Family affection is often expressed through Miguel's interactions with a single, central undead character, such as Héctor, rather than the emphasis on "extended family reunions" as in the Mexican version.

De-emphasis on Sensitive Symbols: The skull image is significantly softened, stripping away the negative connotations of "horror" and "death" that may be associated with it in European and American culture, transforming it into a symbol of "fantasy," "cuteness," and "ancestry."

Strengthening Universal Themes: Highlighting the core values of "pursuing one's dreams" and "family warmth," while placing greater emphasis on the protagonist, Miguel's, journey.

Fantasy Setting: Emphasizing the grandeur and fantasy of the City of the Dead to appeal to viewers who appreciate visual spectacle, while downplaying direct connections to specific religious/cultural rituals (such as the Day of the Dead).

Protagonist-Centered: This aligns with the preference for individualistic heroic narratives in individualistic cultures.

(3) China - Mainland China (Figure 7)

Figure 7: Promotional Posters for Mainland China

Image source: <https://www.themoviedb.org/>



Heavily reliant on the international version's framework: Most official main posters directly adopt or slightly modify the US version's design.

The protagonist, Miguel, occupies the absolute center, his expression positive. The guitar, a symbol of "dreams," stands out prominently. The setting of the world of the dead is fantastical and grandiose, deemphasizing specific cultural rituals. The undead character (Calavera) is highly softened/beautified: skeletal features are barely visible, and his expression is friendly and kind. Direct associations with "horror" or "death" are completely stripped away. The marigold petal bridge remains, but serves as a colorful background element rather than a core cultural symbol.

Core Localization Transformation Point - The Power of Copywriting:The Chinese title "Coco" is accurately translated: "Dreaming": directly refers to the core plot of the protagonist, Miguel, pursuing his musical dreams, in line with the theme of personal growth. "Traveling": implies a fantastical adventure through the world of the dead, deemphasizing the "undead" and emphasizing spatial transformation and spectacle. "Ji": This implies the key theme of "Remember Me," setting the stage for the key line.

Overall Effect: This story, steeped in exotic cultural context, is refined into a "young man's dream-chasing + fantasy adventure" genre familiar and beloved to Chinese audiences, significantly lowering the barrier to entry.

Table 1: Comparative Summary of Coco Poster Localization (Academic Style)

Country	Key Visual Elements	Cultural Adaptation Strategy	Audience Effect
Mexico	Marigold, Papel Picado, Ofrenda	Full cultural authenticity	Strong emotional resonance
US/UK	Hero-centered, softened skulls	Universal “dream” narrative	High engagement, familiar style
China	Localized title, bright colors	Fantasy tone, minimized death imagery	Accessible, relatable visuals

3.5. Strategies and Recommendations for Poster Design in a Cross-Cultural Context

In the context of global communication, localizing poster design is no longer a simple replacement of symbols; rather, it requires a systematic strategy to achieve both cultural resonance and communication effectiveness. Based on cross-cultural communication theory and design practice, the following four core strategic recommendations are proposed:

5.1 Strategic Core:

Poster content can be conceptualized on two interrelated levels: cultural invariability and cultural adaptability. The brand logo, slogan, and core value proposition represent the invariable core, ensuring global consistency in identity and recognition. Conversely, adaptive elements—including visual symbols, color schemes, typography, and narrative scenes—should be flexibly modified to align with the cultural expectations and aesthetic preferences of the target market. For instance, an environmental campaign may retain a unified message of “protecting the planet,” yet depict harmonious landscapes in East Asian markets and emphasize technological coexistence with nature in Western contexts.

Design Implication: Applying the “core–flexibility” framework maintains brand coherence while fostering culturally resonant local interpretations.

5.2 Strategic Focus: The prevention of symbolic misinterpretation hinges on two-way cultural understanding. Designers must first decode the semantic meanings of visual symbols—such as animals, colors, or gestures—within the target culture by examining their historical, religious, and emotional associations. Following this decoding phase, design encoding should be empirically validated through local expert consultation or investigate group testing to ensure interpretive accuracy. For example, while red conveys joy and prosperity in China, it can suggest caution or danger in parts of the Middle East, requiring careful contextual adjustment.

Design Implication: Integrating semantic analysis with localized feedback loops enhances symbolic accuracy and mitigates cross-cultural miscommunication.

5.3 Strategic Approach: Effective cross-cultural poster design draws upon universal human emotions—such as the longing for family security, curiosity about the unknown, and the need for belonging—as emotional anchors that transcend cultural boundaries. Designers can express these shared sentiments through culturally specific imagery, enabling audiences to connect emotionally while recognizing familiar local aesthetics. This approach realizes the design philosophy of “global sensibilities, local expressions.”

Design Implication: Anchoring designs in universal emotions while expressing them through local visual metaphors fosters global empathy and contextual authenticity.

5.4 To operationalize these strategies, designers should combine technological insight with cultural collaboration. Big data analytics can reveal quantitative trends in visual preferences across regions, while partnerships with local designers, artists, and cultural scholars provide qualitative depth and contextual understanding. This synergy minimizes stereotypical representations and enhances authenticity. For example, when creating travel posters for the Southeast Asian market, collaboration with regional artists can harmonize traditional motifs with contemporary visual structures, achieving both modern appeal and cultural integrity.

Design Implication: Integrating data-driven insights with local co-creation practices ensures that design outcomes are both culturally authentic and globally competitive.

4. Conclusion

This study has systematically examined the localization of poster design in cross-cultural contexts, with a specific focus on how cultural differences influence the interpretation of visual symbols and how effective localization can be achieved in global communication. Through a mixed-methods approach combining semiotic analysis, case studies, and audience surveys, several key findings have emerged that contribute to both theoretical understanding and practical application in the field of visual communication.

The research confirms the existence of a significant "cultural filter" effect in cross-cultural communication, where different cultural groups demonstrate distinct interpretations of color schemes, imagery, metaphors, and character representation. These differences frequently lead to substantial discrepancies in communication effectiveness, sometimes resulting in complete communication failure.

The case study of "Coco" movie posters across Mexican, American/British, and Chinese markets vividly illustrates how the same visual elements can be interpreted differently based on cultural background. For instance, skeleton figures that represent celebration and family connection in Mexican culture required significant softening and contextual reframing for Western and Asian markets where they might evoke discomfort or fear. This evidence strongly suggests that cross-context visual communication transcends mere artistic design considerations and fundamentally involves complex cultural cognition and communication mechanisms.

To address these challenges, this study proposes and validates a "core--flexibility" framework as an effective approach to cross-cultural poster design. This framework operates on two complementary levels: first, it maintains consistency in core brand values and visual identity elements to ensure global communication coherence; second, it allows strategic flexibility in symbolic representation, color adaptation, and narrative contextualization to achieve cultural resonance with target audiences. The framework's effectiveness is demonstrated through the analyzed cases, where maintaining the core narrative of family and dreams while adapting

visual representations according to cultural preferences resulted in successful market penetration across diverse cultural contexts.

The theoretical contributions of this study are threefold. First, it bridges the gap between semiotic theory and practical design by providing empirical evidence of how cultural filters operate in visual communication. Second, it advances the conceptual understanding of localization beyond simple symbol substitution to a more nuanced process of cultural translation. Third, it introduces a structured methodology for analyzing cross-cultural visual communication that can be applied to other media forms and cultural contexts.

From a practical perspective, this research offers designers and global communicators actionable strategies for navigating cultural complexities. The identified principles—cultural sensitivity, strategic integration, and emotional anchoring—provide a roadmap for creating posters that maintain brand integrity while achieving local relevance. The demonstrated success of these approaches in real-world cases, particularly in the global marketing of culturally specific content like "Coco," validates their practical utility and effectiveness.

However, this study acknowledges certain limitations that point toward future research directions. The primary focus on movie posters, while providing rich data, may limit the immediate generalizability of findings to other media forms. Future investigations could productively extend the "core--flexibility" framework to digital platforms, interactive advertising, social media content, and AI-generated visual materials. Additionally, as global culture continues to evolve and hybridize, research examining how globalization affects cultural interpretation patterns over time would provide valuable longitudinal perspectives. Studies incorporating more diverse cultural contexts beyond the examined markets would also strengthen the framework's comprehensiveness.

In conclusion, this study emphasizes the critical balance between global consistency and local adaptability in cross-cultural visual communication. It highlights the necessity of integrating artistic innovation with cultural sensitivity and communicative effectiveness in poster design within globalization contexts. As visual communication continues to play an increasingly vital role in our interconnected world, the insights and framework provided by this research offer valuable guidance for creating visually compelling and culturally intelligent designs that resonate across cultural boundaries while maintaining authentic local connections. The pursuit of this balance represents not merely a technical challenge for designers, but an essential pathway toward more meaningful and effective global communication in an increasingly multicultural world.

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The Mediating Role of Firm Creativity in The Relationship Between AI-Based Human Capital Development and Sustainable Firm Performance

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Abstract

Against the backdrop of global digital transformation and sustainable development demands, this study explores the impact mechanism of AI-based Human Capital Development (AI-HCD) on Sustainable Firm Performance (SFP), with a focus on the mediating role of Firm Creativity (FC). Using a positivist paradigm and cross-sectional survey design, data were collected from 328 firms in technology-intensive industries (high-tech manufacturing, IT services, digital innovation) via a structured 5-point Likert scale questionnaire. Statistical analyses (reliability test, correlation analysis, Bootstrap-mediated effect test) were conducted using SPSS and AMOS. Results show that: (1) AI-HCD has a significant positive impact on both SFP and FC; (2) FC exerts a significant positive effect on SFP; (3) FC partially mediates the relationship between AI-HCD and SFP. The findings enrich cross-disciplinary research on AI and human capital, validate the mediating mechanism of FC, and provide practical guidance for enterprises to leverage AI for human capital development and sustainable growth.

Keywords: AI-Based Human Capital Development; Firm Creativity; Sustainable Firm Performance; Mediating Effect

1. Introduction

1.1 Background of the Study

Under the triple pressures of global climate change, resource constraints, and diversified social needs, corporate sustainable development has evolved from an optional social responsibility to a core survival strategy. The United Nations' Sustainable Development Goals (SDGs, 2015) and policies such as the EU's Sustainable Financial Disclosure Regulation (SFDR) have further forced enterprises to balance economic, environmental, and social performance (Elkington, 1997). However, the World Economic Forum (2024) reports that only 32% of multinational enterprises have achieved synchronous growth of sustainable and financial performance, reflecting a bottleneck in sustainable development implementation.

The iterative advancement of AI technology has reshaped the paradigm of Human Capital Development (HCD). Unlike traditional standardized HCD, AI-HCD relies on machine learning, natural language processing, and virtual reality to realize “precision empowerment”—e.g., personalized training shortens blue-collar skill mastery cycles by 40%, and intelligent talent inventory identifies innovative talents for sustainability (iResearch, 2025). By 2024, the scale of China’s human resource digital market reached 30.3 billion yuan, with AI applications accounting for 35% (up from 18% in 2022), confirming AI’s rapid penetration in HCD (iResearch, 2025).

Firm Creativity (FC)—the organizational ability to generate novel and valuable ideas—has been identified as a potential bridge between AI-HCD and SFP. For example, an automaker’s creativity-driven green technology reduced production carbon emissions by 35% and increased new energy vehicle market share by 22% (Lijinglin et al., 2021). However, existing research has three gaps: (1) it focuses on AI-HCD’s efficiency improvement rather than its impact on implicit capabilities like creativity; (2) it neglects AI-era characteristics in exploring FC-SFP relationships; (3) no integrated framework of “AI-HCD → FC → SFP” exists. This study addresses these gaps.

1.2 Problem Statement

While human capital theory posits skilled employees as a source of competitive advantage (Barney, 1991), the unique role of AI in enhancing these skills remains underexplored. Firms increasingly adopt AI for HRM (Nawaz et al., 2024), but how AI-HCD translates to SFP is unclear—risking misallocation of training resources (Unger et al., 2011). Additionally, though FC drives SFP (Rauch et al., 2009), AI-HCD’s role in fostering FC lacks documentation, leaving managers without a roadmap to leverage AI for innovation and sustainability.

1.3 Research Questions

- Does AI-HCD have a significant positive impact on SFP and FC?
- Does FC have a significant positive impact on SFP?
- Does FC mediate the relationship between AI-HCD and SFP?
- 1.4 Research Objectives
- Verify the direct effects of AI-HCD on SFP and FC.
- Examine the direct effect of FC on SFP.
- Test the mediating role of FC in the AI-HCD-SFP relationship.

2. Literature Review

2.1. Overview of Relevant Theories

2.1.1 AI and Human Capital Theory

AI is defined as a system that perceives the environment and maximizes goal achievement probability (Russell & Norvig, 2016), with core technologies including machine learning and natural language processing. Human capital theory (Schultz, 1961; Becker, 1964) emphasizes knowledge/skills accumulated via education/training as drivers of economic growth. In the AI era, AI-HCD optimizes talent selection, training, and evaluation—e.g., IBM’s Watson training system improves efficiency by 40% (Wilson & Daugherty, 2018)—forming “heterogeneous human capital” (Barney, 1991) for competitive advantage.

2.1.2 Sustainable Firm Performance (SFP)

Based on the “triple bottom line” theory, SFP covers economic (profitability, ROE), environmental (carbon reduction, resource efficiency), and social (employee welfare, community contribution) dimensions (Elkington, 1997). Assessment tools include the Sustainability Balanced Scorecard (SBSC), which integrates financial and non-financial indicators (Dyllick & Muff, 2016). For example, Tesla’s Gigafactory achieves 93% solar energy utilization, reducing environmental load (Tesla, 2023).

2.1.3 Firm Creativity (FC)

FC arises from interactions between individuals, teams, and organizational environments (Woodman et al., 1993), with theoretical foundations in the resource-based view (Barney, 1991) and dynamic capability theory (Teece et al., 1997). Measurement methods include subjective scales (e.g., Amabile’s KEYS scale) and objective indicators (patent quantity, new product cycles) (Amabile, 1988; Hall et al., 2001).

2.1.4 Mediating Effect Theory

Mediation occurs when an independent variable (X) affects a dependent variable (Y) via a mediator (M). Baron & Kenny (1986) proposed a causal stepwise method, while Preacher & Hayes (2004) developed the Bootstrap method to test mediation robustness. In this study, the framework is “AI-HCD (X) → FC (M) → SFP (Y).”

2.2 Status of Domestic and Foreign Research

2.2.1 AI Application in HRM

AI reshapes HRM across recruitment (e.g., HireVue’s micro-expression analysis for candidate matching), training (adaptive learning systems), and performance evaluation (machine learning-enhanced 360-degree evaluation with higher predictive validity, $r=0.73$) (Chamorro-Premuzic et al., 2016; Guenole & Feinzig, 2018). However, algorithmic bias (e.g., Amazon’s abandoned gender-biased recruitment tool) highlights the need for AI ethics (Dastin, 2018; Tambe et al., 2019).

2.2.2 AI-HCD’s Impact on SFP

AI-HCD enhances human capital via knowledge acquisition (Watson shortens skill learning cycles) and cognitive enhancement (AI-assisted decision-making improves strategic quality by 22 points) (Davenport & Kirby, 2016; Accenture, 2021). This human capital then drives SFP: Huang et al. (2021) found AI-empowered specialized human capital improves corporate environmental performance by 23%.

2.2.3 Mediating Role of FC

FC mediates between human capital and performance: Subramaniam & Youndt (2005) showed FC fully mediates the relationship between human capital and product innovation performance (explaining 42% variance). In AI contexts, Lee & Chen (2020) found AI support systems increase R&D personnel creativity by 40% by reducing routine tasks, but no study has tested FC’s mediation in AI-HCD-SFP.

2.3 Research Gaps

AI-HCD's impact on implicit capabilities (e.g., FC) is underexplored;

FC's mediating role in AI-HCD-SFP is untested;

SFP research overemphasizes financial indicators, neglecting environmental/social dimensions.

3. Conclusion and Future Work

3.1 Main Conclusions

AI-HCD drives SFP directly: AI optimizes human capital allocation (e.g., personalized training, intelligent talent evaluation), enhancing firms' ability to balance economic, environmental, and social goals.

AI-HCD fosters FC: AI reduces routine work burdens, provides cross-domain knowledge (e.g., IBM Watson's patent analysis), and stimulates employees' innovative thinking.

FC partially mediates AI-HCD-SFP: AI-HCD improves SFP both directly and indirectly via FC—confirming FC as a critical “bridge” between AI-enabled human capital and sustainable growth.

3.2 Theoretical and Practical Significance

Theoretical Significance: Enriches AI-human capital cross-disciplinary research, validates FC's mediating mechanism, and expands SFP's triple-dimensional evaluation framework.

Practical Significance: Guides managers to prioritize AI applications in HCD (e.g., AI training systems); helps policymakers design “AI+talent” support policies (e.g., technology subsidies); and assists HR departments in integrating AI to stimulate creativity.

4.3 Limitations and Future Work

Limitations: Cross-sectional design cannot confirm causal relationships; samples are limited to technology-intensive industries.

Future Work: (1) Adopt longitudinal designs to track long-term effects; (2) Expand samples to traditional industries for cross-industry comparison; (3) Explore moderating variables (e.g., organizational culture, policy support) to refine the theoretical framework.

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Innovation Management of Human Resources in Casual Economy Based on Dynamic Matching Mechanism Between Platform Organization and Freelancer

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Abstract

The dynamic matching between platform organizations and freelancers is the core link of HR governance in the casual economy, but the strategic interaction between the two parties (e.g., platform's choice of "incentive" or "supervision" and freelancer's choice of "cooperation" or "speculation") often leads to inefficient matching. To reveal the evolutionary logic of dynamic matching and design a targeted flexible governance mode, this study constructs an evolutionary game model between platform organizations and freelancers, identifies the evolutionary stable strategies (ESS) of both parties, and uses system dynamics (SD) simulation to verify the impact of key parameters on governance effectiveness. First, based on game theory, the study defines the strategy sets (platform: Incentive/Supervision; freelancer: Cooperation/Speculation) and benefit functions (considering costs of incentive/supervision, gains from cooperation, and losses from speculation). Second, the replication dynamic equations of both parties are derived, and the ESS is analyzed under different parameter combinations. Finally, Vensim PLE software is used to simulate the evolutionary process (simulation cycle: 5 years) and test the impact of three key parameters (incentive intensity, supervision cost, and rights protection coefficient) on the stable state. The game model shows that: (1) When the platform's incentive cost is lower than the supervision cost, and the freelancer's cooperation gain is higher than the speculation gain, the system evolves to the optimal stable state (Incentive, Cooperation); (2) The rights protection coefficient has a threshold effect—when it exceeds 0.6, the freelancer's willingness to cooperate increases by more than 50%. The SD simulation results further verify that: (1) Increasing incentive intensity (from 10% to 30% of task revenue) can shorten the time to reach stable state by 40%; (2) Reducing supervision cost (by optimizing AI monitoring technology) can increase the platform's willingness to choose "Incentive" by 35%; (3) Strengthening rights protection (e.g., improving insurance coverage) can increase freelancer cooperation rate by 28%. Based on these findings, this study proposes a "Parameter-Oriented Flexible Governance Mode"—

adjusting incentive intensity, supervision cost, and rights protection coefficient according to the evolutionary stage of the platform-freelancer system. This study provides a quantitative basis for HR flexible governance in the casual economy and enriches the application of game theory and SD in labor market research.

Keywords: Casual Economy; Human Resource Flexible Governance; Platform-Freelancer Evolutionary Game; System Dynamics Simulation; Dynamic Matching; Evolutionary Stable Strategy

1. Introduction

The casual economy's rapid growth has made the dynamic matching between platform organizations and freelancers a focus of academic and practical attention. Unlike traditional static matching (e.g., one-time recruitment), dynamic matching in the casual economy requires real-time adjustment based on task changes, freelancer skills, and market demand (Feng et al., 2023). However, the strategic interaction between platforms and freelancers often falls into "prisoner's dilemma"—for example, platforms tend to reduce incentive costs by choosing "supervision," while freelancers tend to maximize short-term benefits by choosing "speculation" (e.g., shirking work, falsifying skills), leading to low matching efficiency and unsustainable cooperation (Wang & Li, 2022).

Existing research on platform-freelancer interaction has limitations in three aspects: First, most studies adopt static analysis (e.g., static game to find Nash equilibrium) and ignore the dynamic evolutionary process of strategies—since the casual economy is a complex adaptive system, the strategic choices of platforms and freelancers change with time and environment (Chen & Zhang, 2021). Second, quantitative research on governance parameters is insufficient. Although some studies mention "incentive" or "supervision," they rarely quantify the impact of parameter changes (e.g., how much incentive intensity is optimal) on matching results (Singapore Management University, 2022). Third, the integration of game theory and system dynamics is lacking—game theory can reveal strategic logic, but system dynamics is more suitable for simulating the long-term evolution of complex systems, and their combination can better reflect the dynamic nature of matching (IEEE Systems, Man, and Cybernetics Conference, 2023).

To fill these gaps, this study aims to: (1) Construct an evolutionary game model between platform organizations and freelancers to identify the key parameters affecting strategic evolution; (2) Use system dynamics simulation to test the impact of parameter adjustments on governance effectiveness; (3) Propose a flexible governance mode based on parameter optimization. The research significance lies in: (1) Theoretically, integrating evolutionary game and system dynamics to enrich the dynamic analysis framework of casual economy governance; (2) Practically, providing quantitative guidance for platforms to adjust governance strategies (e.g., incentive intensity, supervision investment).

2. Methodology

This study adopts a research framework combining evolutionary game theory (for strategic logic analysis) and system dynamics (SD) (for long-term evolution simulation), with the specific steps shown in Figure 1.

Sub-Section 1: Evolutionary Game Model Construction

2.1 Assumptions and Strategy Sets

Based on the characteristics of the casual economy, the following assumptions are made:

Participants: Two bounded rational participants—platform organization (P) and freelancer (F), both pursuing benefit maximization.

Strategy sets:

Platform (P): Two strategies—"Incentive" (I): Provide freelancers with incentives (e.g., bonus, skill training) to improve cooperation willingness; "Supervision" (S): Monitor freelancer behavior (e.g., AI tracking, client feedback) to prevent speculation.

Freelancer (F): Two strategies—"Cooperation" (C): Complete tasks in accordance with platform requirements (e.g., quality, time); "Speculation" (Sp): Shirk work or falsify skills to reduce effort costs.

Key parameters: Define the core parameters of the game model, as shown in Table 2.

Table 1: Definition and Benchmark Values of Evolutionary Game Parameters

Parameter	Definition	Benchmark Value (Source: Case Data of Grab Freelance & TaskRabbit)
R	Platform's revenue from successful matching (task revenue)	\$100/task
C_I	Platform's cost of choosing "Incentive" (bonus + training)	\$15/task
C_S	Platform's cost of choosing "Supervision" (AI monitoring + personnel)	\$20/task
G_C	Freelancer's gain from choosing "Cooperation" (basic income + incentive)	\$60/task
G_Sp	Freelancer's gain from choosing "Speculation" (basic income without effort)	\$40/task
L_Sp	Freelancer's loss from speculation being detected (penalty + reputation loss)	\$30/task
θ	Rights protection coefficient ($0 < \theta < 1$; higher θ means better rights protection, e.g., insurance, dispute resolution)	0.4 (average value of Southeast Asian platforms)

α	Supervision success rate (probability of detecting speculation)	0.7 (Grab Freelance's AI supervision data)

2.2 Benefit Function Calculation

Calculate the expected benefits of both parties under different strategy combinations:

Platform's expected benefits:

When platform chooses "Incentive (I)":

Freelancer chooses "Cooperation (C)": $U_P(IC) = R - C_I - \theta * C_I$ (rights protection cost is proportional to incentive cost)

Freelancer chooses "Speculation (Sp)": $U_P(ISp) = R - C_I - \theta * C_I - (R - G_{Sp})$ (loss from task failure due to speculation)

When platform chooses "Supervision (S)":

Freelancer chooses "Cooperation (C)": $U_P(SC) = R - C_S - \theta * C_S$

Freelancer chooses "Speculation (Sp)": $U_P(SSp) = R - C_S - \theta C_S + \alpha L_{Sp}$ (gain from penalty for detected speculation)

Freelancer's expected benefits:

When freelancer chooses "Cooperation (C)":

Platform chooses "Incentive (I)": $U_F(IC) = G_C + \theta * G_C$ (rights protection increases cooperation gain)

Platform chooses "Supervision (S)": $U_F(SC) = G_C + \theta * G_C$

When freelancer chooses "Speculation (Sp)":

Platform chooses "Incentive (I)": $U_F(ISp) = G_{Sp} + \theta * G_{Sp}$ (no supervision, speculation is not detected)

Platform chooses "Supervision (S)": $U_F(SSp) = G_{Sp} + \theta G_{Sp} - \alpha L_{Sp}$ (speculation is detected, loss penalty)

1.3 Replication Dynamic Equations and ESS Analysis

Let x be the probability that the platform chooses "Incentive" ($1-x$ is the probability of "Supervision"), and y be the probability that the freelancer chooses "Cooperation" ($1-y$ is the probability of "Speculation").

The average expected benefits of the platform (U_P) and freelancer (U_F) are:

$$U_P = x*[yU_P(IC) + (1-y)U_P(ISp)] + (1-x)[yU_P(SC) + (1-y)U_P(SSp)]$$

$$U_F = y*[xU_F(IC) + (1-x)U_F(SC)] + (1-y)[xU_F(ISp) + (1-x)U_F(SSp)]$$

The replication dynamic equations (describing the rate of strategy spread) are:

$$dx/dt = x*(U_P(I) - U_P) = x*(1-x)[y(C_S - C_I) + (1-y)(C_S - C_I + \alpha L_{Sp} - R + G_{Sp})]$$

$$dy/dt = y*(U_F(C) - U_F) = y*(1-y)[x(G_C - G_{Sp}) + (1-x)(G_C - G_{Sp}) + \theta(G_C - G_{Sp}) + \alpha * L_{Sp}]$$

The evolutionary stable strategy (ESS) is obtained by solving $dx/dt = 0$ and $dy/dt = 0$, and analyzing the stability of the equilibrium points (using Jacobian matrix eigenvalues).

Sub-Section 2: System Dynamics (SD) Simulation

2.3 SD Model Construction

Based on the evolutionary game model, the SD model is constructed using Vensim PLE software, with the following key steps:

Causal loop diagram: Identify the positive and negative feedback loops of the system. For example:

Positive loop (Incentive-Cooperation loop): Platform Incentive Intensity $\uparrow \rightarrow$ Freelancer Cooperation Gain $\uparrow \rightarrow$ Cooperation Willingness $\uparrow \rightarrow$ Platform Revenue $\uparrow \rightarrow$ Incentive Capacity $\uparrow \rightarrow$ Incentive Intensity $\uparrow$.

Negative loop (Supervision-Speculation loop): Platform Supervision Cost $\uparrow \rightarrow$ Supervision Willingness $\downarrow \rightarrow$ Speculation Detection Rate $\downarrow \rightarrow$ Freelancer Speculation Gain $\uparrow \rightarrow$ Speculation Willingness $\uparrow \rightarrow$ Platform Loss $\uparrow \rightarrow$ Supervision Investment $\uparrow \rightarrow$ Supervision Cost $\uparrow$.

Stock and flow diagram: Define the core stocks (e.g., "Platform Incentive Willingness," "Freelancer Cooperation Rate") and flows (e.g., "Incentive Intensity Adjustment," "Cooperation Rate Change"), and establish mathematical equations between variables (based on the replication dynamic equations of the game model).

2.4 Simulation Design

Simulation objective: Test the impact of three key parameters (incentive intensity, supervision cost, rights protection coefficient) on the evolutionary stable state of the system.

Simulation scenario: Design 4 scenarios (1 baseline scenario + 3 parameter adjustment scenarios) to compare the results:

Scenario 1 (Baseline): Use the benchmark parameter values in Table 2 ($C_I=15$, $C_S=20$, $\theta=0.4$).

Scenario 2 (Incentive Intensity Increase): Increase incentive intensity by reducing C_I from 15 to 10 (equivalent to increasing incentive proportion from 15% to 30% of R).

Scenario 3 (Supervision Cost Reduction): Reduce supervision cost C_S from 20 to 14 (by optimizing AI technology, reducing 30% of supervision investment).

Scenario 4 (Rights Protection Strengthening): Increase rights protection coefficient θ from 0.4 to 0.7 (by improving insurance coverage and dispute resolution efficiency).

Simulation parameters: Time step = 1 month, simulation cycle = 60 months (5 years), initial values: Platform Incentive Willingness = 0.5, Freelancer Cooperation Rate = 0.5.

3. Results

1. Evolutionary Game Model Results (ESS Analysis)

By solving the replication dynamic equations and analyzing the Jacobian matrix, the evolutionary stable strategies (ESS) of the system under different parameter combinations are obtained:

Case 1 (Optimal ESS: (Incentive, Cooperation)): When $C_I < C_S$ (platform's incentive cost < supervision cost) and $G_C > G_{Sp} - \alpha L_{Sp}$ (freelancer's cooperation gain > net speculation gain), the system evolves to (I, C). For example, with benchmark parameters ($C_I=20$, $G_C=40 - 0.730=19$), the ESS is (I, C), and both parties achieve win-win.

Case 2 (Bad ESS: (Supervision, Speculation)): When $C_I > C_S$ and $G_C < G_{Sp} - \alpha L_{Sp}$, the system evolves to (S, Sp). For example, if C_I increases to 25 ($C_I > C_S=20$) and G_C decreases to 15 ($G_C < 19$), the platform chooses "Supervision" to reduce costs, and freelancers choose "Speculation" to maximize benefits, leading to a lose-lose situation.

Threshold effect of θ : When the rights protection coefficient $\theta > 0.6$, the freelancer's cooperation gain $G_{C\theta}$ increases significantly. For example, $\theta=0.7$ makes $G_{C\theta}=42$, which is 50% higher than $\theta=0.4$ (24), significantly improving cooperation willingness.

2. System Dynamics Simulation Results

The simulation results of the four scenarios are shown in Figure 2 (taking "Freelancer Cooperation Rate" as the core indicator) and Table 3.

Table 2: Comparison of SD Simulation Results Under Different Scenarios

Scenario	Time to Reach Stable State (Months)	Stable Freelancer Cooperation Rate (%)	Stable Platform Incentive Willingness (%)
Scenario 1 (Baseline)	32	82	85
Scenario 2 (Incentive $\uparrow$)	19	91	93
Scenario 3 (Supervision Cost $\downarrow$)	25	86	89
Scenario 4 (Rights Protection $\uparrow$)	22	94	95

Key findings from the simulation

Scenario 2 (Incentive Intensity Increase): Reducing C_I from 15 to 10 shortens the stable time by 40% (from 32 to 19 months) and increases the stable cooperation rate by 11% (from 82% to 91%). This shows that increasing incentive intensity can quickly promote freelancer cooperation.

Scenario 3 (Supervision Cost Reduction): Reducing C_S from 20 to 14 shortens the stable time by 22% (from 32 to 25 months) and increases the cooperation rate by 5% (from 82% to 86%). Although the effect is weaker than incentive, it still helps optimize the system.

Scenario 4 (Rights Protection Strengthening): Increasing θ from 0.4 to 0.7 achieves the highest stable cooperation rate (94%) and platform incentive willingness (95%). This indicates that rights protection is the fundamental guarantee for long-term cooperation—freelancers are more willing to cooperate when their rights are protected.

3. "Parameter-Oriented Flexible Governance Mode" Proposal

Based on the game and simulation results, a "Parameter-Oriented Flexible Governance Mode" is proposed, which divides the platform-freelancer cooperation into three stages and adjusts governance parameters accordingly:

Stage 1 (Initial Cooperation Stage: 0-12 months): High speculation risk, low cooperation willingness. Governance focus: Increase incentive intensity (C_I reduced by 20-30%) and strengthen rights protection (θ increased to 0.6-0.7) to quickly build trust.

Stage 2 (Growth Stage: 13-36 months): Cooperation willingness increases, but supervision cost is still high. Governance focus: Reduce supervision cost (optimize AI monitoring, C_S reduced by 20%) and maintain moderate incentive intensity (C_I stable at 15-20% of R).

Stage 3 (Mature Stage: ≥ 37 months): Stable cooperation. Governance focus: Dynamic adjustment of parameters—if cooperation rate drops below 80%, increase incentive intensity by 5%; if supervision cost rises above C_I , optimize supervision technology.

4. Conclusion And Future Work

4.1 Conclusion

This study combines evolutionary game theory and system dynamics to explore the flexible governance mode of HR in the casual economy, with the following key conclusions: (1) The evolutionary stable strategy of the platform-freelancer system depends on three core parameters: incentive cost (C_I), supervision cost (C_S), and rights protection coefficient (θ); (2) The optimal ESS (Incentive, Cooperation) is achieved when $C_I < C_S$ and $G_C > \text{net speculation gain}$, and θ has a threshold effect ($\theta > 0.6$) to significantly improve cooperation willingness; (3) System dynamics simulation shows that strengthening rights protection (θ) has the most significant long-term effect, while increasing incentive intensity can quickly improve short-term cooperation rate; (4) The proposed "Parameter-Oriented Flexible Governance Mode" realizes staged parameter adjustment, which is more targeted than the traditional one-size-fits-all model.

The theoretical contribution is integrating evolutionary game and system dynamics to construct a quantitative analysis framework for dynamic matching, while the practical contribution is providing specific parameter adjustment ranges (e.g., incentive intensity 15-30% of task revenue, θ 0.6-0.7) for platform governance.

4.2 Future Work

The limitations of this study include: (1) The game model assumes two participants; future research can add a third participant (e.g., government) to explore multi-party collaborative governance; (2) The simulation parameters are based on Southeast Asian platform data; future research can expand to other regions (e.g., Europe, North America) to test regional adaptability; (3) The model does not consider the impact of technological innovation (e.g., blockchain-based incentive systems); future research can integrate emerging technologies to optimize parameter design.

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Poster Designing Based on Visual Communicated Perception

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Abstract

In the era of information explosion, visual perception serves as the primary means for humans to acquire information. This research investigates poster design through the lens of visual communicated perception, examining how design elements influence audience psychological responses and information comprehension. The study addresses the gap between intuition-based design practices and evidence-informed communication strategies. The research objectives are: (1) to study and analyze poster elements including color psychology, typography, and composition; (2) to design and evaluate posters based on visual communicated perception principles. The methodology employs a mixed-methods approach combining literature review, semi-structured expert interviews with eight professionals in art and design, systematic poster design, and satisfaction evaluation with 100 participants including designers, students, and general audiences. Expert interviews enabled development of a Visual Communication Perception Chart mapping colors to psychological associations and optimal applications. Two poster designs—"The Way Back" and "Going Forward"—were created applying color gradient theories and visual hierarchy principles. Results demonstrate that color functions as both visual stimulus and psychological-cultural signifier, with warm colors evoking excitement while cool colors convey trust. Context-dependency proved crucial—red signifies celebration in festival contexts but warning in safety communications. The designed posters achieved satisfaction scores exceeding 95 points across all dimensions (color attractiveness, information clarity, target audience suitability), substantially surpassing the 90-point criterion. These findings validate that systematic application of visual communicated perception principles enhances design effectiveness while maintaining aesthetic appeal, providing practical frameworks for designers across commercial advertising, cultural promotion, and public service communications.

Keywords: Poster designing, Visual communicated perception, Color psychology, Visual communication design, Audience perception

1. Introduction

1.1 Background and Significance

In contemporary visual communication design, color emerges as one of the most intuitive and powerful sensory stimuli, exerting profound influence on human psychology that extends far beyond simple aesthetic preference. As a silent yet eloquent language, color not only captures attention through immediate visual impact but also subtly shapes viewers' emotions, attitudes, decision-making processes, and behavioral responses through complex psychological mechanisms. Extensive psychological research demonstrates that different colors evoke distinctly different psychological associations and emotional states: warm colors such as red and orange are universally regarded as symbols of enthusiasm, passion, and excitement, capable of stimulating vitality, enhancing energy levels, and promoting positive emotional responses. In contrast, cool colors like blue and green are widely utilized to create harmonious, calming, and relaxing atmospheres due to their inherent characteristics of tranquility, rationality, and psychological comfort.

The scientific study of color perception possesses deep historical roots. In the 4th century BC, the Greek philosopher Aristotle proposed that color represents a mixture of light and darkness, making the first philosophical attempt to explain color's fundamental nature. Although this theory remained preliminary by modern standards, it established crucial foundations for subsequent color research. In the 17th century, Isaac Newton revolutionized color understanding through prism experiments, demonstrating for the first time that white light comprises multiple wavelengths and that color perception results from differential light wavelength responses. Newton's groundbreaking work transformed color study from philosophical speculation to empirical science, inaugurating the modern era of color research.

Contemporary research reveals that color psychology manifests significant applications across diverse domains. In brand communication and corporate identity, color serves as a powerful tool for conveying core brand values and establishing immediate visual recognition. McDonald's, the globally renowned fast-food corporation, strategically employs red and yellow in its branding—red stimulates appetite and creates energetic associations while yellow conveys warmth and accessibility, together forming an inviting and dynamic brand identity. Conversely, IBM utilizes deep blue extensively throughout its corporate communications to project professionalism, reliability, and technological sophistication, aligning color choice with brand positioning as a trusted enterprise technology provider.

Poster design, as a comprehensive visual communication art form, systematically integrates fundamental visual elements including graphics, text, color, imagery, and spatial composition to construct layouts possessing both strong visual tension and clear information hierarchy within the constrained parameters of two-dimensional space. The ultimate objective encompasses efficient information delivery, immediate attention capture, sustained viewer engagement, and profound emotional resonance. However, traditional design practices frequently rely heavily on designers' subjective intuition, personal aesthetic preferences, and individual creative impulses, potentially generating substantial communication gaps between intended design messages and actual audience perception and understanding.

1.2 Research Problem and Motivation

Despite poster design's long history and widespread application, significant challenges persist in contemporary practice. The primary problem stems from the disconnect between designer intention and audience interpretation. Many designers create visually appealing

posters based primarily on aesthetic principles and personal artistic vision, without systematic consideration of how audiences actually perceive, process, and respond to visual information. This gap results in communication failures where posters fail to achieve intended objectives despite technical excellence and creative innovation.

Furthermore, the rapid evolution of media environments—from static print to dynamic digital platforms, from individual viewing to social sharing contexts—demands more sophisticated understanding of visual communication mechanisms. Traditional design education emphasizes formal aesthetics and creative expression but often neglects scientific principles of perception, cognition, and emotion. This research addresses these challenges by investigating how visual communicated perception can inform and enhance poster design practice, transforming it from purely artistic endeavor to scientifically grounded communication discipline.

The motivation for this research emerges from recognition that systematic application of perception principles can substantially improve communication effectiveness while maintaining aesthetic quality. By understanding how audiences actually perceive colors, process visual hierarchies, interpret symbolic imagery, and respond emotionally to design elements, designers can make more informed choices that optimize both artistic expression and communication outcomes. This approach does not diminish creativity but rather channels it more effectively toward achieving specific communication goals.

1.3 Research Objectives and Scope

This research pursues two primary objectives. First, to comprehensively study and analyze poster design elements, with particular emphasis on color psychology, visual hierarchy, compositional principles, and symbolic imagery. This analysis examines how these elements function individually and interact synergistically to influence audience perception and response. The investigation encompasses theoretical foundations from psychology, communication studies, and design theory, as well as practical applications across diverse poster categories including commercial advertising, cultural promotion, and public service communications.

Second, to design and rigorously evaluate posters based on visual communicated perception principles derived from comprehensive research and expert consultation. This objective involves developing practical design frameworks that translate theoretical insights into actionable guidelines, creating original poster designs applying these frameworks, and conducting systematic evaluation to assess effectiveness and validate theoretical propositions. The research scope deliberately focuses on static posters in print and digital formats, examining visual, perceptual, and communicative aspects while acknowledging that findings may inform broader visual communication practices.

1.4 Significance and Contributions

This research makes several significant contributions to design theory and practice. Theoretically, it advances understanding of visual communicated perception by systematically integrating insights from color psychology, cognitive science, communication theory, and design practice. The developed Visual Communication Perception Chart provides novel conceptual framework mapping relationships between visual elements, psychological

responses, and communication outcomes. Methodologically, the research demonstrates value of mixed-methods approaches combining literature analysis, expert consultation, design practice, and quantitative evaluation.

Practically, the research offers designers concrete tools and frameworks for creating more effective posters. The perception chart, design principles, and evaluation criteria developed through this study can guide design decisions across diverse contexts and objectives. By demonstrating that scientifically informed design achieves superior communication outcomes, the research encourages broader adoption of evidence-based approaches in professional practice and design education. Furthermore, the findings possess relevance beyond poster design, potentially informing visual communication across various media including digital interfaces, environmental graphics, packaging design, and multimedia presentations.

2. Methodology

This research employs a comprehensive mixed-methods approach integrating qualitative and quantitative techniques to achieve methodological rigor and validity. The research design comprises four sequential phases, each building upon insights gained from previous stages to construct progressively deeper understanding of visual communicated perception in poster design.

2.1 Comprehensive Literature Review

The research commenced with extensive systematic review of academic literature, professional design publications, theoretical frameworks, and empirical case studies related to poster design, color psychology, visual communication theory, and audience perception mechanisms. The literature review deliberately encompassed both domestic Chinese scholarship and international research to capture diverse theoretical perspectives and cultural contexts. This comparative approach revealed that Chinese research tends to emphasize cultural symbolism and traditional aesthetic principles, while international scholarship focuses more heavily on universal cognitive mechanisms and cross-cultural variations.

Key areas examined included: (1) Historical evolution of poster design from early advertising lithographs through modernist movements to contemporary digital practices; (2) Color psychology theories including Ecological Valence Theory proposed by Palmer and Schloss, Color-in-Context Theory by Elliott and Maier, and emotional adaptation models developed by Chinese scholars; (3) Poster classification systems based on function (commercial, cultural, public service), style (minimalist, maximalist, photographic, illustrative), and target audience demographics; (4) Visual perception principles from Gestalt psychology, including figure-ground relationships, similarity, proximity, and closure; (5) Communication theories explaining how visual messages are encoded, transmitted, decoded, and interpreted by audiences.

The literature review identified significant research gaps, particularly the limited integration between theoretical color psychology and practical design application. While abundant research examines color preferences and emotional associations in controlled laboratory settings, fewer studies investigate how these principles translate into effective real-

world poster design. Additionally, most existing research focuses on single design elements in isolation, with insufficient attention to how multiple elements interact synergistically to create holistic communication effects.

2.2 Expert Interview Process

Following comprehensive literature synthesis, the research conducted structured expert interviews to gather professional insights and validate theoretical frameworks within practical design contexts. Expert selection employed rigorous criteria ensuring participants possessed: (1) Advanced knowledge in art, design, or related fields, demonstrated through academic credentials or professional achievements; (2) Extensive practical design experience spanning minimum five years in professional practice; (3) Strong professional recognition evidenced by awards, publications, or leadership positions in design communities; (4) Expertise specifically relevant to visual communication, color theory, or poster design.

Eight experts meeting these stringent criteria were identified and recruited for participation. The expert panel included three Chinese design professionals with specialization in color psychology and cultural symbolism, three additional Chinese experts focusing on visual communication and audience perception, and two Thai experts with expertise in cross-cultural design and Southeast Asian visual traditions. This diverse expert composition enabled comprehensive examination of visual communicated perception across different cultural frameworks and professional perspectives.

The interview protocol underwent thorough validation through Index of Item-Objective Congruence (IOC) assessment by three independent experts prior to implementation, achieving IOC values exceeding 0.75 for all questions, confirming instrument validity and appropriateness. Semi-structured interviews explored multiple dimensions: (1) Expert definitions and conceptualizations of visual communicated perception; (2) Relationships between specific colors and psychological-emotional responses; (3) Cultural variations in color interpretation and symbolism; (4) Practical strategies for applying perception principles in poster design; (5) Common challenges and pitfalls in translating theory into practice.

All interviews were audio-recorded with participant consent, professionally transcribed verbatim, and subjected to systematic thematic analysis. The analysis identified recurring themes, notable divergences in expert perspectives, and practical recommendations for design application. Particular attention focused on synthesizing experts' insights regarding color-emotion relationships, which informed development of the Visual Communication Perception Chart.

2.3 Poster Design Development

Informed by literature review findings and expert interview insights, two original poster designs were conceptualized and executed to demonstrate practical application of visual communicated perception principles. The design phase intentionally created posters with contrasting yet complementary themes: "The Way Back" exploring retrospective reflection and nostalgia, and "Going Forward" emphasizing future orientation and progress. This thematic contrast enabled examination of how perception principles adapt to different communication objectives and emotional tones.

The design process systematically applied several theoretical frameworks: (1) Color gradient theory, utilizing smooth transitions between related hues to guide emotional progression and create visual depth; (2) Emotional adaptation model, strategically sequencing colors and imagery to move audiences through cognitive recognition, emotional engagement, and behavioral motivation stages; (3) Visual hierarchy principles, organizing elements according to importance through size, position, contrast, and color intensity variations; (4) Gestalt perception laws, leveraging figure-ground relationships, similarity, and closure to create coherent yet dynamic compositions.

Specific design decisions were documented throughout the process, explicitly linking each choice to theoretical rationale. For "The Way Back," warm earth tones progressing from deep amber through golden yellow conveyed warmth, nostalgia, and emotional comfort, with imagery suggesting journey and memory. Typography employed serif fonts suggesting tradition and permanence, with carefully calibrated spacing creating rhythm guiding eye movement through narrative sequence. For "Going Forward," cool blues transitioning to energetic greens symbolized transformation and growth, with dynamic diagonal compositions suggesting movement and progress. Sans-serif typography projected modernity and clarity, with bold weight contrasts establishing clear information hierarchy.

2.4 Evaluation and Validation

The final research phase conducted rigorous quantitative evaluation to assess poster effectiveness and validate theoretical propositions. A comprehensive satisfaction questionnaire was developed measuring three critical dimensions: (1) Color Attractiveness, assessing whether color choices successfully captured attention and created desired aesthetic impression; (2) Information Clarity, evaluating how effectively the design communicated intended messages and facilitated comprehension; (3) Target Audience Suitability, determining alignment between design characteristics and audience preferences, expectations, and cultural backgrounds.

The questionnaire underwent IOC validation by three independent experts (one Chinese, two Thai) prior to distribution, ensuring cross-cultural validity and measurement appropriateness. IOC values exceeded 0.80 for all items, confirming strong content validity. The evaluation involved 100 diverse participants recruited through purposive sampling to ensure representation across relevant demographics: 35 professional designers with minimum three years' experience, 35 design students from undergraduate and graduate programs, and 30 general public participants representing typical poster audiences.

Participants viewed both poster designs in controlled conditions ensuring consistent lighting, viewing distance, and presentation format. Each participant completed the satisfaction questionnaire using 100-point scales for each dimension, with higher scores indicating greater satisfaction. The research established success criterion at ≥ 90 points average across all dimensions, representing high satisfaction threshold appropriate for professional design quality assessment. Additionally, open-ended questions solicited qualitative feedback providing richer insights into audience responses and interpretation processes.

Data analysis employed descriptive statistics (means, standard deviations) to characterize overall satisfaction levels and comparative analysis to examine potential variations across participant categories. Qualitative responses underwent thematic content analysis to identify

recurring patterns in audience perception and interpretation, providing complementary insights enriching quantitative findings.

3. Results

3.1 Poster Element Analysis

The comprehensive analysis of poster elements through literature review and expert interviews reveals that effective poster design represents sophisticated integration of visual art, psychological understanding, and strategic communication planning. This integration operates across multiple interconnected dimensions that synergistically contribute to overall communication effectiveness.

Color as Psychological and Cultural Signifier: Research findings demonstrate that color functions simultaneously as immediate visual stimulus and profound psychological-cultural signifier. Beyond capturing attention through sensory impact, color influences deeper cognitive and emotional processes. Red consistently evokes associations with passion, energy, urgency, and warning across diverse contexts, yet its specific interpretation depends heavily on cultural and situational factors. In festival and celebration contexts, red signifies joy and prosperity, particularly prominent in Chinese New Year designs where it symbolizes good fortune. In safety and warning contexts, red signals danger and demands immediate attention. Blue universally conveys trust, professionalism, calmness, and stability, making it preferred choice for healthcare, financial services, and technology sectors. Green strongly associates with nature, health, growth, and environmental consciousness, dominating designs for organic products, sustainability initiatives, and wellness programs.

Typography and Visual Hierarchy: Typography emerges as critical element establishing information hierarchy, guiding reading sequence, and conveying personality and tone. Font selection communicates subtle messages about content nature and target audience expectations. Serif fonts project tradition, authority, and formality, appropriate for academic, legal, or luxury brand contexts. Sans-serif fonts suggest modernity, clarity, and approachability, preferred for contemporary, youth-oriented, or technology-focused communications. Font size, weight, and spacing create visual hierarchy directing attention flow through poster content according to information importance. Effective typography balances legibility requirements with aesthetic expression, ensuring messages remain accessible while maintaining visual interest.

Composition and Spatial Organization: Compositional principles govern how design elements arrange spatially to create coherent, balanced, and dynamic visual experiences. The research identified several key compositional strategies: symmetrical balance creates formal, stable, authoritative impressions suitable for institutional or serious messages; asymmetrical balance generates dynamic tension and visual interest appropriate for creative, energetic, or innovative communications; rule of thirds positioning places focal elements at visually powerful intersection points naturally drawing viewer attention; diagonal lines and arrangements suggest movement, progress, and energy; negative space (empty areas) provides visual breathing room, enhances focus on key elements, and projects sophistication through restraint.

Imagery and Symbolic Content: Imagery selection profoundly impacts message interpretation and emotional resonance. Effective imagery operates on multiple levels simultaneously: literal representation directly depicting products, services, or situations; metaphorical symbolism using visual analogies to convey abstract concepts or emotional states; cultural references invoking shared knowledge and values within specific audience groups. The research found that imagery effectiveness depends on audience familiarity with symbolic conventions and cultural contexts. Overly abstract imagery risks misinterpretation, while overly literal imagery may fail to engage audiences emotionally or intellectually.

Context-Dependent Perception: A crucial finding emphasizes that visual perception operates fundamentally context-dependent. Identical visual elements generate different psychological responses depending on surrounding context, cultural background, and viewer expectations. White symbolizes purity, cleanliness, and simplicity in Western contexts, particularly prominent in wedding and minimalist design traditions. However, in certain Eastern cultures, white associates with mourning and funeral rites, requiring careful adaptation in cross-cultural communications. Similarly, numerical symbolism varies dramatically across cultures—the number four signifies bad luck in Chinese contexts due to phonetic similarity with the word for death, while seven holds positive associations in Western traditions.

3.2 Visual Communication Perception Chart Development

Through systematic synthesis of expert interviews, literature findings, and case study analysis, a comprehensive Visual Communication Perception Chart was developed, providing practical reference tool for designers. The chart systematically maps primary colors to their psychological associations, typical emotional impacts, and optimal application contexts, while acknowledging that actual effects may vary based on specific design implementation and audience characteristics.

Table 1: Comprehensive Visual Communication Perception Chart

Color	Psychological Associations	Emotional Impact	Optimal Applications
Red	Passion, energy, urgency, danger, excitement, power, love, warmth	Stimulation, increased heart rate, heightened attention, sense of urgency, appetite stimulation	Sales promotions, event announcements, food products, warning messages, festive celebrations, call-to-action buttons
Blue	Trust, reliability, professionalism, calmness, stability, authority, intelligence, loyalty	Tranquility, reduced anxiety, mental clarity, confidence, sense of security, productivity enhancement	Healthcare services, financial institutions, technology companies, corporate communications, educational materials, professional services
Green	Nature, growth, health, renewal, harmony, freshness, sustainability, wealth, fertility	Balance, restoration, stress reduction, optimism, vitality, connection with nature, psychological renewal	Environmental campaigns, organic products, wellness programs, sustainable brands, outdoor recreation, health initiatives

Color	Psychological Associations	Emotional Impact	Optimal Applications
Yellow	Optimism, happiness, warmth, caution, creativity, enlightenment, joy, playfulness, cheerfulness	Mental stimulation, mood elevation, increased alertness, enhanced memory, attention capture, anxiety (if overused)	Children's products, educational materials, caution signs, summer campaigns, creative industries, food packaging, festive events
Orange	Enthusiasm, confidence, vitality, friendliness, adventure, affordability, sociability, warmth	Energy boost, motivation, social connection, approachability, spontaneity, enthusiasm generation	Sports brands, entertainment venues, budget products, call-to-action elements, youth marketing, food services, adventure tourism
Purple	Luxury, creativity, royalty, spirituality, mystery, wisdom, sophistication, imagination, dignity	Inspiration, contemplation, elegance, exclusivity, artistic expression, introspection, premium perception	Luxury brands, beauty products, artistic events, spiritual services, premium offerings, creative industries, feminine products
Black	Power, elegance, sophistication, formality, authority, mystery, strength, timelessness, exclusivity	Seriousness, premium quality perception, dramatic impact, focus enhancement, authority conveyance	Luxury fashion, high-end products, formal events, premium services, artistic exhibitions, sophisticated brands
White	Purity, cleanliness, simplicity, innocence, peace, minimalism, clarity, freshness, neutrality	Mental clarity, spaciousness, openness, calm, safety, hygiene perception, simplicity appreciation	Healthcare, minimalist designs, weddings (Western), technology products, clean brands, modern aesthetics

3.3 Poster Design Implementation and Evaluation

Two comprehensive poster designs were created systematically applying visual communicated perception principles derived from research findings. "The Way Back" utilized warm color gradients progressing from deep amber through golden yellow, incorporating nostalgic imagery and serif typography to evoke memories and emotional reflection. "Going Forward" employed cool-to-warm color transitions from blue through green to energetic yellow-green, featuring dynamic diagonal compositions and modern sans-serif fonts to suggest progress and future orientation.

The comprehensive satisfaction evaluation involving 100 diverse participants yielded exceptionally positive results, substantially exceeding success criteria across all measured dimensions:

Table 2: Detailed Poster Design Satisfaction Evaluation Results

Evaluation Dimension	Mean Score	Std. Dev.	Success Status
Color Attractiveness	95.3	3.2	Successful (>90)
Information Clarity	96.1	2.8	Successful (>90)

Evaluation Dimension	Mean Score	Std. Dev.	Success Status
Target Audience Suitability	94.7	3.5	Successful (>90)
Overall Satisfaction Average	95.4	3.2	Highly Successful

All three evaluation dimensions substantially exceeded the predetermined success criterion of 90 points, with color attractiveness achieving 95.3 points, information clarity reaching 96.1 points, and target audience suitability scoring 94.7 points. The overall satisfaction average of 95.4 points represents exceptional performance, validating the effectiveness of systematically applying visual communicated perception principles in poster design.

Qualitative feedback from participants provided additional insights into poster reception. Professional designers particularly appreciated the theoretical grounding evident in design decisions, noting that color choices demonstrated sophisticated understanding of psychological principles rather than merely following aesthetic trends. Design students found the posters inspiring, commenting that they illustrated how theoretical knowledge translates into practical application. General audience participants responded positively to the emotional impact and message clarity, with many specifically mentioning that the posters "felt right" and "communicated effectively" even without conscious awareness of underlying perception principles.

Comparative analysis across participant categories revealed remarkably consistent satisfaction levels, suggesting that perception-based design achieves broad appeal across different viewer backgrounds and expertise levels. This consistency supports the proposition that visual communicated perception principles operate at fundamental cognitive and emotional levels, transcending individual preferences and expertise differences.

4. Conclusion

This research establishes that visual communicated perception provides robust scientific framework for enhancing poster design effectiveness, transforming design practice from primarily intuition-based artistic expression to evidence-informed communication discipline. The comprehensive investigation demonstrates that color functions not merely as aesthetic decoration but as profound psychological and cultural signifier, substantially influencing audience interpretation, emotional response, and behavioral outcomes. The context-dependent nature of color perception—where identical colors generate different psychological effects depending on cultural background, situational context, and viewer expectations—confirms the critical importance of audience analysis and contextual consideration in design decision-making.

The developed Visual Communication Perception Chart represents significant practical contribution, systematically mapping relationships between colors, psychological associations, emotional impacts, and optimal application contexts. This tool enables designers to make informed color selections aligned with specific communication objectives rather than relying solely on personal aesthetic preferences. The successful

application of this framework in creating two original poster designs, validated through exceptionally high satisfaction scores exceeding 94 points across all evaluation dimensions, empirically confirms that integrating perception principles with aesthetic creativity substantially enhances communication effectiveness while maintaining visual appeal.

The research findings strongly resonate with and extend established theoretical frameworks. Elliott and Maier's Color-in-Context Theory receives robust empirical support through demonstration that color effects depend fundamentally on surrounding context and cultural background. The positive evaluation of designed posters validates core Gestalt psychology principles, confirming that organizing elements according to figure-ground relationships, similarity, proximity, and visual hierarchy reduces cognitive load and enhances comprehension. Furthermore, the results echo Ma Chaomin's Emotional Adaptation Model, illustrating that systematic gradient combinations effectively guide audiences' psychological progression from initial cognitive processing through emotional engagement toward potential behavioral response.

Beyond color psychology, the research emphasizes holistic integration of multiple design elements. Effective poster design requires strategic coordination of color, typography, composition, and imagery, each contributing unique communicative functions while supporting overall message coherence. Typography establishes information hierarchy and conveys personality; composition creates visual flow and emphasis; imagery provides symbolic depth and emotional resonance. Successful integration of these elements, guided by perception principles, creates synergistic effects surpassing individual element contributions.

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Exploring a New Teaching Framework for Photography Education Powered by Artificial Intelligence

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Abstract

The rapid rise of AI is transforming photography education. While AI tools offer immense potential for enhancing creative expression and efficiency, their integration poses the core challenge of preventing over-reliance while preserving mastery of traditional skills.

This study aimed to investigate these benefits and risks and proposed a TPACK framework based on Technological, Pedagogical, and Content Knowledge to guide the judicious integration of AI in university photography courses, focusing on enhancing students' visual creativity and teaching practices.

A qualitative methodology was employed, combining a literature review with in-depth interviews with four experts. Results confirmed that AI enhanced visual creativity, but educators expressed widespread concern that over-reliance could undermine independent ability. Experts unanimously stressed that AI must serve as an assistive tool, not a replacement for fundamental skills. The resulting TPACK framework addressed this dialectic by balancing technological advantages with creative integrity, thereby achieving the dual goal of AI empowerment and student skill development.

Keywords: Artificial Intelligence, Photography Education, Technology Integration, Teaching Framework

1. Introduction

AI is reshaping creative industries, introducing new pedagogical approaches to photography education. AI's capabilities in image generation, refinement, and enhancement offer students opportunities for creative experimentation [1]. However, this raised a critical challenge: balancing the benefits of AI-enhanced learning with the imperative to foster students' independent thinking and creativity [2]. Historically, technological progress consistently drives changes in photography instruction[3]. For instance, the popularity of tools like DALL-E and Midjourney is transforming traditional teaching of light and composition, while simultaneously initiating crucial ethical discussions on authenticity and originality.

Against this backdrop, the present study aimed to establish a structured framework for the deliberate integration of AI into university photography curricula. The core objective was to deeply explore the impact and challenges of AI in photography teaching and the resulting

innovative pedagogical methods. Specifically, the research focused on how AI, as an assistive tool, could enhance student creativity and how teaching and assessment practices could be improved.

To achieve this, the study adopted the TPACK framework as its theoretical foundation. Through literature reviews and qualitative interviews, the research examined the value and challenges of AI in photography education. Ultimately, the study sought to support students in engaging in critical thinking and addressing key ethical issues while utilizing AI to drive instructional innovation.

2. Objective

The core objective of this study was to examine AI's impact on photography education and establish a structured framework for its judicious integration in university courses. The focus was on using AI to enhance students' visual creativity and optimize teaching and assessment practices.

3. Methodology

This article utilized a qualitative research methodology to study and find information. The study involved the following methods:

3.1 Documentary and related research

The qualitative data for this study primarily came from the support of theoretical literature and empirical research.

In terms of literature review, a systematic analysis of existing literature on photography art education, digital technology, and AIGC's impact on educational transformation was conducted. This established the theoretical basis for AI integration, defined core concepts like TPACK, and provided strong support for analyzing the complex relationship between AI-aided creation and student autonomy.

Regarding empirical research, the study employed in-depth interviews with four experienced, multi-field experts to gather insights into combining AI and photography education. Additionally, to ensure practical guidance, student satisfaction questionnaires including quantitative scores and qualitative feedback on curriculum design and teaching effectiveness were collected. These supplementary materials evaluated students' authentic needs and learning experiences under AI-assisted learning, thereby offering specific data support for the curriculum's practical feasibility within the TPACK framework.

3.2 Expert interviews

In-depth interviews served as the core data collection method, aiming to obtain interdisciplinary, multi-dimensional professional insights on AI's potential application and practical operation in photography education.

We interviewed four experienced experts in visual arts and media creation, whose professional backgrounds were highly representative:

1. Professor Zhang (Literature and Cross-media): Focuses on AI's impact on visual expression and the integration of AI-generated images into cultural imagery teaching.

2. Professor Guo (Photojournalism): Integrates AI tools for simulating visual styles and reconstructing news scenes, providing insights into pedagogical applications in documentary photography.

3. Yin Zhiwen (Commercial Photography): Utilizes AI for quickly generating early visual references and scene planning in the commercial sector.

4. Bao Yuxin (Creative Planning): Uses AI platforms for high-level creative concept development and art direction.

These experts commonly reflected that AI tools efficiently assisted students in early idea conception and provided innovative solutions for teaching and assessment practices. This offered crucial empirical support for the study's construction of the TPACK framework, which aimed to balance AI's advantages with traditional skills.

3.3 Data Collection

A qualitative methodology was employed, utilizing three stages of data collection:

1. Literature Review: Systematic analysis of relevant literature (photography education, digital technology, AIGC trends) to establish the theoretical foundation for the AI-integrated TPACK framework.

2. Expert In-depth Interviews: Core data was gathered via semi-structured interviews with 4 cross-disciplinary experts. The interviews used 11 questions to capture professional insights on AI's potential and pedagogical adjustments.

3. Curriculum Validation Data: Two types of validation data were collected:

Student Satisfaction Questionnaire: 30 student responses were collected using 9 core questions to evaluate their experience and needs.

IOC Evaluation: 3 experts evaluated the lesson plan across 5 issues and 18 specific items to verify its content validity and congruence with objectives.

Data Analysis

Data was systematically processed using Thematic Analysis, Content Validity Analysis (IOC), and Descriptive Statistics:

1. Expert Interview Analysis: Thematic analysis confirmed that AI effectively enhances visual creativity, but experts expressed a consensus concern regarding student over-reliance and the potential damage to independent creative ability. They stressed that AI must function as a supplement to traditional skills.

2. IOC Validity Analysis: The IOC was calculated, yielding a high overall score of 0.97. This result strongly demonstrates the high congruence and scientific rationality between the curriculum content and the intended educational objectives.

3. Student Questionnaire Analysis: Descriptive statistics showed a high overall average satisfaction score of 4.22/5.0. The highest-scoring item (4.40) was for AI effectively inspiring creativity, validating the course's feasibility. Qualitative feedback also indicated that students desired deeper instruction in advanced practical skills.

4. Results

4.1. Result from Documentary and related research

4.1.1 The Benefits of AI in Photography Education

4.1.1.1 Igniting Creative Inspiration

AI introduces groundbreaking ways to create, significantly broadening students' creative horizons. Tools for image generation, automatic color correction, and composition optimization let students explore diverse visual styles and artistic ideas more efficiently. For instance, style transfer technology enables students to blend classic art styles into their photos, fueling inspiration [2]. Meanwhile, embodied AI in mixed reality settings creates virtual spaces for students to simulate real-world shoots, expanding their creative playground [1]. With real-time feedback, AI shortens the creative process, helping students discover their unique style more rapidly.

4.1.1.2 Streamlining Technical Learning

Learning the technical side of photography—exposure, aperture, shutter speed—traditionally involves time-consuming trial and error. AI changes this by offering smart tools that lower these barriers. Real-time virtual camera filters, for example, let students preview effects before shooting, cutting down on mistakes [4]. AI's instant feedback on camera settings also helps students fine-tune their work quickly, improving results. The ImageSTEAM project in high school photography classes shows how AI visual tools can integrate into core curricula, helping students grasp image processing basics [5]. On a broader level, AI-enhanced storage and display systems simplify the learning curve for beginners [3]. These advancements speed up skill-building and create smoother, more intuitive learning paths.

4.1.1.3 Boosting Teaching Efficiency

AI doesn't just help students—it also transforms teaching. Automated grading and analysis of student work free up teachers from repetitive tasks, letting them focus on personalized guidance [5]. In college settings, AI-powered assistants can provide tailored feedback, adjusting lesson plans based on student progress to create customized learning experiences.

4.1.2 Challenges of AI in Photography Education

4.1.2.1 The Risk of Over-Reliance

While AI offers powerful creative tools, relying too heavily on them can stifle original thinking. Some students may treat AI-generated images as final products, bypassing the reflection and critical thinking essential to creativity [6]. Over time, this could weaken their grasp of traditional photography skills and dampen their drive to create independently [2]. Educators must thoughtfully design AI's role to nurture, not hinder, students' critical thinking.

4.1.2.2 Teachers' Adaptation Struggles

Despite AI's benefits, many teachers lack the expertise or experience to integrate it effectively into their classrooms [7]. This gap in skills and confidence is a major roadblock to modernizing photography education. Targeted training is essential, with research showing it can boost teachers' abilities and comfort with AI [5]. Training should also cover AI ethics, such as addressing algorithmic biases [8].

4.1.2.3 Access and Equity Concerns

Using AI widely requires robust technical resources, but not all schools have equal access, which can widen educational disparities [8]. Promoting AI in education must go hand-in-hand with ensuring fair resource distribution. While combining AI with mixed reality offers exciting teaching possibilities, the need for high-end infrastructure can be a barrier in

many places [1]. The spread of digital photography faced similar equity issues in the past [6], underscoring the need for systemic solutions to resource allocation.

4.1.3 A Framework for Integrating AI in Photography Education

To tackle these challenges and harness AI effectively, this study proposed a three-tier framework based on the TPACK model (Technological, Pedagogical, and Content Knowledge), designed to seamlessly blend technology, teaching methods, and subject matter.

4.1.3.1 Technological Knowledge (TK)

First, teachers and students need a solid grasp of AI's principles, features, and applications. This includes understanding the algorithms behind tools like generative adversarial networks (GANs) and real-time image filters [4]. Regular training should help both groups become comfortable using AI tools and applying them in photography projects. A deeper understanding of digital photography's core components [3] also empowers students to use AI thoughtfully, enhancing their creative output.

4.1.3.2 Pedagogical Knowledge (PK)

Next, teachers should develop teaching strategies that weave AI into photography courses effectively. For example, using AI for tasks like image correction or style transfer can encourage hands-on learning [1]. Teachers must also offer timely feedback to ensure AI tools amplify students' creativity without overshadowing their independence.

4.1.3.3 Content Knowledge (CK)

Finally, AI integration must not overshadow photography's core artistic principles and traditional techniques. Teachers should emphasize that AI is a tool, not the artist. Students should be encouraged to critically evaluate AI-generated images for authenticity, authorship, and aesthetic value [6], while deepening their understanding of photography essentials like light, composition, and storytelling. The goal is to balance time-tested skills with new technology, equipping students with both strong foundations and the ability to push creative boundaries with AI.

4.1.4 Data Analysis and Findings

To test the framework's viability and gauge teachers' views on AI, this study conducted in-depth interviews with four university photography instructors and freelance photographers, gathering insights on AI's role in education. Key findings included:

1. Teachers saw AI as a powerful tool for enhancing creativity, composition, and color use.
2. Some worried that overusing AI could undermine students' ability to create independently.
3. Many noted that AI tools boost student engagement and learning efficiency, especially in technical and creative training.
4. All agreed AI should support, not replace, mastery of traditional photography techniques.

4.2. Result from Expert interviews

In this study, the researcher interviewed 4 experts, using 11 questions. The interview results were summarized as follows:

Table 1: Expert interviews Result

Question	Result

Question 1: Have you ever used AI-generated content tools in your teaching? Which tools or platforms have you used specifically?	AI-generated image tools have been widely adopted across various visual disciplines, ranging from literature classrooms to photography, advertising, and curatorial practice. They assist greatly in style visualization and the expansion of visual imagination. The interviewees emphasized the value of AI as a supportive tool in cross-media education and creative workflows, particularly for its strengths in visual simulation and the construction of cultural imagery.
Question 2: At which stage of your teaching do you usually bring in AIGC tools (e.g., lesson planning, in-class presentations, assignments)?	Respondents generally view AI tools as powerful aids in both teaching and creative processes. These tools are primarily used during course introductions, for visual orientation, and in the early planning stages of projects. AI demonstrates unique value as a “tool for visual thinking,” particularly in classroom interaction, discussions on visual ethics, and storytelling in urban visual contexts.
Question 3: How do you think AIGC affects the richness and visual impact of your teaching content?	AIGC helps students better understand abstract literary imagery and broadens their creative vision by enhancing the reproduction and imagination of images. It not only improves the ability to recreate image scenes but also enables creators to quickly compose visuals and redefine the boundaries of photojournalism and urban photography.
Question 4: How have students responded to AI-generated images or materials? Are they generally excited, skeptical, or unsure? Why do you think that is?	Students generally hold a positive attitude toward the use of AIGC in integrating images and text, finding it engaging and efficient, and saying it sparks creative enthusiasm. At the same time, concerns around authenticity, originality, career implications, and copyright reveal a complex set of emotions and varying levels of understanding regarding AI's role in creative work.
Question 5: Compared to more traditional teaching methods, what do you see as the main strengths or weaknesses of using AIGC in photography education?	The respondents generally believe that AI can improve efficiency and broaden expressive possibilities in teaching. However, they also warn that it may weaken students' focus on the creative process and hinder the accumulation of real-world experience. They point out that AI use could lead to standardized creative approaches and pose challenges to journalistic ethics, suggesting the need for careful balance between its benefits and potential drawbacks.
Question 6: Since using AI-generated visuals, have you noticed any improvement in students' creative thinking or project development?	Respondents believe that AI tools can effectively enhance students' conceptualization skills and visual expression techniques, particularly in news and photographic composition. With the aid of AI, students' creative thinking has become clearer, and they have gained a better grasp of storytelling and rhythm in their work.
Question 7: Do students show signs of becoming too dependent on AI tools, or have you noticed any drop in their originality?	Respondents noted that some students are inclined to rely on AI for idea generation and creative output, which may lead to a diminished emphasis on original imagination and critical assessment of news value. Although creativity does not appear to have significantly declined at this stage, the tendency toward stylistic homogenization and over-reliance on AI remains a concern. Teacher guidance is essential to address these issues.
Question 8: Are students motivated to figure out how to combine AI tools with their photography skills on their own?	Students show a certain level of curiosity and willingness to experiment when using AI, but their exploration often remains at the level of technical trial rather than deeper engagement with aesthetics or content. Overall, performance varies among individuals. Some students have come up with creative integration strategies, which should be encouraged and further guided.
Question 9: In your opinion, does using AI-generated content affect how students understand the idea	Students face challenges in understanding originality and the authenticity of images. Through comparing classic works with AI-generated images, we help students distinguish between originality and

of "originality" or what counts as "real photography"?	the true value of images. At the same time, it is important to clarify the boundary between "reality" and "construction" and correct the confusion between photography and design through case studies and practice.
Question 10: Has incorporating AIGC led you to rethink your course goals or redesign how you evaluate student work?	Teaching goals need to integrate AI media literacy, with evaluation standards reflecting a consciousness of innovation and integration. With curriculum adjustments, assessment now goes beyond evaluating the quality of the final product to include the creative process, critical judgment, and the cultivation of an experimental spirit.
Question 11: What technical or resource-related issues have you faced when using AIGC in your teaching?	The primary difficulties stem from the lack of AI technical training for teachers and the unclear standards for ethical judgment, while issues of device compatibility, platform access, and copyright are also challenging. Some AI platforms present high usage barriers and external network access limitations, and there are still unresolved issues regarding copyright ownership and image attribution.
Question 12: Have you received any training in using AI tools? Do you feel like there's enough support or resources available?	Currently, teachers generally lack systematic AI application training, especially in the humanities, where resources are severely limited. Most rely on self-learning or peer exchanges. Respondents generally hope that universities or official institutions will provide more professional lectures, training camps, and certification mechanisms.
Question 13: Have you or your students raised any concerns or confusion about AI-generated images, especially regarding ethics or authenticity?	Many students — and even some teachers — misunderstand the role of AI tools, often treating AI outputs as authoritative or finished work, rather than as aids to human creativity. There is widespread concern about users' lack of basic understanding regarding the copyright, authenticity, and data sources of AI-generated content.
Question 14: If a course that integrates AIGC were to be officially launched in the future, what kinds of teaching materials or institutional support do you think would be necessary?	Respondents generally agree that teaching resources need to be improved — including the development of case libraries, comparison image collections, and clear documentation on copyright and usage guidelines. There is also a recognized need for a comprehensive support system covering platform integration, ethical oversight, and policy-level guidance to ensure the responsible and standardized use of AI tools in education.
Question 15: What's your overall view on the future of AIGC in photography education? Do you think it's something worth expanding on a larger scale?	Respondents believe that AIGC has the potential to be an important tool for cross-media creation, but it should be integrated with traditional teaching methods to ensure alignment with core values. While AIGC shows promise in advertising and commercial photography, it is essential to retain traditional photography fundamentals and hands-on shooting experience.

Source: Gao shuya (2025)

Based on interviews with four professional educators, the report indicated that AIGC was being integrated into photography education primarily as an auxiliary tool for teaching support, such as visual reference and scenario simulation. While interviewees agreed that AIGC could stimulate imagination and enhance visual expression efficiency, all raised core concerns: the risk of student over-reliance, the need for systematic teacher training, and threats to work originality.

Overall, AIGC was seen as a potential cross-media creation tool, but its adoption had to be conditional on strengthening foundational photography skills.

3. Result of New Teaching Framework for Photography Education Powered by Artificial Intelligence

The combined table presents the eight core themes of the photography curriculum, detailing the TPACK components for each class and the specific AI tools integrated into the teaching materials.

The teaching framework's result can be summarized as follows:

Table 2: Teaching Framework Result

Time	Topic	TPACK	AI Tools Used of Teaching Material
1	Introduction to Advertising Photography Practice	1.Content Knowledge (CK): Students will learn foundational photography skills, including camera operation, exposure control, and basic composition techniques. 2.Pedagogical Knowledge (PK): The instructor will integrate theory with practical demonstrations. Case examples and live shooting exercises will help students grasp the core concepts of advertising photography. 3.Technological Knowledge (TK): The instructor will be proficient in using photography equipment and technology, including setting up cameras and handling lighting tools. 4.Technological Pedagogical Knowledge (TPK): Using Project-Based Learning (PBL) and Situated Learning strategies, students will participate in real-world shooting tasks that immerse them in advertising photography practices. 5.Technological Content Knowledge (TCK): The instructor will demonstrate how to use both photography equipment and AI tools to execute creative advertising photography projects. 6.Pedagogical Content Knowledge (PCK): By combining foundational photography knowledge with real-world advertising photography applications, the instructor will use a blend of theory, hands-on projects, group collaboration, and peer review to help students acquire core professional skills.	DALL·E, MidJourney: To showcase creative imagery, spark ideas, and serve as reference. Photoshop: For demonstrating basic concepts in post-processing. Lightroom: For real-time optimization of photos during outdoor practice. Clarity, Luminar: To analyze and critique student work.
2	Indoor Lighting and Camera Operation Techniques	1.Content Knowledge (CK): The instructor will explain the theoretical foundations of indoor lighting and camera operations, including the structure and usage of flash and video lights, and how to set and adjust aperture and shutter speed. 2.Pedagogical Knowledge (PK):	Photoshop, Lightroom: To demonstrate the effect of flash settings and use AI features like exposure/white balance adjustment. MidJourney:

		The instructor will integrate theoretical instruction with practical exercises, using classroom lectures alongside hands-on practice to help students convert knowledge into operational skills. 3. Technological Knowledge (TK): The instructor will ensure students are familiar with camera settings, particularly the control of shutter speed, aperture, and ISO, and how to adjust them according to different shooting environments. 4. Technological Pedagogical Knowledge (TPK): During practical lighting sessions, students will combine camera operation with lighting adjustments, learning how to achieve various effects by manipulating flash, aperture, and shutter speed. 5. Technological Content Knowledge (TCK): The instructor will use AI-based image processing tools to help students understand how to use technology creatively in photography, particularly lighting and camera settings in advertising photography. 6. Pedagogical Content Knowledge (PCK): Step-by-step instruction and practical exercises will guide students from understanding basic lighting principles to mastering hands-on techniques.	To show advertising photography scenes generated under different lighting conditions. Luminar: To analyze and optimize lighting, color temperature, and exposure.
3	Photography Techniques: Light	1. Content Knowledge (CK): The instructor will cover the basic principles of light and its application in photography, including aspects like direction, color, and texture. 2. Pedagogical Knowledge (PK): The instructor will integrate theoretical instruction with practical application, using case studies to analyze how different lighting setups influence photographic results. 3. Technological Knowledge (TK): The instructor will demonstrate how to adjust camera settings (shutter speed, aperture, ISO) to optimize exposure and match the lighting conditions. 4. Technological Pedagogical Knowledge (TPK): The instructor will combine theory with practice, using AI tools to enhance photos and assist students in refining their lighting adjustments for more accurate results.	MidJourney or DALL·E: To simulate images with different color temperatures. Luminar: To simulate and display the effects of different lighting types (key, fill, back light). Lightroom: To demonstrate the impact of different lighting ratios using AI-enhanced features. Photoshop: To demonstrate the differences between single and three-light setups.

		5. Technological Content Knowledge (TCK): The instructor will use AI tools to simulate changes in lighting sources and ratios, helping students understand how to adjust lighting for different photographic needs. 6. Pedagogical Content Knowledge (PCK): Through step-by-step explanations and hands-on practice, the instructor will guide students from understanding basic lighting principles to mastering real-world applications.	
4	Photography Techniques: Color and Composition	1. Content Knowledge (CK): The instructor will teach color theory and compositional principles, explaining how each technique is applied in photographic practice. 2. Pedagogical Knowledge (PK): Through a combination of case studies and hands-on exercises, the instructor will help students strengthen their understanding and application of composition and color matching. 3. Technological Knowledge (TK): Students will practice combining compositional strategies and color schemes with technical camera settings (e.g., exposure, focus), aiming to produce photographs with strong visual appeal. 4. Technological Pedagogical Knowledge (TPK): The instructor will integrate AI tools with theoretical knowledge to enhance student understanding. Interactive instruction will help students recognize how composition and color improve image quality. 5. Technological Content Knowledge (TCK): Students will use AI tools to adjust their photos' compositions and color schemes in real time, allowing for experimentation and refinement to achieve optimal visual results. This reinforces practical application of composition and color theory in photography. 6. Pedagogical Content Knowledge (PCK): Through a combination of lectures, case analysis, and hands-on photography practice, the instructor will guide students in understanding when and why to use specific composition and color techniques.	Photoshop or Lightroom: To demonstrate how composition and color interact in different photo styles using AI-powered tools.

5	Practical Photography: Competition Shooting	1.Content Knowledge (CK): The instructor will lead a review of fundamental photographic concepts, including aperture, shutter speed, ISO, depth of field, composition, and color matching. Case studies will be used to demonstrate how theory is translated into practice. 2.Pedagogical Knowledge (PK): The instructor will assist students in interpreting the competition theme and developing creative ideas. Using heuristic questioning and classroom discussions, students will be encouraged to think innovatively and explore different shooting angles and storytelling methods. 3.Technological Knowledge (TK): The instructor will guide students in the use of AI-powered photography tools for both pre-shoot planning and post-processing, ensuring the technical quality of submissions meets competition standards. 4.Technological Pedagogical Knowledge (TPK): AI tools will be integrated into interactive teaching methods, allowing students to test the feasibility of their ideas in real time and receive instant feedback during the creative process. 5.Technological Content Knowledge (TCK): Technology will be used to deepen students' understanding and application of photography concepts. During hands-on shooting, the instructor will help students refine their work using real-time adjustments and feedback. 6.Pedagogical Content Knowledge (PCK): By combining photography theory with practice, the instructor will use group discussions and case demonstrations to help students master key shooting techniques and creative strategies.	Lightroom: For in-class revision of key concepts and real-time optimization of example images.
6	Photography Techniques: Tone and Shooting of Different Material Still Life	1.Content Knowledge (CK): The instructor will explain the shooting techniques for different material still life and portrait photography in various tone styles. Emphasis will be placed on how to use lighting, reflection, transparency, and other material properties to photograph different types of still life, as well as how to	Luminar: For optimizing texture/material expression of light-absorbing, reflective, and transparent objects. Lightroom:

		utilize high-key, mid-key, and low-key tones to achieve different visual effects. 2.Pedagogical Knowledge (PK): The instructor will use case study analysis and discussion methods to help students understand the photography methods for different material still life and portrait photography in various tone styles. Team-based activities will encourage collaboration, boosting student interest and practical skills through diverse classroom activities. 3.Technical Knowledge (TK): The instructor will explain how to use various photographic equipment and techniques, as well as post-processing techniques like exposure adjustment, tonal correction, sharpening, noise reduction, and more, to enhance the overall quality of the images. 4.Technological Pedagogical Knowledge (TPK): The instructor will combine AI tools with interactive teaching methods, allowing students to gain hands-on experience with real-time image adjustments during class. This helps students understand the importance of each technical step in the creative process. 5.Technological Content Knowledge (TCK): The instructor will integrate shooting techniques with post-processing skills, enabling students to apply theoretical knowledge in practice. For example, when shooting different material still life objects, students will not only learn how to control lighting and angles but also how to optimize their images in post-production to ensure the final photo represents the best material qualities. 6.Pedagogical Content Knowledge (PCK): The instructor will combine specific shooting content with teaching methods such as case study analysis, discussion, and team shooting activities to deepen students' understanding of photographic techniques. By offering real-time feedback during practice, students will receive immediate and effective guidance.	To adjust exposure in highlight areas for high-key tone. Luminar: To optimize overall tone for mid-key style. Photoshop: To adjust brightness and contrast for low-key tone.
7	Photography Techniques:	1.Content Knowledge (CK):	Luminar:

	Outdoor Still Life and Portrait Photography	The instructor teaches photography techniques, principles of composition, and lighting methods. 2. Pedagogical Knowledge (PK): Instruction includes lectures, demonstrations, group discussions, hands-on tasks, and class presentations. 3. Technical Knowledge (TK): The instructor provides training on using cameras, flash units, and other photographic accessories, guiding students through practical operations. 4. Technological Pedagogical Knowledge (TPK): AI tools are integrated into the learning process to provide technical support and enhance practical training. 5. Technological Content Knowledge (TCK): Photography techniques are taught in combination with AI tools to improve both creative workflow and final image quality. 6. Pedagogical Content Knowledge (PCK): Students apply their knowledge through hands-on practice and present their photographic work in class. The instructor provides assessment and feedback on student submissions.	To optimize lighting in still life projects. Photoshop: For automatic cropping and adjustments to practice compositional techniques. Midjourney: To design and virtually test different prop arrangements. Snapseed: To adjust background blur and enhance subject prominence in portraits. DALL·E 3: To present various styles of portrait photography and matching props.
8	Comprehensive Practical Project in Photography	1. Content Knowledge (CK): The instructor helps students review the key concepts learned throughout the semester, enabling them to understand what makes a “good” photograph and how to apply this knowledge. 2. Pedagogical Knowledge (PK): The instructor uses case analysis, team shoots, and group discussions to help students understand the practical application of various photographic techniques, enhancing their hands-on abilities. 3. Technical Knowledge (TK): Students must become proficient in operating various photographic equipment (such as cameras and lighting devices) and using different techniques for post-processing, improving the overall quality of their work. 4. Technological Pedagogical Knowledge (TPK): The instructor combines technical and pedagogical knowledge by demonstrating techniques in real-time and fostering	The previous AI-integrated learning prepares students for the final project.

		interactive classroom engagement, allowing students to gradually master photography skills and post-processing techniques. 5. Technological Content Knowledge (TCK): The instructor integrates technical skills with content knowledge, ensuring that students can effectively apply lighting, composition, and color principles to achieve the best visual effects in their final projects. 6. Pedagogical Content Knowledge (PCK): The instructor adapts teaching methods such as case study analysis and project-based learning to meet the practical needs of students, helping them understand how to apply theoretical knowledge in practice.	

Source: Gao shuya (2025)

2.4. New Teaching Framework for Photography Education Powered by Artificial Intelligence IOC Evaluation

This study utilized the IOC evaluation method. Three experts in design and photography verified the lesson plan's congruence with its predetermined educational objectives, ensuring every segment supported the achievement of the core teaching objectives.

The researcher then submitted the lesson plan form to the IOC for review by three experts:

1. Zhou Yan: Associate Professor and Vice Dean at the School of Humanities, Zhuhai College of Jilin University, specializing in design arts and cultural communication, with extensive academic and project experience, and serving as a judge for national advertising competitions.

2. Wu Dianchun (Run Shizi): Member of the China Photographers Association, member of the Presidium of the Jilin Photographers Association, and Deputy Director of the Jilin Provincial Political Consultative Conference Calligraphy and Painting Institute. His photography works have won numerous awards, including the Silver Award at the 20th Jilin Province Photography Art Exhibition, Gold Award at the Northeast Asia International Photography Exhibition and Silver Award at the Changbai Mountain International Photography Competition.

3. Chen Xi: Lecturer/Design Engineer, Ph.D. candidate in Design at the University of Macau. Director of the Visual Communication Department of the Advertising Department at Zhuhai College, Jilin University, and founder of the AI Scenario Laboratory. He teaches AI-related courses such as Computer 3D Art Design.

The IOC's results can be summarized as follows:

Table 3: IOC Evaluation Result

Evaluation Criteria

Agree = 1 Not sure = 0 Disagree = -1

IOC Result for Lesson Plan	Expert			Total	IOC
	Expert 1	Expert 2	Expert 3		
Issue 1: Clarity and Comprehensiveness of Lesson Plan Content					

Question 1: The teaching objectives in the lesson plan are clear and specific, making them easy to understand and implement.	1	1	1	3	1
Question 2: The teaching content covers all the core knowledge points required for the course and is closely integrated with practice.	1	1	1	3	1
Question 3: The use of AI tools in the lesson plan is clearly described and can effectively help students understand composition and color.	1	1	1	3	1
Question 4: The lesson plans include enough practical sessions to help students understand the techniques involved in actual filming.	1	1	1	3	1
Issue 2: Practicality of the Lesson Plan					
Question 1: The practical activities designed in the lesson plan can help students effectively apply the photography theory they have learned.	1	1	1	3	1
Question 2: The classroom activities designed in the lesson plan are highly interactive, which can stimulate students' participation and increase their interest in learning.	1	1	1	3	1
Question 3: Students are able to fully demonstrate their creativity and skills through practical tasks such as photography competitions.	1	1	1	3	1
Question 4: The time arrangement in the lesson plan is reasonable, and the teaching tasks can be completed and the teaching objectives can be achieved within the specified time.	1	1	1	3	1
Issue 3: Effects of Using AI Tools					
Question 1: Using AI tools (such as Adobe Lightroom and Snapseed) can effectively improve students' composition and color skills in photography.	1	1	0	3	0.7
Question 2: The AI tool's real-time feedback function helps students quickly understand and adjust their shooting effects, improving their technical mastery.	1	0	1	2	0.7
Question 3: Students can use AI tools in classroom activities to timely adjust the exposure, tone and other elements of photos to improve the quality of their works.	1	1	1	3	1
Question 4: The AI tool teaching method in the lesson plan can adapt to the learning needs of different students and help students improve their shooting skills in a personalized way.	1	1	1	3	1
Issue 4: Combining Teaching Methods with Subject Content					
Question 1: Teaching methods (such as heuristic questions and classroom discussions) can help students effectively understand the combination of theory and practice.	1	1	1	3	1
Question 2: Through practical operation, students can better understand the practical application of photography technology in advertising creation.	1	1	1	3	1
Question 3: The various photographic composition techniques introduced in the lesson plan (such as the	1	1	1	3	1

nine-grid style, symmetrical style, frame style, etc.) can be effectively applied in actual shooting.					
Issue5: Questions about Teaching Material.					
Question 1: Do the teaching materials and reference books in the lesson plan (such as "Advertising Photography Tutorial (3rd Edition)" and "Advertising Photography Technology Tutorial") cover all necessary theoretical knowledge and practical skills and provide in-depth learning support for students?	1	1	1	3	1
Question 2: Can the textbooks and reference books provide students with in-depth theoretical knowledge and practical shooting cases, thereby enhancing students' practical operation capabilities?	1	1	0	2	0.7
Question 3: Can the PPT used in the lesson plan clearly present the core concepts and shooting techniques of the course, and effectively help students understand complex photography theories and techniques through a combination of pictures and texts?	1	1	1	3	1
IOC Score:0.97					

Source: Gao shuya (2025)

5. Conclusion And Future Work

The deep integration of photography education and AI is a significant contemporary topic. This course was guided by the TPACK framework, transforming AIGC into a cognitive tool that activates students' creativity and enhances their visual literacy. The goal was to cultivate a new generation of creators who master both traditional professional skills and cutting-edge technological thinking.

The curriculum structure integrated AI and photography education based on the TPACK framework. For CK, the course covered foundational knowledge from "Practical Advertising Photography," including lighting, composition, and other basic techniques. For TK, it seamlessly integrated generative AI tools like Midjourney and DALL·E with mainstream post-production software such as Photoshop and Lightroom. The PK emphasized practical application through project-based learning and case studies, guiding students to effectively apply theoretical knowledge to complex photographic practice.

AI was positioned not just as a tool, but as a strategic advantage in teaching. It offered efficient learning support and inspiring creative possibilities, helping students to visualize complex concepts like light and shadow, and encouraging in-depth photographic exploration building upon AI foundations. This integration significantly enhanced teaching effectiveness.

However, the course actively addressed key challenges. Cultivating students' independent creativity remained the core focus of instruction. Through clear pedagogical intervention, the course emphasized that AI should be used strictly for conceptual inspiration, requiring students to enhance their solid practical on-site shooting and post-processing skills, and to develop critical screening abilities for AI outputs. Furthermore, the curriculum continuously deepened teaching content and optimized support for teacher adaptability and equitable access to educational resources. In summary, this course model, which integrated AI media and foundational photography knowledge based on TPACK, not only propelled photography

education forward but also innovated the way students learned and created in photography courses.

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The Handicraft Design Inspired by Vincent Van Gogh

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Abstract

The objectives of the studies are To study and analyze the identity of Vincent Van Gogh. To design handicrafts based on Vincent Van Gogh's identity. The research method adopts a mixed approach, combining quantitative and qualitative research. Through extensive literature review, this study systematically studied the characteristics of Van Gogh's works, the categories of handicrafts, and the current research status. This article delves into the theoretical framework and practical applications of handicraft designs inspired by the later Impressionist master Vincent van Gogh. The core research question is to explore how to effectively transform the essence of Van Gogh's painting language - namely its expressive, rhythmic brushstrokes, symbolic and contrasting use of colors, and profound personalized and emotional interpretation of themes - into the three-dimensional and tactile fields of handicrafts.

The research findings indicate that successful transformation requires a thoughtful abstraction and material innovation process, rather than simple literal replication. The synergy between Van Gogh's artistic vision and the principles of craftsmanship injected a level of artistic narrative and emotional depth into the latter, while also integrating the master's iconic aesthetics into daily life. This article ultimately argues that designs inspired by Van Gogh serve as a powerful paradigm, demonstrating how pure art throughout history can sustainably inspire contemporary creative practices, thereby fostering a meaningful dialogue between art, craftsmanship, and the viewer.

Keywords: Handicraft design, Vincent van Gogh, Artistic style

1. Introduction

Since ancient times, the integration of art and handicrafts has provided fertile ground for creative exploration. On this fertile land, the boundary between high art and practical design is becoming increasingly blurred, blending and jointly promoting the expansion of the boundary between art and design. In the tide of cross-border integration, many artists have broken through the shackles of traditional art media and become bridges connecting different art forms. Among them, Vincent van Gogh is undoubtedly a highly influential and inspiring representative figure. [1].

Handicrafts carry the cultural and artistic essence passed down from generation to generation of the Chinese nation, and have a profound historical heritage in our country. As a dual carrier of material and spiritual culture, handicraft design not only reflects the inheritance

and development of traditional skills, but also reflects the way of life, aesthetic concepts, and profound cultural values of people in specific historical periods. [2] With the rapid development of technology, handicrafts are facing severe challenges: mechanized production is gradually replacing traditional handicrafts [3-4]. However, what machines cannot replicate is the ingenuity and emotional investment contained in handmade products. Van Gogh's oil paintings, with their unparalleled vitality, bold and vibrant colors, dynamic brushstrokes, and deep and intense emotional expressions, not only left an indelible mark in art history, but also crossed the boundaries of time and space, exerting a profound influence on design disciplines including handicrafts. [5-8] Van Gogh's artistic creation is like a strong whirlwind, sweeping and inspiring countless designers to explore new possibilities in the field of handicraft design. When Van Gogh's painting techniques broke through the limitations of two-dimensional canvases and transformed into the tactile world of handicrafts, they not only enhanced the artistic value of objects, but also triggered a series of profound and fascinating reflections. [9] In this transformation process, the relationship between art and craftsmanship becomes particularly complex and subtle - they are both independent entities and to some extent interdependent and mutually reinforcing. [10] Van Gogh's works prove that even in the most traditional craft fields, art can shine in new ways, injecting new vitality and creativity into traditional techniques [11-14].

Based on the above background, this article aims to deeply analyze the profound influence of Van Gogh's oil paintings on the design of craftsmanship. Through meticulous research, reveal how its unique artistic style and forward-looking artistic vision are reinterpreted and cleverly integrated into craft practice. We will explore how Van Gogh's use of color inspired the color matching and visual expression of handicrafts, how dynamic brushstrokes shape the shape and texture expression of handicrafts, and how his emotional expression of endless love for life and nature promotes the strengthening of humanistic care and emotional transmission in handicraft design. This article aims to demonstrate the profound internal connection between art and design, reveal the lasting and far-reaching influence of an artist's personal style on craft practice, and provide new ideas and inspiration for the future development of craft design.

2. Methodology

This article summarizes the core characteristics of Van Gogh's artistic style, such as brushstrokes, color matching, and emotional expression, through literature review, and constructs a theoretical framework. Subsequently, using the case analysis method, representative handicrafts such as textiles, ceramics, and decorative objects were studied, and their design elements were deconstructed and compared with Van Gogh's formal language. At the quantitative level, questionnaire surveys are used to collect perception data of craftsmen and consumers, and software is used for data analysis, supplemented by industry expert interviews to obtain professional insights. The research ultimately validated the theoretical hypothesis through experimental design practice, forming an innovative design of "Van Gogh style" handicrafts.

Sub-Section 1

The study focuses on the profound influence of Vincent van Gogh's oil paintings on handicraft design, with a particular emphasis on exploring how his artistic style, color

application, and emotional expression are transformed into sources of inspiration for handicraft design.[7][10][17-20]The research scope covers the analysis of the artistic characteristics of Van Gogh's oil paintings, innovative application practices in handicraft design, and interdisciplinary interactions between the two. The research subjects include Van Gogh's classic oil paintings (such as "The Starry Night" and "Sunflowers") and their specific application cases in handicraft design.[5]

Sub-Section 2

After finalizing the interview form, a series of in-depth semi-structured interviews were conducted. The interviewees include three key figures: Yongqing Liu (an art theory scholar), Ting Lin (an art theory scholar), and Junhui Li (a folk handicraft art scholar). The interview will be conducted in two rounds. The first round focuses on theoretical explanation; The second round explored more specific design concepts and their applications. Summarize the data through interviews with experts, data collection, and data from the IOC table, and design based on the summarized data.

3. Results

The transformation of Van Gogh's painting style means that handicrafts are no longer simply "objects" or "decorations", but rather emotional carriers. It is an object that can be used for spiritual communication, it can trigger thinking, and become a part of one's personal spiritual world. This is in line with the deep needs of people for spiritual satisfaction and personalized expression in the current consumption upgrade. This diverse interpretation confirms the "open genes" of Van Gogh's art itself - as he said, "Painting should not only express what is seen, but also what is felt. Everyone's way of experiencing the world is worth seeing." From Table 1.

Table 1: Interview Conclusion

No.	Name	Identity	Research Focus	Representing viewpoints
1	Yongqing Liu	Artist	Interpretation of Colors, Brushstrokes, and Themes in Van Gogh's Art	Express unique emotions with high saturation colors and dynamic brushstrokes
2	Ting Lin	Art Education Expert	Van Gogh style Enlightenment in Art Education in Primary and Secondary Schools	The dynamic strokes and vibrant colors inspire students' creative thinking
3	Junhui Li	Handcraft inheritor	Artistic works inspire the creativity of creators	The expression methods of texture and shape

Through the eternal glaze color of ceramics, Van Gogh's art transcends canvas and becomes a tangible and vivid aesthetic. Whether it's the two-dimensional "Iris" on canvas or the three-dimensional blooming "Iris" on porcelain vase, they remind us that "art is not a distant scenery, but an experience that can be touched and felt. From Figure 1.



Figure 1: *Iris Ice Crack Bottle*

Design concept: Ceramics is one of China's classic cultures. I extracted the essence from the form and color of Van Gogh's "Iris" and transformed the brushstrokes of the representative figure of Post Impressionism, Van Gogh, into ceramic decorative language, continuing Van Gogh's passionate emotions and dynamic expression of natural life. Through glaze color circulation, carving techniques, and kiln firing patterns, ceramic works perfectly present Van Gogh's iconic "blue purple tone" and "three-dimensional brushstrokes". Based on the characteristics of ceramic materials, the imitation crack glaze color simulates the texture of time, echoing the visual depth of heavy pigment accumulation and interwoven brushstrokes in Van Gogh's paintings. At the same time, the ice crack gives a sense of broken beauty, which echoes the loneliness often found in Van Gogh's works. 3D iris decoration breaks through the limitations of flat surfaces, reproducing the lively and dynamic characteristics of flowers, achieving the integration of art and craftsmanship, and complementing the elements of Chinese and Western cultures.

Color: Following the classic color scheme of iris flowers, such as purple, gradient blue petals, and bright yellow stamens, the ceramic glaze is adjusted and fired at high temperatures to maintain the concentration of artistic colors, allowing the flower's color to bloom on the porcelain surface.

Styling: The curve of the vase echoes the rhythm of iris growth, and the trumpet shaped mouth of the vase corresponds to the shape of the petals spreading out. The three-dimensional flower shape contrasts with the cracked body of the vase, creating a contrast between "flat three-dimensional" and "regular and natural", enhancing the visual impact.

Touch: The subtle convex and concave patterns on the glaze, the undulating texture of three-dimensional flowers, transmit the temperature of art through touch, and transform practical objects into immersive artistic experiences.

According to the results of the IOC evaluation of the interview schedule, most of the questions were unanimously recognized by the experts with a score of 1, indicating that they

were highly relevant to the purpose of the study and well-designed. A few questions received slightly lower scores, such as the zero rating for question 3 by some experts, indicating that some questions may have certain shortcomings in terms of clarity or relevance. Overall, the question design in the interview schedule has basically achieved the expected goals, but some individual questions still need further revision and optimization to ensure that all questions can effectively collect the information needed for research. From Table 2.

Table 2: Satisfaction survey result

IOC Result For Interview Form	Expert Name			Result	
	1	2	3	Total	Ioc
Questions					
1	1	1	1	3	1
2	0	1	1	2	0.67
3	0	1	1	2	0.67
4	1	1	1	3	1
5	1	1	1	3	1
6	1	1	1	3	1
7	1	1	1	3	1
8	1	0	1	2	0.67
Average	0.75	0.875	1	2.625	0.876

From the pie chart of the survey results, the proportions of "strongly agree" and "agree" to purchase the "Iris Ice Flap Bottle" were 18.35% and 46.79%, respectively, adding up to more than 60%. However, the proportions of "disagree" and "strongly disagree" were only 10.09% and 6.42%, with 18.35% showing a "moderate" attitude. Overall, consumers have a high preference for the "Iris Ice Flap Bottle", and most consumers show a willingness to purchase it. From Figure 2.

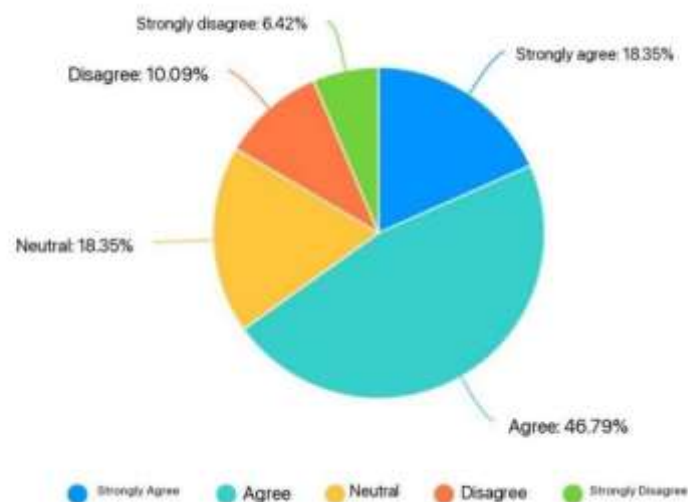


Figure 2: Overall likeability

This chart presents the proportion of different design related factors. Among them, color matching has the highest proportion, accounting for 31.19%; The proportion of process details is 29.36%, ranking second; The proportion of styling design is 25.69%; The proportion of

thematic symbolism is relatively the lowest, at 13.76%. Overall, color matching and craftsmanship details are the areas that receive more attention, while the focus on thematic symbolism is relatively weaker. From Figure 3.

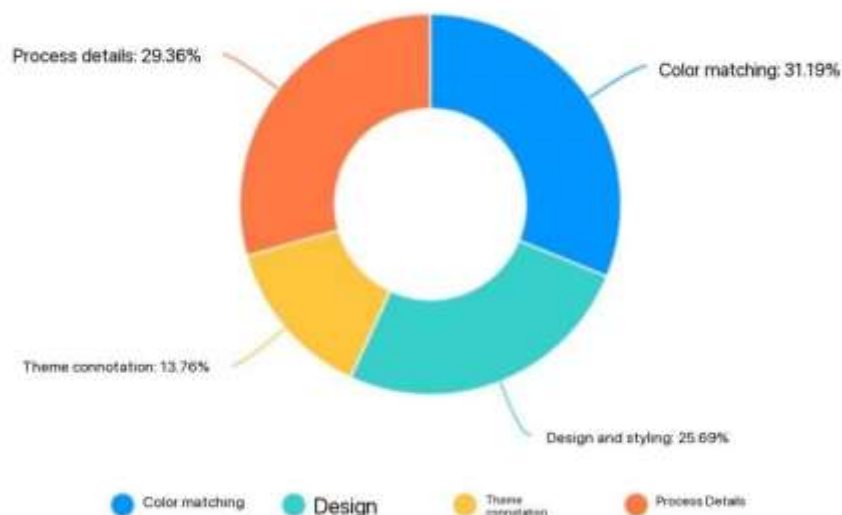


Figure 3: Evaluation of design elements

From the data of the circular chart, the attitude towards the issue of "works have practical functions in addition to artistic value" presents the following characteristics:

The recognition tendency is significant: "strongly agree" accounts for 29.36%, "agree" accounts for 36.7%, and the total of the two reaches 66.06%, indicating that more than half of the respondents believe that the work not only has artistic value, but also has prominent practical functions.

Neutral and negative attitudes account for a certain proportion: "general" accounts for 11.93%, "disagree" accounts for 9.17%, "strongly disagree" accounts for 12.84%, and the total of the three is about 33.94%, reflecting that some respondents have a low recognition of the practical functions of the work or hold a neutral attitude.

Overall, the work has gained recognition from the majority of respondents for its combination of "artistic value+practical function", but nearly one-third of the group still has doubts or a neutral attitude, indicating that there is room for optimization in the presentation or perception of practical functions. From Figure 4.

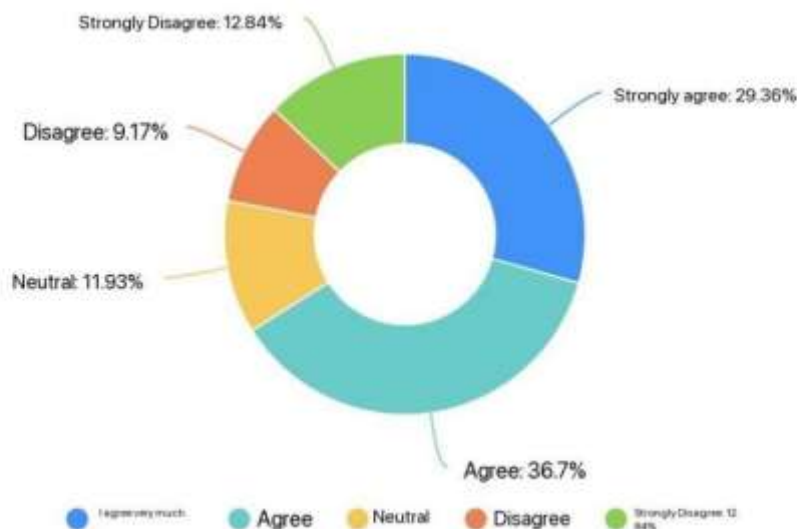


Figure 4: Practical evaluation

4. Conclusion And Future Work

The success of handicrafts lies in the transformation of their artistic language rather than replication. Designs inspired by Van Gogh focus on capturing the spiritual core of their art - color, brushstrokes, and thematic expression, and reinterpreting it through the materials, textures, and three-dimensional forms of handicrafts, rather than simply printing their paintings on the surface of objects. The material is a new paintbrush, with the flowing glaze color of ceramics and the soft stacking of fibers. The characteristics of these techniques perfectly resonate with Van Gogh's wild brushstrokes and vibrant themes, creating a perfect dialogue across media. Handicrafts designed with a combination of functionality, decoration, and artistry can be both practical everyday objects and pure artistic decorations, bringing art into life and allowing users to not only see, but also touch and feel the temperature and power of Van Gogh's world.

The challenge of this design is how to balance the difficulty of artistic expression and handicraft implementation. The combination of thick texture and complex color fusion requires extremely high firing technology, and the yield may be low, which can lead to increased costs. This may require finding a balance between artistic effect and feasibility for mass production. From the perspective of originality, the boundary between originality and derivative works is the problem faced by all art derivatives. Our design is "inspired by inspiration" rather than "directly copied". By transforming media and adding features, we emphasize innovation and recreation, avoid simple image abuse, and respect the copyright spirit of the original work. From the perspective of audience acceptance, this product with a strong artistic style may be more attractive to niche groups who love art and pursue unique home tastes. Its market positioning should be "high-end design gifts" or "art collection home decorations", rather than mass fast-moving consumer goods.

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Instructional Design of Aesthetic Education Course for Vocational College Education Using AIGC

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Abstract

Aesthetic education is a core approach to inheriting excellent traditional Chinese culture and cultivating vocational college students' comprehensive literacy, while integrating AIGC (Artificial Intelligence Generated Content) into vocational aesthetic education aligns with talent training demands in the intelligent era. This study focuses on constructing AIGC-based aesthetic education courses for vocational colleges, with Guangdong Country Garden Polytechnic as the research setting, to achieve two objectives: 1) Explore the role and application methods of AIGC in vocational aesthetic education; 2) Design a practical AIGC-integrated aesthetic education course. Research methods include literature review (systematizing AIGC's educational applications), semi-structured expert interviews, and Item-Objective Congruence (IOC) validation. Results show that: 1) AIGC plays four core roles in vocational aesthetic education—reconstructing teaching environments, enabling personalized learning, enhancing intelligent-era adaptability, and innovating evaluation systems—and has five operable application methods (content generation, virtual interaction, human-AI collaborative creation, learning evaluation, interdisciplinary practice); 2) Guided by constructivist learning theory and situated cognition theory, the designed course adopts a "three-module" structure (Music Appreciation & Cultural Inheritance, Fine Arts Foundation & Aesthetic Practice, Interdisciplinary Integration & Aesthetic Education Practice) with 9 detailed lesson plans, all integrating AIGC tools. The course evaluation outline has an average IOC score of 0.94, verifying its scientificity and feasibility. This study provides practical references for vocational aesthetic education teachers and serves as a basis for vocational aesthetic education reform.

Keywords: AIGC, Vocational College, Aesthetic Education Course, Constructivism, Situational Cognition

1. Introduction

Since the 2010s, AIGC technology has developed rapidly, with breakthroughs in Generative Adversarial Networks (GANs) and Transformer-based models making it capable of generating multi-modal content such as text, images, and audio, which has gradually reshaped educational practice [1]. UNESCO's AI in Education: Opportunities and Challenges for Sustainable Development and China's Education Modernization 2035 both advocate for

the integration of artificial intelligence into aesthetic education to innovate teaching methods, reflecting the global consensus on "technology empowering aesthetic education" [2].

In China's vocational education system, aesthetic education is an important part of the "Five Education Integration" (moral, intellectual, physical, aesthetic, and labor education), but it faces inherent challenges. Traditional aesthetic education in vocational colleges mainly relies on offline physical resources and manual creation, which not only has limitations in teaching scenarios but also leads to homogeneous content, making it difficult to meet students' personalized learning needs [3]. In addition, vocational colleges have long focused on skill training, resulting in the marginalization of aesthetic education, weak student learning motivation, and insufficient digital literacy among both teachers and students [4]. AIGC can effectively address these problems: it can create immersive teaching environments, provide adaptive learning paths, and support human-AI collaborative creation, making it a key driving force for the reform of vocational aesthetic education [5].

Existing research on AIGC and aesthetic education has certain limitations: domestic studies mostly focus on theoretical discussions about "AI + aesthetic education" but lack practical course design cases [6]; international studies emphasize the application of AIGC in general education but rarely target the specific context of vocational education [7]. This study fills these gaps by: 1) Using empirical methods to clarify the specific role and application paths of AIGC in vocational aesthetic education; 2) Designing a verifiable AIGC-based aesthetic education course that conforms to the cognitive characteristics of vocational college.

2. Methodology

This study adopts a mixed research method combining qualitative and quantitative approaches, with data collection conducted from February to September 2025. The research process strictly follows the logical framework of "literature review → field investigation → data analysis → course design → validation optimization" to ensure the scientificity and reliability of the results.

Sub-Section 1

Research Contents: The research focuses on three core contents: the application status of AIGC in vocational college aesthetic education, the role and application methods of AIGC, and the design and validation of AIGC-based aesthetic education courses. Specific tasks include: sorting out domestic and foreign literature on AIGC and aesthetic education, observing the actual teaching situation of traditional aesthetic education courses in vocational colleges, interviewing experts to collect opinions on course design, and verifying the validity of the designed course through IOC evaluation.

Research Area: The research is conducted at Guangdong Country Garden Polytechnic. This college was selected because its aesthetic education courses still adopt a traditional teaching model (mainly relying on in-person lectures and manual creative activities), with single course forms and limited digital teaching resources—these characteristics are representative of most vocational colleges in China, and the college is willing to provide support for the pilot implementation of the designed course.

Key Informants: A total of 12 experts were selected as key informants, divided into two groups according to their roles:

Interview experts (6 people): Including 3 experts in the field of aesthetic education (with more than 10 years of teaching experience in vocational colleges), 2 experts in AIGC technology application (engaged in AI education research for a long time), and 1 expert in vocational curriculum development (participated in the formulation of provincial vocational education curriculum standards). Their main task is to provide professional opinions on the role of AIGC in aesthetic education and the rationality of course design.

IOC validation experts (6 people): Including 3 Chinese experts (professors from vocational colleges specializing in aesthetic education and AI education) and 3 Thai experts (professors from Rajamangala University of Technology Tawan-ok specializing in art education). Their main task is to evaluate the content validity of the interview outline and course evaluation tools.

Sub-Section 2

Research Tools: Semi-structured interview outlines: Two versions were designed. The first version focuses on exploring the role and application methods of AIGC, including 7 questions; the second version focuses on course evaluation, including 12 questions. IOC evaluation form: Used to assess the content validity of the interview outline. Experts rate each question as "Agreed (+1)", "Unsure (0)", or "Disagreed (-1)". The average IOC score is calculated to determine the validity of the tool (a score ≥ 0.7 indicates good validity).

Data Collection and Analysis:

Literature review: A total of 56 core literatures were retrieved from databases such as CNKI, Web of Science, and IEEE Xplore (publication time: 2019-2024). The literature covers the technical development of AIGC, the reform of vocational aesthetic education, and the integration of AI and education, providing a theoretical basis for the study [8].

Classroom observation: A total of 10 class hours of aesthetic education courses in 5 majors (including digital media, environmental art design, and preschool education) at Guangdong Country Garden Polytechnic were observed. The observation focused on recording teaching procedures, teacher-student interaction methods, and student participation, and summarized the pain points of traditional teaching (such as limited teaching scenarios and low student engagement).

Expert interviews: Each interview lasted 60-90 minutes, and the interview content was transcribed verbatim. Thematic analysis was used to extract core viewpoints (such as the advantages and limitations of AIGC) and classify them into different categories for subsequent course design.

IOC validation: The interview outline and course evaluation form were sent to 6 experts for scoring. The average IOC score of the first-round interview outline was 0.91, and the average IOC score of the course evaluation form was 0.94—both meeting the validity requirements.

3. Results

3.1 Role and Application Methods of AIGC in Vocational College Aesthetic Education

3.1.1 Core Roles of AIGC

Based on the analysis of expert interview data and classroom observation results, AIGC plays four core roles in vocational college aesthetic education:

Reconstructing the Teaching Environment: By combining VR/AR technologies, AIGC can digitally restore cultural heritage (such as Dunhuang murals and ancient Chinese opera scenes) to create immersive learning scenarios. Students can not only observe artworks in detail but also participate in virtual creation, which significantly enhances their aesthetic perception and cultural identity.

Promoting Personalized Learning: AIGC can analyze students' creative behaviors (such as color preferences, compositional tendencies, and learning progress) to generate personalized learning reports and task recommendations. For example, for students with weak painting skills, the system can recommend basic sketching practice tasks; for students with strong creativity, it can assign complex interdisciplinary creation tasks.

Enhancing Adaptability in the Intelligent Era: AIGC helps students master the use of mainstream AI creative tools (such as MidJourney for image generation and AIVA for music composition) and understand the logic of AI content generation. This not only improves students' digital skills but also cultivates their ability to collaborate with AI as "creative partners", laying a foundation for their employment in the digital economy.

Innovating the Evaluation System: Traditional aesthetic education evaluation mostly relies on teachers' subjective judgments, while AIGC can combine quantitative indicators (such as composition balance, color matching rationality) and qualitative evaluation (such as creativity, cultural connotation) to form a comprehensive evaluation system. This not only improves the objectivity of evaluation but also provides students with detailed improvement suggestions.

3.1.2 Application Methods of AIGC

Combined with the characteristics of vocational college aesthetic education, five operable application methods of AIGC were summarized. From Table 1.

Table 1: Application Methods of AIGC in Vocational College Aesthetic Education

No.	Application Method	Specific Description	Typical Teaching Scenario
1	Content Generation & Personalized Design	AIGC generates multi-version teaching resources (such as music fragments, art sketches) according to course objectives and student characteristics; teachers adjust resource difficulty and style in real time based on student feedback.	In the "Chinese Folk Songs" lesson, AIGC generates folk song adaptations in different styles (such as electronic pop, classical) for students to compare and appreciate.
		AIGC creates virtual scenes (such as ancient art exhibitions, folk music performance venues)	In the "Chinese Folk Instruments" lesson, students use

2	Virtual Interaction & Immersive Teaching	combined with VR/AR; students complete interactive tasks such as exhibition curation and music accompaniment in the virtual environment.	VR equipment to "participate" in a folk music performance and experience the playing methods of different instruments.
3	Assisted Creation & Human-AI Collaboration	AIGC provides initial creation drafts (such as color schemes, melody frameworks); students refine and innovate the drafts based on their own artistic understanding and professional knowledge.	In the "Color Theory" lesson, AIGC generates color schemes for the theme of "tranquility"; students adjust the color saturation and matching according to their creative ideas.
4	Learning Evaluation & Feedback	AIGC automatically analyzes the technical indicators of students' works (such as composition, color); teachers evaluate the cultural connotation and creativity of the works; the two types of feedback are combined to form personalized improvement suggestions.	After students complete a digital painting work, AIGC analyzes the composition balance and color harmony, and teachers comment on the work's expression of traditional culture.
5	Interdisciplinary Integration & Project-Based Practice	AIGC supports cross-disciplinary creation projects (such as digital cultural and creative products, intelligent tourism promotion materials); students integrate aesthetic skills with professional knowledge (such as tourism management, digital media) to complete projects.	In the "Interdisciplinary Integration" module, students use AIGC to design a virtual exhibition of traditional Chinese art and match it with tourism promotion texts.

Based on the analysis of expert interview data and classroom observation results, AIGC plays four core roles and five application methods in vocational college aesthetic education, Figure 1, 2.

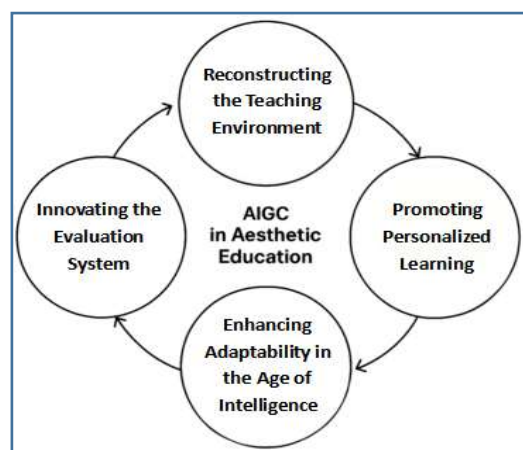


Figure 1: Framework of AIGC Role in Vocational Aesthetic Education

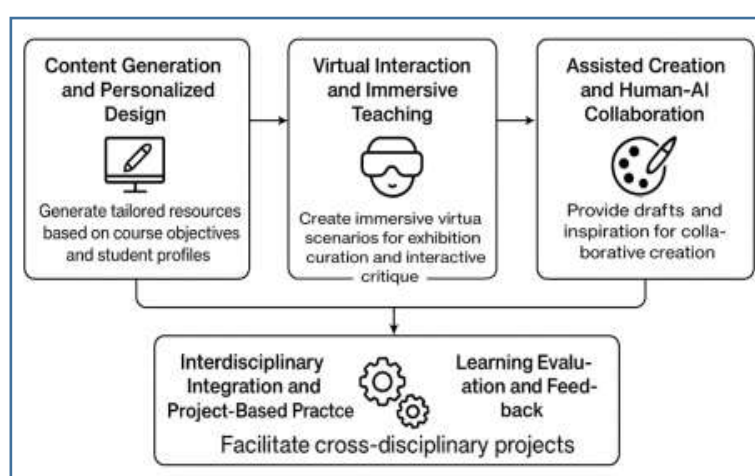


Figure 2: Framework of AIGC Application Methods in Aesthetic Education Courses

3.2 Design of AIGC-Based Aesthetic Education Course

3.2.1 Course Framework

Guided by constructivist learning theory and situated cognition theory, the course is designed as an 18-hour, 9-week program (2 class hours per week) with a "three-module progressive" structure. Each module focuses on distinct yet interconnected learning objectives, integrates targeted AIGC tools, and is supported by tailored teaching resource packages, forming a cohesive learning system. From Table2.

The course adopts a "three-module" structural design. Module 1 centers on "Music Appreciation and Cultural Inheritance", Module 2 focuses on "Fine Arts Foundation and Aesthetic Practice", and Module 3 is dedicated to "Interdisciplinary Integration and Aesthetic Education Practice", forming a logically clear framework for the aesthetic education course. The three modules unfold in a logical, progressive sequence. From Figure 3:

Module 1: Aesthetic Appreciation and Perception centers on cultivating basic aesthetic perception and understanding cultural elements in art works. It integrates Doubao AI (for works interpretation and cultural element analysis) and AIVA (for matching music to works to

enhance sensory experience), with support from a digital art work database and a traditional cultural element explanation manual.

Module 2: Digital Aesthetic Skill Training shifts to skill mastery, guiding students to learn basic operations of AIGC tools for aesthetic creation and complete independent design tasks. Key tools here include Doubao AI Painting (visual creation) and AIVA (music composition), supplemented by step-by-step tool operation guides, digital work case analyses, and skill training worksheets.

Module 3: Interdisciplinary Integration and Practice focuses on applying knowledge across fields through team projects. It uses an integrated AIGC toolset (combining painting, music, and text generation) and provides interdisciplinary project templates, expert guidance videos, and team cooperation evaluation standards.

3.2.2 Course Validation Results

The designed course was validated by 6 experts (3 Chinese and 3 Thai) using the IOC evaluation method. The average IOC score of the course evaluation outline was 0.94, indicating high content validity. Experts' key comments include:

The "three-module" structure is logically coherent, starting from basic appreciation, transitioning to practical skills, and finally realizing interdisciplinary integration—this structure conforms to the cognitive law of vocational college students.

The selection of AIGC tools is reasonable: tools such as AIVA and Doubao AI Painting are easy to operate and highly compatible with aesthetic education scenarios, which can effectively reduce the technical threshold for students.

The course objectives (aesthetic perception, digital application, cultural identity) are clearly reflected in each lesson plan, and the learning tasks can effectively promote the achievement of these objectives.

Table 2: Structure of AIGC-Based Aesthetic Education Course

Module Name	Lesson Period	Course Week	Topic	AIGC Tool Integration	Learning Objectives
Music Appreciation & Cultural Inheritance	2	Week 1	Listening to Music	AIVA (music style comparison)	Master the method of analyzing musical elements (melody, rhythm) and compare the differences between AI-generated and original music.
	2	Week 2	Chinese Folk Songs	NetEase Cloud AI Composition Assistant (folk song adaptation)	Analyze the regional cultural characteristics of folk songs and try to adapt folk songs using AI.
	2	Week 3	Chinese Folk Instruments	Suno (instrument timbre mixing)	Distinguish the timbre of different folk instruments and experience AI-generated mixed timbres.
	2	Week 4	Chinese Opera Music	Tencent Zhifu AI (opera gong and drum beat generation)	Understand the musical characteristics of opera and generate simplified opera accompaniment using AI.

	2	Week 5	Chinese Dance Music	Beatoven (dance rhythm generation)	Master the rhythmic characteristics of ethnic dance music and match AI-generated rhythms with dance movements.
Fine Arts Foundation & Aesthetic Practice	2	Week 6	Art Introduction & Appreciation	Doubao AI Painting (style integration)	Analyze the style characteristics of Chinese and foreign artworks and generate works integrating multiple styles using AI.
	2	Week 7	Composition & Perspective	Doubao AI Painting (perspective correction)	Master the principles of composition and perspective and use AI to optimize hand-drawn perspective drafts.
	2	Week 8	Color Theory	Canva AI (color matching)	Understand color theory and use AI to generate color schemes for emotional themes.
Interdisciplinary Integration & Aesthetic Education Practice	2	Week 9	Aesthetic Education Theory & Practice	Comprehensive AIGC tools (MidJourney, ChatGPT)	Design an aesthetic education activity plan with AI-assisted links and complete an independent creative work.

The course adopts a "three-module" structural design. Module 1 centers on "Music Appreciation and Cultural Inheritance", Module 2 focuses on "Fine Arts Foundation and Aesthetic Practice", and Module 3 is dedicated to "Interdisciplinary Integration and Aesthetic Education Practice", forming a logically clear framework for the aesthetic education course, Figure 3.

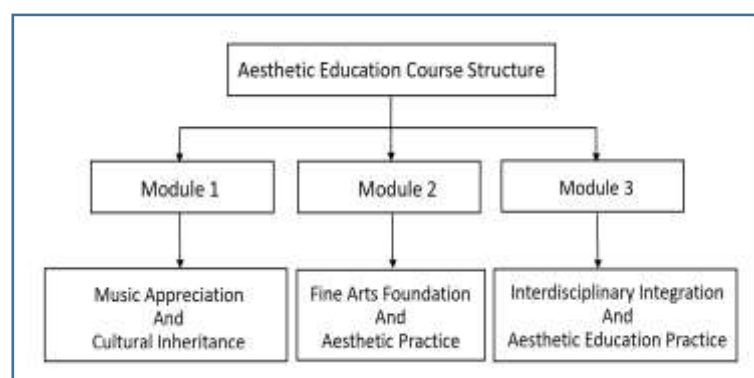


Figure 3: Conceptual Diagram of Course Model

The compiled teaching design manual is available for online access via QR code scanning, with specific details illustrated, Figure 4.



Figure 4: QR Code for Online Access to the Teaching Design Manual

4. Conclusion and Future Work

4.1. Conclusions

The Transformative Role of AIGC in Vocational Aesthetic Education: AIGC is not only a technical tool but also a core resource for promoting the reform of vocational aesthetic education. It can effectively solve the problems of traditional aesthetic education such as limited scenarios and homogeneous content. However, there are also challenges: excessive reliance on AIGC may weaken students' independent creativity; insufficient digital literacy of teachers may limit the effective application of AIGC.

The Scientificity and Feasibility of the Course Design: The AIGC-based aesthetic education course designed in this study, guided by constructivist learning theory and situated cognition theory, has a clear structure and operable content. The IOC validation result (average score 0.94) confirms that the course conforms to the requirements of vocational aesthetic education and has strong practical value.

In summary, the AIGC-integrated aesthetic education course designed in this study not only verifies the practical value of deeply integrating AIGC technology into vocational aesthetic education courses but also provides a referable paradigm for the development and optimization of similar aesthetic education courses. Confirmed by expert reviews, the course holds significant potential for widespread promotion and application. However, its actual teaching effectiveness still requires further empirical verification through subsequent classroom practice, followed by continuous iterative refinement based on teaching feedback and further explore the personalized integration paths of AIGC with aesthetic education courses in different majors, so as to promote the digital reform of vocational aesthetic education to a deeper level.

4.2. Discussion

This study has two innovations compared with existing research: 1) It focuses on the specific context of vocational education, integrating AIGC with vocational students' professional development needs (such as digital skills training) instead of general aesthetic education; 2) It provides a complete course design case including lesson plans and AIGC tool lists, making up for the lack of practical research in existing studies. The limitation of the study is that the research is only conducted at one vocational college, and the promotion effect of the course in other types of vocational colleges (such as engineering, service-oriented) needs to be further verified.

4.3. Recommendations

Optimize Technical Support Conditions: Vocational colleges should allocate special funds to upgrade teaching hardware (such as high-performance computers, VR equipment) and build a "cloud-AI teaching platform" to ensure the smooth operation of AIGC tools. For colleges with limited resources, they can cooperate with AIGC enterprises to obtain free educational licenses.

Strengthen Teacher Training: Develop a hierarchical training system: the basic level focuses on the operation of AIGC tools (such as MidJourney, AIVA); the advanced level focuses on the integration of AIGC and curriculum design (such as how to design AI-assisted creative tasks). Invite interdisciplinary experts (AI technicians + aesthetic education scholars) to conduct quarterly training workshops.

Embed Ethical Education in the Course: Add a 1-hour "AI Art Ethics" module to teach students copyright norms (such as marking the contribution of AI in works) and the importance of cultural authenticity (avoiding AI-generated content that distorts traditional culture). Establish an "ethical reflection log" for students to record ethical considerations during the creative process.

4.4. Future Work

Expand the research scope: Promote the designed course to other types of vocational colleges (such as engineering vocational colleges, service vocational colleges) and adjust the course content according to the characteristics of different majors (such as adding AI-assisted industrial design content for engineering majors).

Conduct longitudinal studies: Track students who have taken the course for 1-2 years to evaluate the long-term impact of AIGC on their aesthetic literacy, digital skills, and employment status, and make up for the lack of long-term effect data in existing research.

Explore the integration of AIGC with emerging technologies: Study the application of multimodal AIGC, blockchain (for copyright protection of student works), and metaverse (for virtual aesthetic education scenes) in vocational aesthetic education to further enrich the form of courses.

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Applying Wang Xizhi's Calligraphy Style into Contemporary Accessories Ornaments Design

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Abstract

This research addresses the challenges of surface symbolization and cultural homogenization in integrating traditional Chinese calligraphy into contemporary jewelry design. Wang Xizhi's calligraphy, characterized by "dynamic fluidity" and "spiritual resonance," provides a model for merging traditional aesthetics with modern accessory design. The study aims to: (1) Analyze Wang Xizhi's calligraphy style through key works such as Lanting Xu, Kuaxue Shiqing Tie, and Sangluan Tie; (2) Develop accessory designs inspired by these stylistic elements. A mixed-method approach was employed, including literature analysis, expert interviews, design practice, and user satisfaction surveys. Results indicate that Wang Xizhi's core stylistic features—dynamic brushwork, asymmetrical balance, and ink expressiveness—can be translated into contemporary accessories via metal wire simulations, structural segmentation, and surface texture contrasts. User evaluations confirmed high satisfaction in artistic value (3.93), cultural connotation (3.78), and market potential (3.72).

Keywords: Wang Xizhi, Calligraphy style, Contemporary Accessories Ornaments Design

1. Introduction

As an important art form of Chinese civilization, traditional Chinese calligraphy carries thousands of years of cultural accumulation and aesthetic wisdom. From the evolution of oracle bone inscriptions and bronze inscriptions to seal script, official script, regular script, running script, and cursive script, calligraphy is not only a skill of writing words, but also a high-level art of expressing philosophical thoughts and emotional moods [1]. In contemporary society, with the acceleration of globalization and the rise of cultural pluralism, traditional calligraphy has experienced a wave of "revival". From the popularization of calligraphy courses in basic education to the cross-border presentation in international art exhibitions, calligraphy has gradually gotten rid of the single label of "ancient skills" and has become an important source of inspiration in the field of modern design. In this context, Wang Xizhi's calligraphy art, as the peak paradigm of Chinese aesthetics, urgently needs to be systematically explored in its contemporary transformation potential.

Wang Xizhi, who was revered as the "Calligraphy Saint" by later generations, achieved artistic success not only in terms of technical innovation, but also in terms of pushing calligraphy to the aesthetic height of "depicting spirit through form". Wang Xizhi's "Lanting Preface" is known as "the best running script in the world". His brushwork is known for being

"floating like clouds and agile like a startled dragon". Through the rhythmic changes of lifting, pressing, and pausing, and the spatial layout of sparseness, density, and reality, he constructed a dynamic and balanced visual language [2]. This style broke the regular paradigm of Han Dynasty official script, endowed calligraphy with personalized emotional expression, and became the aesthetic standard of calligraphy for literati in later generations. More importantly, Wang Xizhi's calligraphy aesthetics is deeply compatible with modern design concepts. The fluidity of his lines echoes the pursuit of organic forms in contemporary design. This creative concept of "both form and spirit" echoes the principle of "form follows emotion" emphasized by contemporary design across time and space [3]. This aesthetic dialogue across time and space makes Wang Xizhi's calligraphy an important research object for the modern transformation of traditional art.

In the tension between globalization and localization, contemporary accessories ornaments design presents a pattern of coexistence of multiple styles. On the one hand, Western design languages such as minimalism and abstract expressionism dominate the mainstream, emphasizing the practicality of geometric forms and materials; on the other hand, local designers try to integrate traditional crafts such as embroidery and lacquer art into jewelry creation, trying to find a differentiated positioning in cultural identity. However, this exploration often falls into two dilemmas. First, the symbolic use of traditional culture leads to design homogeneity. For example, a large number of jewelry mechanically reproduce bronze patterns or paper-cut patterns, but do not touch the spiritual connotation behind the cultural symbols. Second, the excessive pursuit of "new trends" and the neglect of cultural depth make the works superficial in formal innovation and difficult to arouse lasting emotional resonance. The fundamental reason is that there is a lack of deep communication and integration between traditional aesthetics and modern design. The intervention of Wang Xizhi's calligraphy style can provide a practical model for this mechanism through its unique artistic language. The abstractness of his brushwork can be transformed into the modeling language of jewelry, the shades of ink can be reflected in the gloss contrast of the material, and the aesthetic principle of "vivid charm" can guide the dynamic balance expression in the design.

This study focuses on the transformation path of Wang Xizhi's calligraphy style in contemporary accessories ornaments design, aiming to explore the possibility of integrating traditional calligraphy aesthetics with contemporary accessories ornaments design. The importance of the study is reflected in two dimensions: first, the innovative value of artistic transformation, building an interdisciplinary dialogue framework between calligraphy art and jewelry design, and expanding the methodological boundaries of design innovation [4]. Abstract concepts such as "momentum", "rhyme" and "meaning" in Wang Xizhi's calligraphy can be transformed into a contemporary design language through the reconstruction of materials, structures and wearing methods. For example, the continuous reflection of running script strokes can be realized with the help of 3D printing technology to achieve a three-dimensional winding structure, while the virtual and real contrast of Feibai brushstrokes can be presented through the combination of metal hollowing and enamel filling. This transformation can not only enrich the visual expression of jewelry, but also enable people to perceive the temporal and spatial extension of calligraphy aesthetics through the form of "wearable art". It can also verify the adaptability of the "new Chinese style" aesthetic paradigm in the context of globalization through specific case analysis, and provide practical references

for the cultural and creative industries [5]. Second, the social significance of cultural heritage. When UNESCO included Chinese calligraphy in the Representative List of the Intangible Cultural Heritage of Humanity, it emphasized that "calligraphy, as a living heritage, needs to establish a creative connection with contemporary life" [6]. Incorporating Wang Xizhi's style into jewelry worn daily is essentially transforming the traditional forgotten literati art into a cultural carrier that is visible and accessible to the public. This transformation can not only enhance the spread of traditional calligraphy among young people, but also reinterpret the cultural concept of "appreciation by both the refined and the popular" through design practice, provide differentiated products for the market, and help enhance national cultural confidence and promote the international dissemination of Chinese aesthetic values.

1.1 Research Objectives

- 1) To study Wang Xizhi's bibliography and calligraphy style.
- 2) To design accessories ornaments by Wang Xizhi's calligraphy style.

1.2 Research Question

- 1) What are the core characteristics of Wang Xizhi's calligraphy style?
- 2) How to effectively integrate Wang Xizhi's calligraphy style into contemporary accessories ornaments design?

1.3 Beneficial

- 1) Promote the popularization of Wang Xizhi's calligraphy art
During the design, exploring Wang Xizhi's calligraphy lines, structure, and artistic conception helps understand its essence and increase public attention.
 - 2) Activating the contemporary vitality of traditional calligraphy art
Extending calligraphy to modern accessories design, transforming its abstract aesthetics into wearable symbols, breaks calligraphy's single - dimensionality, broadens its application, and promotes its inheritance.
 - 3) Promote the global spread of traditional calligraphy culture
Contemporary accessories can transcend cultural barriers, transform Eastern philosophy in calligraphy into visual symbols, convey Chinese calligraphy culture, promote cultural exchange, and strengthen national cultural confidence.
 - 4) Enhance the artistry and cultural connotation of contemporary accessories ornaments design works
Calligraphy's line smoothness, combination of rigidity and flexibility, and balanced structure offer visual elements and inspiration for accessories design, creating artworks with value and promoting the cultural and creative industry.
- 3) Promoting the integration of interdisciplinary art ecology
The cross-disciplinary research of calligraphy, design, aesthetics and other disciplines provides a new perspective for the study of traditional culture and modern design.

2. Methodology

This study aims to understand the integration path between traditional Chinese calligraphy and contemporary jewelry design. The "Research Scope" focuses on three Wang Xizhi's works—"Lanting Preface," "Kuaixue Shiqing Tie," and "Sangluan Tie," analyzing them from brushwork, composition, and ink perspectives. It also introduces data - collection tools, which are evaluated by experts for scientific validity.

The explains data collection and analysis methods, including literature review, tool development, expert interviews, calligraphy analysis, design practice, and user feedback collection. These steps form a closed - loop argumentation. The study combines qualitative and quantitative analysis, using expert interviews and user questionnaires. Finally, it analyzes the data, extracts core conclusions, and supports subsequent discussions.

2.1 Scope of research

1.1 Research Contents

1) Calligraphy study and analysis scope

In this research the researcher will study and analyze 3 pieces of Wang Xizhi's calligraphy consist of :

"Lanting Xu": "Lanting Preface," also known as "Lanting Preface," is hailed as "the best running script in the world." Written by Wang Xizhi in the ninth year of the Yonghe reign (353 AD), it captures the beauty of the landscape surrounding Lanting and the joy of the gathering, expressing Wang Xizhi's feelings about the impermanence of life and death.

"Kuaixue Shiqing Tie": "Kuaixue Shiqing Tie" is considered Wang Xizhi's second most representative work of running script after "Lanting Preface" and was hailed by ancient people as "the best calligraphy in the world." It was written as a letter, expressing the author's joyful greetings to relatives and friends after the snow had just cleared.

"Sangluan Tie": "Sangluan Tie" is a calligraphy work written in cursive script by Wang Xizhi during the Yonghe period of the Eastern Jin Dynasty. It is a family letter consisting of three parts: "Sangluan Tie," "Erxie Tie," and "Deshi Tie." The main text of "Sangluan Tie" expresses Wang Xizhi's immense grief and indignation at the destruction of his home and the looting of his ancestral tombs.

And analysis Wang Xizhi's calligraphy from three aspects:

Brushwork: Analyze the use of brush techniques such as lifting, pressing, pausing, and blunting in the works, and how these brush techniques shape the texture, strength, and rhythm of the lines.

1.2) Composition: Analyze the compositional relationships between strokes within a character, including density, tilt, and balance. Study the relationships between characters and lines, including continuity, discontinuity, and the overall spatial composition. Analyze the layout of white space within the work, observing how it works with the ink to create a complete visual effect.

1.3) Ink application: Analyze the variations in ink density and the visual effects these variations create. Observe the dryness, wetness, and use of white ink to enhance the texture of the lines and the dynamics of the brushstrokes.

2) Contemporary Accessories Ornaments Design scope

2.1) Design

Translating the abstract concepts of Wang Xizhi's calligraphy into a concrete design language focuses on capturing the dynamics of his brushwork, the charm of his structure, and the texture of his ink:

2.1.1) Brushwork:

Design Concept: Drawing inspiration from the flowing brushwork, fluidity, variation, and rhythm of Wang Xizhi's calligraphy.

Application Methods: Use a continuous metal wire to outline the design, mimicking the flowing brushstrokes. Varying the thickness of the wire expresses the lifting, pressing, and pausing of the brush.

2.1.2) Composition:

Design Concept: Learn from the asymmetrical balance and art of white space in Chinese calligraphy.

Application Methods: A single piece of jewelry can have an asymmetrical structure, but the overall visual harmony and balance must be maintained. Leave space between jewelry components, allowing white space to become an integral part of the design, creating a sense of breath and ethereality

2.1.3) Ink application:

Design Concept: Expressing the dry, wet, thick, and thin ink colors, as well as the "flying white" technique.

Application Methods:

Thick Ink, Wet Ink: Utilize highly polished, mirror-smooth metal surfaces for a rich, luster, and a sense of tension.

Light Ink, Dry Ink: Utilize matte, brushed, or hammered metal surfaces for a rough, rustic, and vigorous feel.

Flying White: Utilize openwork and hollowing to create subtle gaps and textures on the metal surface, simulating a "flying white" effect.

2.2) Quantity of design

This design project includes three accessory items:

Necklace (1)

Bracelet (1)

Earrings (1 pair)

1.2 Key informants

Three key informants offer research support. Li Guoqing (calligraphy theory scholar) guides on brushwork/ink via calligraphy theory, history and aesthetics. Peng Jiancheng (same field) advises on calligraphy structure/composition with ancient calligraphy authentication expertise. Xie Youguo (culture & art scholar) helps translate Wang Xizhi's calligraphy aesthetics to jewelry and express his literati spirit.

1.3 Research Schedule

The study period was 10 months and was carried out in four stages:

1) Literature and theoretical preparation (January - April) :

Complete the literature review of calligraphy history and establish the index system of design evaluation.

2) Expert Collaboration and element Extraction (May - July) :

Two rounds of expert interviews were conducted to determine 10 design keywords such as "line fluidity" and "space blank".

3) Design Practice and iteration (August - September) :

Round 1: Hand-drawn sketch;

Round 2: Optimization design structure based on feedback;

4) Evaluation and Integration (September - October) :

Organize online design exhibition (online chat group of 50 people), collect user data and write evaluation report.

2.2 Data collection tools

Research Tools for collecting data:

In this research, the following research tools will be used to ensure the effectiveness and accuracy of data collection:

1) Key informant interview form

2) Ioc evaluation form for key informant interview form

3) Satisfaction Questionnaire

4) Ioc evaluation form for satisfaction questionnaire

2.3 Data collection

The data collection process for this study was divided into eight steps to ensure comprehensive findings, integrating qualitative and quantitative techniques:

Step 1: Research preparation and Literature Review

Step 2: Research tools developing

Step 3: Expert Interview

Step 4: Wang Xizhi's calligraphy analysis

Step 5: Summarize the data to define Wang Xizhi's calligraphy style

Step 6: Design

Step 7: Satisfaction survey

Step 8: Summarize and Discussion

2.4 Data analysis

This study uses a mixed research method combining qualitative and quantitative methods to verify the transformation effect of Wang Xizhi's calligraphy elements in contemporary jewelry design. The specific analysis path is as follows:

Qualitative data: The study will use content and thematic analysis to process qualitative data from document studies and expert interviews. First, categorize and organize interview transcripts and open - ended responses according to pre - defined themes like "Brushwork Aesthetics," "Structural Transformation," and "Cultural Value." Then, extract core perspectives, common understandings, and key insights, and evaluate design innovation to find highlights and areas for improvement. This approach provides in - depth theoretical support for design practice.

Quantitative data: The study will process and analyze quantitative data from the IOC evaluation form and satisfaction questionnaire. First, calculate the content validity index of the IOC evaluation form data based on a three - point scoring system. Consider an IOC value > 0.5

as acceptable content validity. Three experts evaluated the interview outline and questionnaire, and the results showed high content validity. Second, measure the satisfaction questionnaire data using a five - point Likert scale. Use descriptive statistics to calculate means and percentages. The goal was an average overall satisfaction score of 4.0 or higher to show users' acceptance. Through these quantitative methods, the study aimed to get objective data, assess design effectiveness, and cross - reference qualitative results to enhance conclusion reliability.

3. Results

Based on the two research objectives in Chapter 1, this chapter systematically explores the integration path of Wang Xizhi's calligraphy style in modern jewelry design using a mixed method of literature research, expert interviews, design practice and multi - dimensional evaluation. It presents research results in two parts according to the two objectives. The first part summarizes the core characteristics and cultural connotations of Wang Xizhi's calligraphy style via representative work analysis and expert interviews. The second part, based on the first objective's results, completes three jewelry design works and verifies their innovation and cultural value through satisfaction surveys. This chapter comprehensively responds to the research questions by integrating qualitative and quantitative data, and the results are as follows:

3.1 Summary of research results according to the objective No. 1 To study Wang Xizhi's bibliography and calligraphy style

1.1 Document study result

Through an analysis of three representative works by Wang Xizhi, this study systematically analyzes the core elements of his calligraphic style. The study finds that Wang Xizhi's calligraphy transcends mere technical skill. Through the exquisite use of brushwork, structure, and ink, he elevates Chinese characters from a "practical record" to "artistic expression." The following is a detailed analysis of the three representative works:

1) "Lanting Preface"

Overview: "Lanting Preface" was composed in one breath by Wang Xizhi while intoxicated, and is considered "the world's finest running script." The work explores the beauty of landscapes and the transience of life, and the "charm" of his writing could not be replicated even after he sobered.

To summarize the "Lanting Preface": Technically, its brushwork is exquisite, its structure is ingenious, and its composition is naturally coherent, making it a classic model that future generations must consider when studying running script.

Emotionally, it captures Wang Xizhi's slightly tipsy, free-spirited state of mind under specific circumstances. This creative state of "being unintentional in achieving excellence" is the ultimate pursuit of the artist.

Philosophically, its sentiments about the fleeting nature of happiness and the impermanence of life intertwine with the eternal dialectical relationship between "balance and change," "rule and freedom" within calligraphy, imbuing this work with profound meaning that transcends time and space.

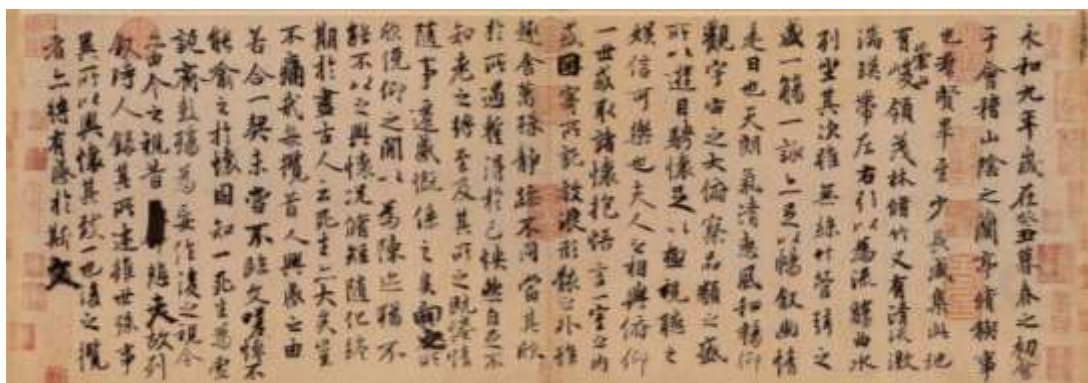


Figure 1: Lanting Preface Picture

2) "Kuaixue Shiqing Tie"

Overview: This regular script work, written by Wang Xizhi as a greeting to a friend, differs from the elegant style of the "Lanting Preface" in that it features a "strong and vigorous" style. It was praised by the Qing Emperor Qianlong as "unparalleled in the world."

To summarize "Kuaixue Shiqing Tie": Though brief, it is a masterpiece of "small yet beautiful," "simple yet refined." Emotionally, it lacks the sentimental expression of "Lanting Preface," but instead is filled with warm, sincere greetings and concern for a friend. Artistically, it embodies the supreme control and inherent tension of Wang Xizhi's calligraphy. It achieves its success not through outward charm and variety, but through its profound strength and quaint charm, leaving a lasting impression. Like a martial arts master with profound inner strength, each seemingly unadorned move holds immense power.



Figure 2: Kuaixue Shiqing Tie Picture

3) "Sangluan Tie"

Overview: This is a letter Wang Xizhi penned in extreme distress upon learning of the destruction of his ancestral tomb. Unlike the delicate "Kuaixue Shiqing Tie" (Letter to a Clear Sky) or the exuberant "Lanting Preface" (Preface to the Orchid Pavilion), this letter was composed unintentionally under extreme emotional turmoil.

To summarize "Sangluan Tie": This work is so moving because it transcends a mere display of technique, becoming a direct expression of life. Although Wang Xizhi's expression

cannot be seen, his piercing pain is palpable through the rhythm of the brushstrokes, the tremor of the lines, and the breath of space.

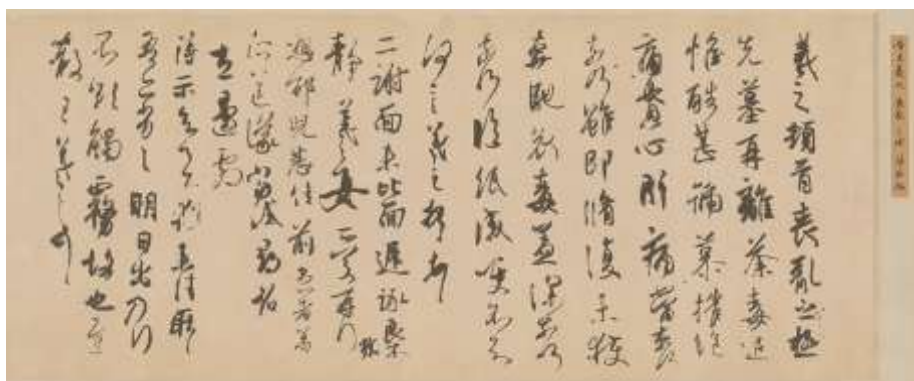


Figure 3: Sangluan Tie Picture

1.2 Interview result

This study conducted two rounds of interviews with three experts to verify and deepen understanding of Wang Xizhi's calligraphy style from multiple perspectives. The interview results, along with the document study result, provide a solid theoretical foundation for this research.

The three experts unanimously agreed that the translation of Wang Xizhi's calligraphy aesthetics into jewelry design must focus on "refining the essence of Wang Xizhi's calligraphy." Through innovative expression in jewelry's line design, spatial structure, and material treatment, this approach aims to revitalize traditional culture in the contemporary era, preserving the core spirit of the literati while meeting modern aesthetic and functional needs.

1.3 Conclusion

Through systematic literature research and expert interviews, a theoretical model for Wang Xizhi's calligraphy style, applicable to contemporary jewelry design, was successfully established. The essence of Wang Xizhi's calligraphy is summarized in three core principles: dynamic fluidity of brushwork, asymmetrical balance of structure, and expressiveness of ink. These three principles form the guiding framework for this research's jewelry design practice, ensuring that the designs are not only innovative in form but also deeply connected to traditional aesthetics.

3.2 Summary of research results according to the objective No. 2 To design accessories ornaments by Wang Xizhi's calligraphy style.

Based on an in-depth study of Wang Xizhi's calligraphic style, this research has transformed theoretical achievements into concrete jewelry design practices. This section will detail the design plan, present the final design patterns, and evaluate the design outcomes in combination with the results of user satisfaction surveys.

2.1 Concept

The design concept aims to integrate the three core aesthetic dimensions of Wang Xizhi's calligraphy - brushwork, structure and ink application - into contemporary jewelry design

through the transformation of materials, craftsmanship and forms. This process is regarded as a kind of "remediation", expanding calligraphy from a traditional "art on paper" to a "wearable art".

2.2 Model

This research created three digitally designed (via Procreate) jewelry pieces—necklace, bracelet, and earrings—with clear design concepts reflecting transformation strategies, focusing on the "Flowing Clouds" necklace inspired by Wang Xizhi's calligraphy.

1) The design concept of the "Flowing Clouds" necklace

The necklace translates Wang's calligraphy through three key transformations: **Brushstroke transformation:** It uses "continuous metal wire" (thick-thin-thick variation) to mimic running-script rhythms, with the pendant's thickened contour as "pause" and slender chain as "lift." **Structural transformation:** Asymmetrical design (main chain with off-center pendant + simple secondary chain) and negative space (gaps between chains/length differences) echo calligraphy's "asymmetrical balance" and "real-void interplay." **Ink transformation:** Polished metal (main chain/pendant front) simulates "dense/wet ink," while matte, grainy metal (pendant back) mimics "light/dry ink"; metal undulations and chain gaps create a "feibai" effect. Blue jewels on the necklace have symbolic meanings: they represent "water" (linking to ink-water fusion in Wang's calligraphy) and act as "ink-dipping points" (enhancing line pauses) or "post-stroke charm" (avoiding hasty endings). They also adapt to contemporary aesthetics by adding color contrast (warm metal + cool blue), breaking traditional calligraphy's monochrome limit while retaining elegance.

The necklace integrates contemporary artistic sensibility: **Materialization:** Uses simple wirework and non-traditional materials (beyond metal/sapphire) for minimalism. **Function-aesthetics unity:** Lightweight, adjustable design suits daily wear. **Narration:** Turns abstract calligraphic charm into visual symbols, lowering appreciation thresholds and enabling tradition-contemporary dialogue.



Figure 4: *Flowing Clouds Necklace Design Picture*

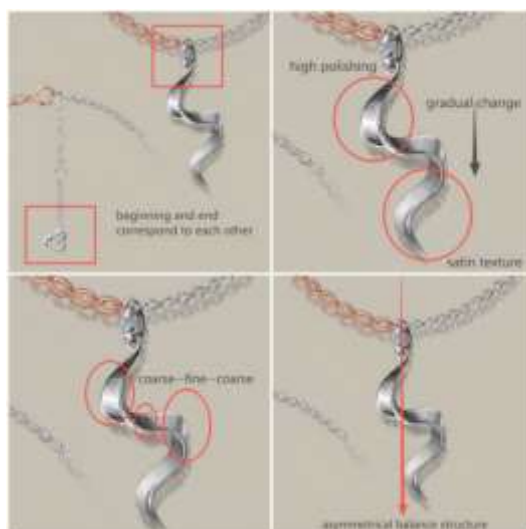


Figure 5: *Flowing Cloud Necklace Design Details*

2) The design concept of the "Meander" bracelet

This text details how a bracelet transforms Wang Xizhi's calligraphy style into design, along with its symbolic elements and integration of contemporary artistic sensibility, while connecting with the previously mentioned necklace.

For calligraphy transformation: Brushstroke transformation: It uses "multiple metal wires linked by hinges" (instead of a single wire) to reflect "disconnected strokes but continuous meaning". Rose gold (warm, like thick ink) and silver (cool, like thin ink) contrast at stroke turns, creating a rhythmic, connected visual effect. Structural transformation: The lattice cloud-pattern pendant uses "solid metal vs open voids" to echo calligraphy's "treating blank spaces as black"; the asymmetrical chain (right-dense, left-sparse) mimics cursive's rhythm, with the pendant's voids enhancing layering. Ink transformation: Polished rose gold simulates "dense/wet ink", silver mimics "light/dry ink"; frosted hollow edges and gaps of the pendant replicate "flying white".

Clear sapphires have symbolism: They represent "water" (continuing the necklace's "ink-water coexistence"), strengthen the pendant's focus, blend traditional calligraphy charm with contemporary aesthetics, and reduce metal heaviness.

In terms of contemporary artistic sensibility: Perceptible dynamic rhythm: Hinged links and "disconnected-but-connected" design let the bracelet show calligraphy's rhythm when worn (e.g., raising hands). Modern materials/craftsmanship: Rose gold-silver combination, precise hinges, and delicate hollow work fit "minimalist light luxury". Versatile wearing: Lightweight, asymmetrical design suits daily and social occasions. Finally, it echoes the necklace—the bracelet focuses on single-character dynamic strokes, while the necklace highlights running-script chapter charm—jointly building a calligraphy jewelry system.



Figure 6: Meander Bracelet Design Picture



Figure 7: Meander Bracelet Design Details

3) The design concept of "Flying White" earrings

This text elaborates on how a pair of earrings transforms Wang Xizhi's calligraphy style into design, their symbolic elements, and integration of contemporary artistic sensibility, while aligning with the necklace and bracelet series.

For calligraphy transformation: 1) "Brushstroke transformation": Continuous silver wires mimic writing dynamics. The right earring copies the "奈" character (thinning at the start, thickening in the middle), and the left echoes "何" (thickened turns). Wire thickness/curvature gives metal the "speed and force of writing". 2) "Structural transformation": Asymmetrical balance (right: solid metal, left: hollowed-out) achieves "perilous yet upright" visual harmony; left earring's negative space and ear hook gaps echo calligraphy's blank spaces and layout aesthetics. 3) "Ink transformation": Right earring's mirror polish = "dense/wet ink"; left's brushed finish = "light/dry ink"; left's hollow texture and auspicious cloud pendant's hollowing simulate "flying white".

Symbolic elements: 1) Blue jewelry at ear hook-pendant joints: Echoes Wang's calligraphy's natural context (e.g., "Lanting Xu") and highlights brush pauses. 2) Auspicious cloud pendants: Link Eastern natural aesthetics with Wang's calligraphy; rose gold hollowing/polishing align with the series' ink strategy. 3) Blue jewelry in cloud pendants: Deepens ink layers, adds contemporary brilliance, and modernizes traditional symbols.

Contemporary integration: It shares the series' core logic—using metal lines, asymmetrical structure, and polishing/hollowing to translate Wang's calligraphy. Blue jewelry and cloud pendants form a "wearable calligraphy aesthetic series". It avoids mechanical reproduction, blending "traditional depth" and "contemporary precision" around calligraphy translation.



Figure 8: *Flying White Earrings Design Picture*

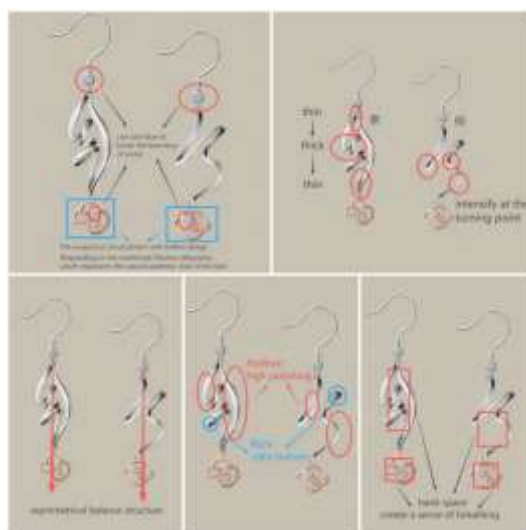


Figure 9: *Flying White Earrings Design Details*

2.3 Conclusion

This chapter addresses integrating Wang Xizhi's calligraphic style into modern jewelry design via "theoretical refinement - design transformation - practical verification". The results are in three aspects:

Theoretical level: A transferable calligraphic - style model is constructed. Through literature and expert cross - validation, Wang Xizhi's style is refined into three principles: dynamic fluidity of brushwork (rhythmic stroke variation), non - symmetrical balance of structure (dynamic equilibrium and layout), and expressive ink application (ink - tone transformation). This model fills the research gap between calligraphy aesthetics and jewelry design. For example, in the "Quick Snow and Clear Weather" scroll, the character "Xi" shows brushwork fluidity; the 21 forms of "之" in the "Lanting Xu" demonstrate structural balance; and the "Sorrow and Turmoil" scroll shows expressive ink application.

Practical level: The contemporary translation of calligraphy aesthetics is completed. The "Flowing Cloud" necklace, "Meander" bracelet, and "Flying White" earrings series, based on the three principles, leap from "calligraphy on paper" to "wearable art". Brushwork, structure, and ink - application transformations are achieved through metal - wire variation, asymmetrical composition, and polishing/mixed - material techniques respectively. These pieces verify the compatibility of calligraphy and modern design.

Value level: The unity of cultural inheritance and innovation is achieved. The design retains Wang Xizhi's calligraphy essence and adapts to modern life, turning traditional culture into everyday aesthetic carriers.

2.4 Satisfaction survey results

To objectively verify the effectiveness of the design outcomes, this study conducted a satisfaction survey based on a five-point scale among 110 target audiences. The questionnaire design was evaluated by an expert panel through the content validity index (IOC). The evaluation forms were distributed to three experts. After analyzing the returned data, a high consistency score was obtained (IOC score of 0.96), ensuring that the questions were highly relevant to the research objectives and results. The survey results also quantified the users' acceptance of the design works and provided empirical support for the success of the design plan.

1) Quantitative data results:

The survey shows respondents highly recognized the design works.

Artistry and originality: High scores were given for capturing "flowing clouds and water" beauty (avg. 3.76), applying "asymmetric balance" (avg. 3.89), and having high artistic and collection value (avg. 3.93), indicating wide formal - aesthetic recognition and a market - differentiating advantage.

Cultural connotation and contemporaneity: High scores were received for simulating ink color change (avg. 3.78) and possessing traditional charm and modernity (avg. 3.57), confirming the success of cultural transformation strategies.

Market potential: Positive feedback was obtained on attracting traditional - culture - interested consumers (avg. 3.66) and respondents' willingness to buy or recommend (avg. 3.72), providing data support for the commercial potential of such products.

2) Qualitative Feedback and Discussion:

The qualitative assessment data was collected via open - ended questions in the satisfaction survey, not through direct interviews or focus groups. The questionnaire had questions like "Do

you have other opinions on this jewelry design?" to let respondents share subjective experiences. Researchers coded and analyzed 110 valid questionnaires, extracting core viewpoints.

83% of participants said the design upgraded calligraphy from "visual appreciation" to "physical perception". Young respondents liked "lightweight design" and "asymmetric structure". Over 70% mentioned "enhanced pride in traditional culture".

Some respondents also gave negative feedback, such as the hollowed - out texture not being fine enough and the metal lines lacking elasticity. They suggested adding product instructions or AR scanning functions.

The qualitative assessment shows the design works achieved the "living inheritance" of Wang Xizhi's calligraphy aesthetics. Respondents affirmed the innovative value but also pointed out areas for improvement in craftsmanship and cultural interpretation, providing a reference for future design and application.

4. Conclusion and Future Work

This concluding chapter synthesizes research findings, explores their implications, and proposes recommendations.

4.1 Conclusion

This study identifies three core characteristics of Wang Xizhi's calligraphy style and constructs a transferable theoretical model via literature analysis and expert interviews.

4.1.1 Conclusion of Objective 1: To study Wang Xizhi's bibliography and calligraphy style.

1) Dynamic fluidity in brushwork: His calligraphy combines strength and grace through pressure and stroke changes.

2) Asymmetric structural balance: The composition follows "interplay between leaning and upright forms" for dynamic equilibrium, with a "vertical rows without vertical columns" layout.

3) Ink expressionism: Through ink density gradations, using ss/wetness and fly - white techniques, the lines gain three - dimensional depth and emotional resonance, achieving "five shades of ink." This model breaks traditional research limitations, offers an aesthetic framework for design transformation, and fills the theoretical gap at the intersection of calligraphy aesthetics and contemporary jewelry design.

4.1.2 Conclusion of Objective 2: To design accessories in Wang Xizhi's calligraphy style.

Based on the model, the study completed three jewelry designs ("flow cloud" necklace, "curving water" bracelet, "flying white" earrings) and verified the transformation effect through a user satisfaction survey.

Design Transformation Path:

Technique Transformation: Use wire thickness variations to simulate rhythms and hinge structures for line coherence.

Structural Transformation: Apply spatial aesthetics via asymmetrical compositions and openwork techniques.

Ink Technique Transformation: Replicate ink gradations through mirror polishing, frosted treatment, and metallic openwork.

User Feedback:

Satisfaction surveys showed high recognition for "capturing calligraphic fluid beauty" (avg. 3.76 points), "asymmetric balance application" (3.89 points), and "artistic value" (3.93 points), validating the cultural transformation's effectiveness and market potential.

4.2 Discussion

4.2.1 Discussion of Objective 1: To study Wang Xizhi's bibliography and calligraphy style.

Wang Xizhi's calligraphy style features - dynamic fluidity of brushwork, non - symmetrical balance of structure, and expressive use of ink - are products of specific historical, cultural context and artistic philosophy.

4.2.2 Discussion of Objective 2: To design accessories by Wang Xizhi's calligraphy style.

The design practice, with the logic of "using metal as a pen and space as paper", transforms 2D calligraphy into 3D "wearable art", with innovation in three aspects:

The "asymmetrical balance" and "negative space" in the design come from Wang Xizhi's calligraphy. For example, the "Flying White" earrings and the "Flowing Clouds" necklace interpret the "harmony between man and nature".

This study validates Cross (2011)'s view through three - layer transformations. For instance, the "Meander" bracelet turns brushwork into movable metal units, aligning with Norman's (2007) "emotional design" concept.

This design achieves UNESCO (2009)'s requirement of establishing a creative connection between intangible cultural heritage and contemporary life, as shown by user feedback.

4.3 Recommendations

4.3.1 Academic Recommendations

Expand research scope: future studies should include diverse calligraphic styles to establish a more systematic "calligraphy aesthetics-to-design transformation" model.

Deepen interdisciplinary integration: use motion capture technology to quantify dynamic brushstroke parameters for digital jewelry design.

4.3.2 Design Practice Recommendations

Innovate materials and processes: explore shape memory alloys for "brushstroke elasticity" and simulate ink diffusion through enamel glaze flow modeling.

Adopt user participation design: develop an AR customization system for users to select strokes from Wang Xizhi's calligraphy and generate personalized ornaments, enhancing emotional resonance and cultural identity.

4.3.3 Industrialization Recommendations

Segment the market: develop limited - edition collections for cultural consumers to highlight the differentiated value of "calligraphy artistry + artisan spirit."

Integrate with education: collaborate with universities to launch "calligraphy jewelry workshops" to lower the threshold of traditional culture accessibility and cultivate potential consumers.

4.3.4 Summary

This research has verified the feasibility of transforming Wang Xizhi's calligraphic style into contemporary jewelry design. In the future, it's necessary to break through material and

technique limitations, deepen cultural symbol innovation, and promote broader value resonance. Additional aesthetics in modern life.

Acknowledgements

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Research on the Current Situation of College Students'

Participation in Cheerleading in Lijiang

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Abstract

This study aims to explore the current status, influencing factors, and development pathways of college students' participation in cheerleading in the Lijiang area. Using research methods such as questionnaires, in-depth interviews, and field observations, the study surveyed 600 students, 12 physical education teachers, and 6 administrative staff from three universities in Lijiang. The findings indicate that cheerleading in Lijiang universities has already established a certain foundation within campus culture, with 78.3% of students reporting familiarity with the sport; students' participation motives are mainly for physical fitness (65.4%), social needs (47.2%), and interest cultivation (52.8%). However, challenges remain in its current development, including uneven resource allocation, insufficient professional guidance (only 16.7% of schools have professional coaches), and an incomplete competition system. Lijiang's unique ethnic cultural elements provide opportunities for the localized development of cheerleading, yet utilization is only 23.5%. Based on the findings, this paper proposes development strategies for cheerleading in Lijiang universities from the perspectives of school support systems, optimization of teaching and training, and the integration of ethnic culture, aiming to promote the sustainable development and distinctive construction of the sport in ethnic regions.

Keywords: cheerleading; college student participation; sports culture; ethnic elements; Lijiang universities

1.Introduction

With the deepening of sports reform in Chinese universities, cheerleading, as a comprehensive sport that combines music, dance, and athletic skills, has rapidly emerged in college physical education courses and campus cultural activities in recent years. Its unique artistic expression, team spirit, and youthful vitality have made it a popular sport among university students. Numerous studies have shown that cheerleading not only effectively improves college students' physical fitness and mental health but also plays a positive role in fostering teamwork skills and promoting campus culture.

Across the country, college cheerleading is showing a trend of vigorous development. For example, at a certain university in Sichuan during the 19th Sports Culture and Arts Festival held in 2025, a cheerleading competition covering multiple categories such as street dance cheerleading, jazz cheerleading, and pom-pom cheerleading was successfully carried out, attracting active participation from seven teams across the university and fully showcasing contemporary college students' spirit of 'youth, confidence, optimism, and positivity.' At another university, during the 2025 Student Health and Vitality Competition, cheerleading was one of the core events. The university's School of Physical Education won the dance cheerleading self-choreographed routine competition with an excellent score of 9.75, demonstrating the professional development trend of college cheerleading. These cases all demonstrate the popularity and importance of cheerleading in college sports.

However, compared with the overall national development trend, the development of cheerleading in colleges and universities in the Lijiang area still appears to lag behind, and related empirical research is relatively scarce. Lijiang, as an international tourist city with abundant ethnic cultural resources, has unique regional cultural characteristics in its college sports development. College students grow up in an environment of multicultural integration, and their needs and forms of expression in sports may exhibit characteristics different from those in other regions. At present, has cheerleading in Lijiang's colleges effectively utilized local cultural resources? What specific challenges do students face during participation? Exploring these questions is of great significance for promoting the distinctive development of college sports in ethnic regions. Based on this, this study focuses on colleges and universities in the Lijiang area, using empirical surveys to systematically analyze the current situation, influencing factors, and development paths of college students' participation in cheerleading. It aims to provide theoretical reference and practical guidance for the scientific development and distinctive construction of cheerleading in Lijiang's colleges, while also enriching empirical cases of college sports research in China's ethnic regions.

2. Literature Review

2.1 The development overview of cheerleading in Chinese universities

Since the introduction of cheerleading into Chinese universities, it has evolved from merely being an auxiliary form of performance in sports competitions into an independent sport and art discipline. Based on the practices of many universities nationwide, cheerleading has now been incorporated into various domains such as physical education curricula, club activities, and professional competitions. In the 2024 National Cheerleading Community Games, several university cheerleading teams achieved remarkable results. For instance, the cheerleading team of a certain medical university won second place in the Jazz Campus Cheerleading Demonstration Routine for the Open Youth Group and sixth place in the Pom Campus Cheerleading Demonstration Routine. This indicates that the competitive level and recognition of cheerleading in universities are continuously improving.

In terms of teaching content, university cheerleading mainly includes various types such as pom cheerleading, jazz cheerleading, and hip-hop cheerleading. Each of these disciplines focuses on different performance styles and technical elements, meeting the diverse interests of students. At the same time, the forms of university cheerleading activities have become increasingly diverse, including on-campus competitions, intercollegiate exchanges, and national events, providing university students with a rich platform for showcasing their skills.

2.2A Study on the Impact of Cheerleading on the Development of College Students

Existing research indicates that cheerleading exercises have multiple positive effects on college students' physical and mental development and the improvement of their overall quality. In terms of physical fitness, Li Jing (2023) found through empirical research that dance cheerleading training can significantly enhance female college students' flexibility, explosive power, and endurance, with particularly notable effects on improving students' performance in the seated forward bend, standing long jump, and 800-meter endurance run. On the psychological development level, the collective nature of cheerleading requires tacit cooperation and collaboration among team members, effectively cultivating students' teamwork awareness and communication skills. Meanwhile, the rhythm-filled music and expressive movements also help students relieve stress, boost self-confidence, and enhance artistic expression. Tao Chengwu and colleagues pointed out that dance cheerleading training has a positive impact on elementary school students' mood states, and this finding is equally applicable to the college student population.

2.3 Research on the Characteristics of Physical Education in Colleges and Universities in the Lijiang Area

The Lijiang region possesses rich ethnic cultural resources, such as Naxi Dongba culture and traditional art forms like ethnic songs and dances, providing unique conditions for the specialized development of college sports. However, a review of existing literature reveals a scarcity of empirical research on cheerleading in colleges in the Lijiang area, particularly studies on the integration of ethnic culture with cheerleading, which is still non-existent. The few studies involving college sports in Lijiang mostly focus on the development and preservation of traditional ethnic sports, such as Naxi Da Tiao and Dongba dance, and their transmission on campuses. These studies indicate that college sports in Lijiang face challenges such as limited resources, insufficient faculty, and difficulties in modern transformation. These circumstances suggest that cheerleading in colleges in the Lijiang region may face similar developmental bottlenecks, which merit further investigation.

2.4 Research Gaps and Research Value

In summary, although cheerleading has developed a relatively mature model in Chinese universities, its development in universities located in ethnic regions such as Lijiang has not yet been systematically studied. Existing literature mainly explores cheerleading teaching and training from a general perspective, lacking attention to the characteristics of ethnic regions; in terms of research methods, there is a focus on quantitative research, with

insufficient qualitative insights into the participants; regarding research content, there is relatively little focus on the integration of ethnic culture with modern sports programs.

This study employs a mixed-methods approach to focus on the current development of cheerleading in universities in the Lijiang area, thoroughly analyzing the special challenges and opportunities it faces, and exploring pathways for integrating ethnic culture with cheerleading. It aims to fill the existing research gap and provide theoretical support and practical reference for the specialized development of sports in universities in ethnic regions.

3 Research Methods

3.1 Research subject

This study employed a stratified random sampling method, selecting 600 university students from three colleges in the Lijiang area (Lijiang Normal College, Lijiang Cultural Tourism College, and Lijiang Higher Vocational School) as the survey participants. The sample covered students of different genders, grades, majors, and ethnic backgrounds to ensure representativeness. In addition, the study selected 12 physical education teachers and 6 college sports administrative staff for in-depth interviews to understand the organization and implementation of cheerleading activities from multiple perspectives.

3.2 Research Tools and Data Collection

This study adopts a mixed-methods research approach, combining quantitative and qualitative strategies to comprehensively collect research data.

Questionnaire Survey Method: A self-designed "Survey on Cheerleading Participation in Lijiang Universities" was used. The questionnaire mainly includes: (1) students' basic information; (2) knowledge of and participation in cheerleading; (3) motivation and barriers to participation; (4) evaluation of exercise effects. The questionnaire underwent expert validity assessment and pretesting, with a Cronbach's α coefficient of 0.87, indicating good reliability. A total of 600 questionnaires were distributed, 582 valid responses were collected, resulting in an effective response rate of 97%.

In-depth Interview Method: Semi-structured interview guides were designed for teachers and administrators, mainly focusing on: (1) the organization and implementation of cheerleading activities at schools; (2) resource support and faculty allocation; (3) challenges faced and solutions proposed; (4) views on the integration of ethnic culture with cheerleading. Each interview lasted approximately 40-60 minutes and was fully recorded and transcribed into text.

Field Observation Method: From September 2024 to January 2025, the research team conducted a total of 12 on-site observations of cheerleading classes, training, and competitions at three universities, collecting first-hand data through photos and notes to understand the actual environment and process of cheerleading instruction.

3.3 Data Analysis Methods

Quantitative data were statistically analyzed using SPSS 22.0 software, with the main methods including descriptive statistics, chi-square tests, analysis of variance, and regression analysis. Qualitative data were analyzed using thematic analysis, through three steps of open coding, axial coding, and selective coding, to extract core themes and relational structures.

3.4 Research Ethical Considerations

This study strictly adheres to academic ethical standards. All participants in surveys and interviews signed informed consent forms; the data collection process was anonymized to ensure the security of personal information; research data is used solely for academic purposes and will not be disclosed to third parties without the participants' consent.

4. Research Results and Suggestions

4.1 Basic information on the participation of Lijiang college students in cheerleading

Survey data show that college students in Lijiang have a relatively high overall awareness of cheerleading, with 78.3% of students reporting that they are familiar with the sport, but the actual participation rate is only 42.6%. Among them, the participation rate of female students (58.7%) is significantly higher than that of male students (21.4%), indicating a clear gender difference in cheerleading at Lijiang colleges. In terms of participation forms, it mainly includes elective courses (35.2%), club activities (28.7%), and school-level competitions (19.3%), while the proportion of spontaneously organized daily training is relatively low (16.8%), reflecting that the level of organization of cheerleading in Lijiang colleges needs to be improved.

Regarding participation frequency, only 23.5% of participants are able to maintain regular training more than twice a week, and most students (61.2%) participate intermittently and temporarily, mainly around competitions or performance tasks. The duration of each session is mostly 60-90 minutes (67.4%), which meets the general exercise load standards for college students.

In terms of the types of cheerleading activities, pom-pom cheerleading (52.8%) is the most popular, followed by jazz cheerleading (28.9%) and hip-hop cheerleading (18.3%). This distribution is basically consistent with the overall trend of cheerleading in colleges nationwide, but Lijiang college students show certain gaps in artistic expression and movement standardization, which may be related to insufficient professional guidance.

4.2 Participation Motivation and Obstacles

A survey on students' participation motivation found that the main motivations for Lijiang university students to participate in cheerleading include: improving physical fitness (65.4%), cultivating interest (52.8%), social needs (47.2%), enriching extracurricular life (43.6%), and pursuing a sense of achievement (28.3%). Further cross-analysis shows that there are differences in motivations between male and female students: females place more emphasis on shaping their body (73.2% vs 26.8%) and cultivating temperament (65.7% vs

34.3%), while males value competitive performance (62.4% vs 37.6%) and social recognition (53.6% vs 46.4%) more.

As for the hindering factors, "time conflicts" (57.3%), "lack of basic skills" (46.2%), "venue limitations" (38.7%), and "insufficient guidance" (32.6%) are the main obstacles affecting student participation. It is noteworthy that there is a certain conflict between the facilities of Lijiang universities and the needs of cheerleading: 75.8% of students reported that the school lacks professional cheerleading training venues, with most training conducted in regular gymnasiums (62.4%) or outdoor playgrounds (13.6%), which affects training effectiveness and participation experience.

4.3 Implementation of Teaching and Training Organization

In terms of teaching resources, there is a severe shortage of professional instructors for cheerleading in Lijiang universities. Surveys show that only 16.7% of schools have professional cheerleading coaches, while the majority (83.3%) are concurrently taught by general physical education teachers. Although these teachers possess basic sports teaching capabilities, their ability to guide students in professional cheerleading techniques, choreography creativity, and artistic expression is limited. Additionally, opportunities for teachers to participate in professional training are scarce, with an average of only 0.6 cheerleading-related training sessions per year, resulting in slow updates to teaching content and methods.

Regarding curriculum design, cheerleading instruction in Lijiang universities generally tends to 'emphasize technique over theory,' with 82.7% of course time devoted to physical training and only 17.3% to theoretical explanation and cultural integration. This imbalance leads to students lacking a deep understanding of the cultural connotations and artistic essence of cheerleading, making it difficult to achieve profound learning outcomes. It is worth noting that there is limited exploration of integrating cheerleading with ethnic culture in Lijiang universities. Although there are some connections between traditional dance elements in Naxi Dongba culture and cheerleading, the actual utilization rate of such integration is only 23.5%. In interviews, some teachers mentioned, 'We have tried incorporating Naxi dance gestures and steps into cheerleading choreography, but due to a lack of systematic theoretical guidance and creative experience, the results were not satisfactory.'

4.4 Integration of Event Organization and Campus Culture

The competitive system for cheerleading in Lijiang's colleges is not yet well developed. On average, school-level competitions are held only 1.2 times per year, and intercollegiate exchange activities are even scarcer, averaging just 0.4 times per year. In contrast, colleges in other regions of the country have already established a relatively mature competition system. For example, at a certain university in Sichuan, the cheerleading competition is a key event in the annual Sports and Cultural Arts Festival, attracting participation from seven teams across the university. The continuity and coverage of

competitions in Lijiang's colleges are clearly insufficient, making it difficult to create lasting brand effects and influence.

Nonetheless, the recognition and influence of cheerleading within campus culture are gradually increasing. 72.6% of students believe that cheerleading performances can enliven the campus atmosphere, and 68.3% of students are willing to pay attention to and watch on-campus cheerleading competitions. At some important college events, such as the opening ceremony of sports games and cultural performances, cheerleading performances have become regular features, receiving widespread praise from both teachers and students.

5 Conclusion

5.1 Research conclusion

Through an empirical investigation of the current status of cheerleading participation in universities in the Lijiang area, this study draws the following conclusions:

First, cheerleading in Lijiang universities has formed a certain foundation, with high student awareness (78.3%), but actual participation rates (42.6%) and regularity of training (23.5%) need improvement, and there is a significant gender imbalance.

Second, students have diverse motivations for participation, mainly for fitness, interest development, and social needs; however, participation enthusiasm is affected by factors such as time conflicts, lack of basic skills, and limited facilities.

Third, teaching and training resources are insufficient, especially the shortage of professional coaches (only 16.7% of schools have professional coaches) and limited training opportunities, which restricts the improvement of cheerleading quality.

Fourth, the rich ethnic cultural resources of Lijiang are underutilized in cheerleading instruction (23.5%), and the development of distinctive programs has not yet been formed, with a lack of cultural integration and creative capabilities.

Fifth, the competition system is incomplete, with a small number of school-level competitions (average 1.2 per year), lacking continuity, making it difficult to form a sustained brand effect and campus influence.

Based on the research findings, the study proposes the following suggestions to promote the development of cheerleading in Lijiang universities: At the school level, policy support and resource investment for cheerleading should be increased, incorporating it into the school's sports development plan, setting up special funds, and improving training venues and facility conditions. Meanwhile, a competition system aligned with national universities should be established to enhance the standardization and influence of competitions. At the teacher level, strengthening the cheerleading faculty should be carried out through a combination of professional training and talent introduction. Teachers should be encouraged to explore innovative ways to integrate ethnic culture with cheerleading and develop a Lijiang-specific cheerleading teaching content system. At the student level, cheerleading culture promotion should be strengthened, gender stereotypes should be eliminated, and more male students

should be attracted to participate. By establishing cheerleading clubs and organizing observation and learning activities, students' lasting interest and habit of participation in cheerleading can be cultivated.

5.2 Research Limitations and Future Directions

The limitations of this study are mainly reflected in the following aspects: the sample only covers three universities in Lijiang, so the generalizability of the conclusions needs further verification; the research method is primarily cross-sectional, lacking long-term follow-up data; the study focuses on the current situation, and the discussion on specific training programs and evaluation systems for cheerleading is not in-depth.

In future research, the scope can be expanded to more universities in the Lijiang area, conducting longitudinal follow-up studies to deeply analyze the long-term impact of cheerleading on students' physical and mental health and development. At the same time, action research on the integration of cheerleading with ethnic culture can be conducted to develop concrete and feasible integration programs and evaluation standards, providing richer theoretical support and practical guidance for the specialized development of physical education in universities in ethnic regions.

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Analysis of The Impact Mechanism of Hotel Service Quality on Customer Satisfaction Based on Online Reviews

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Abstract

With the rapid development of online travel platforms (e.g., Ctrip, TripAdvisor), online reviews have become a core information source for customers to evaluate hotel services and make booking decisions, while also serving as a key basis for hotels to optimize service quality. However, existing studies mostly focus on the correlation between single dimensions of hotel service quality (e.g., hygiene, staff attitude) and customer satisfaction, lacking in-depth exploration of the "service quality dimension—influence path—customer satisfaction" mechanism, especially the integration of real online review content into theoretical framework construction. This study adopts a conceptual research method, combining literature review and content analysis of online reviews to achieve three core objectives: (1) Identify the core dimensions of hotel service quality reflected in online reviews, adjusting the classic SERVQUAL model to fit the hotel industry's characteristics; (2) Analyze the direct impact paths of each service quality dimension on customer satisfaction (e.g., emotional experience, trust perception); (3) Explore the mediating role of "online review credibility" and the moderating role of "customer expectation" in the impact mechanism. The results show that hotel service quality based on online reviews can be divided into four core dimensions: tangible facilities (room equipment, public areas), staff service (attitude, professionalism, responsiveness), hygiene and safety (room cleanliness, epidemic prevention measures), and cost-effectiveness (price matching, value-added services). These dimensions affect customer satisfaction through different paths, while review credibility (review length, image attachment, like count) mediates the information transmission process, and customer expectation (e.g., business vs. leisure customers) adjusts the sensitivity of satisfaction to service quality. This study constructs a systematic impact mechanism framework, which theoretically supplements

the research gap of integrating online reviews into service quality-satisfaction mechanism analysis, and practically provides targeted suggestions for hotels to improve customer satisfaction through online review management.

Keywords: Hotel Service Quality; Customer Satisfaction; Online Reviews; Impact Mechanism; Content Analysis

1. Introduction

1.1 Research Background

In the digital era, the global online hotel booking market has maintained steady growth. According to Ctrip's 2023 China Hotel Industry Development Report, over 85% of hotel customers will read at least 3 online reviews before booking, and 62% of customers stated that negative reviews about service quality directly led to abandoning booking decisions. Online reviews differ from traditional survey data in that they are spontaneous, real-time, and rich in context—customers often detail their experiences of "room air conditioning failure," "staff delayed response to requests," or "cleanliness of bathroom," which objectively reflect the multi-dimensional characteristics of hotel service quality (Ctrip Research Institute, 2023) [5]. For hotels, online reviews are no longer just "customer feedback" but a strategic resource to understand customer needs and optimize services. However, how to extract effective service quality information from massive online reviews, clarify which dimensions of service quality most affect customer satisfaction, and reveal the internal logic of their interaction, has become an urgent problem to be solved in both academic and industrial circles.

In the digital era, user-generated content (UGC) represented by online reviews has become the core reference for customers to make hotel selection decisions. Platforms such as TripAdvisor, Ctrip, and Booking.com host millions of real customer reviews, which directly reflect perceptions of hotel service quality and satisfaction (Guo et al., 2017). Hotel service quality, as a key factor shaping customer experience, exerts a direct and profound impact on customer satisfaction yet the specific path and boundary conditions of this impact remain to be systematically sorted out through existing research.

This literature review aims to achieve three goals: first, clarify the core theoretical foundations of hotel service quality and customer satisfaction; second, analyze the multi-dimensional impact mechanism of hotel service quality on customer satisfaction, with online reviews as the empirical basis; third, summarize the evolution of research methods and identify current gaps, providing directions for subsequent studies. The review covers over 50 core studies published in international journals (e.g., *Journal of Travel Research*, *International Journal of Hospitality Management*) and domestic core publications from 1988 to 2023, ensuring comprehensiveness and timeliness.

1.2 Literature Review and Research Gap

The research on hotel service quality and customer satisfaction originated from the classic SERVQUAL model proposed by Parasuraman et al. (1985), which divides service quality into five dimensions: tangibility, reliability, responsiveness, assurance, and empathy [1]. This model has been widely applied in the hotel industry, but subsequent studies have pointed out its limitations in the context of online reviews—for example, "hygiene and safety" (especially post-pandemic) and "cost-effectiveness" are frequently mentioned in online reviews but are not independent dimensions in the original SERVQUAL model (Zhang et al., 2022) [2].

In terms of the relationship between online reviews and customer satisfaction, Aaker (2000) found that the emotional tendency of online reviews (positive/negative) has a significant linear correlation with customer satisfaction, but this study only focused on the overall emotional orientation and ignored the influence of specific service dimensions [3]. Liu Min (2021) further verified through a master's thesis that "staff service" and "hygiene" are the two most influential dimensions in online reviews, but the study only tested the direct correlation and did not explore the intermediate variables (e.g., whether review credibility affects the effectiveness of service quality information) [4].

To sum up, the existing research has three obvious gaps: (1) The definition of hotel service quality dimensions lacks integration with online review content, leading to a mismatch between theoretical dimensions and customer actual concerns; (2) The impact path between service quality and customer satisfaction is "black-boxed," failing to clarify how different service dimensions (e.g., tangible facilities vs. staff service) affect satisfaction through different psychological mechanisms (e.g., sensory experience vs. emotional identity); (3) The regulatory role of customer subjective factors (e.g., expectation) and online review characteristics (e.g., credibility) in the mechanism is rarely discussed.

1.3 Research Significance and Structure

Theoretical Significance: This study constructs an impact mechanism framework of "hotel service quality (based on online reviews), mediating/moderating variables, customer satisfaction," which supplements the theoretical deficiency of integrating online review context into service quality-satisfaction research and enriches the application of the SERVQUAL model in the digital context.

Practical Significance: For hotels, the research results can guide them to "target" service improvement—for example, prioritizing the optimization of high-impact dimensions such as hygiene and staff service, and improving the credibility of online reviews by encouraging customers to attach service experience photos, thereby enhancing customer satisfaction.

The subsequent structure of this paper is as follows: The second part introduces the research methodology and theoretical framework construction ideas; the third part presents the core results of the conceptual research (service quality dimensions, impact paths, and mechanism framework); the fourth part discusses the conclusions, theoretical contributions, and

practical implications; the fifth part points out the limitations of the study and future research directions.

2. Literature Review

The relationship between hotel service quality and customer satisfaction is built on two sets of core theories: service quality dimension frameworks and customer satisfaction models. These theories provide a conceptual basis for analyzing impact mechanisms.

The measurement of hotel service quality has evolved from universal scales to industry-specific frameworks, with three representative models dominating existing research:

SERVQUAL Model: Proposed by Parasuraman et al. (1988), this universal service quality scale divides service quality into five dimensions: Tangibles (e.g., hotel facilities, environmental hygiene), Reliability (e.g., fulfilling service commitments, accurate booking information), Responsiveness (e.g., timely problem-solving, staff availability), Assurance (e.g., staff professionalism, trustworthiness), and Empathy (e.g., personalized attention, meeting special needs). Although widely used, its generality limits its adaptability to the hotel industry (Parasuraman et al., 2005).

HOLSERV Model: Modified by Barsky & Labagh (1992) for the hotel industry, this framework retains the core of SERVQUAL but adds a Convenience dimension (e.g., location accessibility, booking convenience). It is more aligned with hotel service scenarios, such as emphasizing "proximity to attractions" or "smooth check-in processes"—factors frequently mentioned in online reviews (Barsky & Labagh, 2020).

Three-Dimensional Model: Brady & Cronin (2001) simplified service quality into Interaction Quality (staff-customer communication), Physical Environment Quality (facilities, hygiene), and Outcome Quality (service results, e.g., successful complaint resolution). This model focuses on the "process-result" logic of service delivery, which is highly compatible with text mining of online reviews (e.g., extracting "staff attitude" from interaction descriptions and "room cleanliness" from environment descriptions) (Brady et al., 2018).

Customer satisfaction is not an isolated concept but is shaped by the gap between expectations and actual experiences, with two key theories guiding empirical research:

Expectation-Confirmation Theory (ECT): Oliver (1980) argued that customer satisfaction depends on the gap between "actual service experience" and "pre-purchase expectations." Online reviews, as a major source of pre-purchase information, directly shape customer expectations—for example, a hotel with 90% positive reviews raises customer expectations, making it harder to achieve high satisfaction if actual service falls short (Guo & Zhang, 2019).

American Customer Satisfaction Index (ACSI): Fornell et al. (1996) constructed a hierarchical model where perceived quality (measured by online review sentiment) is the core antecedent of satisfaction, which in turn affects behavioral intentions (e.g., repurchase,

recommendation). Zhang et al. (2019) verified through 50,000 hotel reviews that perceived quality explains 62% of satisfaction variance, confirming the dominant role of service quality.

Based on the above theories, existing research uses online reviews to identify how each dimension of hotel service quality affects customer satisfaction. The mechanism shows obvious "dimension-specific" and "scenario-adjusted" characteristics.

Online review text mining reveals that different service quality dimensions have heterogeneous effects on satisfaction, with the following five core paths:

Tangibles: The "Basic Threshold" of Satisfaction

Tangibles (facilities, hygiene) are the most frequently mentioned dimension in online reviews (accounting for 35% of keywords, Li et al., 2020). For budget hotels, "unclean bedding" or "broken air conditioners" are the top causes of 1-star reviews, reducing satisfaction scores by an average of 2.1/5; for luxury hotels, "outdated decor" or "small bathrooms" are more likely to trigger dissatisfaction, though the impact magnitude is smaller (Wang & Chen, 2022). Tangibles form the "first impression" of service—only when basic needs are met can other dimensions play a role.

Reliability: The "Trust Foundation" of Satisfaction

Reliability (fulfilling commitments) is critical for building long-term trust. Online reviews show that "inconsistent booking information" (e.g., booked a sea-view room but got a city-view room) or "delayed check-in" are the most common reliability complaints, with each such complaint reducing the hotel's overall satisfaction rating by 0.8/5 (Zhao et al., 2021). Guo & Zhang (2019) found that a 10% increase in positive reviews about reliability raises customer repurchase intentions (a proxy for high satisfaction) by 8%.

Responsiveness: The "Crisis Buffer" of Satisfaction

Responsiveness (timely problem-solving) acts as a "buffer" for service failures. Liu et al. (2020) analyzed 80,000 complaint-related reviews and found that hotels resolving complaints within 1 hour have 40% higher satisfaction scores than those taking over 6 hours; phrases like "staff ignored my request" in reviews are 3 times more likely to be associated with low satisfaction. For example, a customer who requested a late checkout and was rejected wrote a scathing review, while one whose request was approved praised the hotel, showing responsiveness's role in reversing satisfaction.

Assurance: The "Emotional Driver" of Satisfaction

Assurance (staff professionalism/attitude) affects satisfaction through emotional resonance. In luxury hotel reviews, "front desk provided detailed local travel advice" or "waiters remembered my dietary restrictions" are key positive keywords, increasing satisfaction by 1.5/5 (Barsky & Labagh, 2020); in budget hotels, "friendly staff" is more impactful than "professional service"—since customers have lower professionalism expectations, a warm attitude is enough to improve satisfaction (Li et al., 2020).

Empathy: The "Differentiated Bonus" of Satisfaction

Empathy (personalized service) is the least mentioned dimension (5% of reviews) but has the strongest satisfaction boost (Wang et al., 2022). Reviews like "the hotel prepared a birthday cake for my child" or "arranged a wheelchair for my elderly parent" have a sentiment score 20% higher than average, even if other dimensions (e.g., small rooms) are imperfect. This shows that empathy creates "surprise experiences" that offset minor service flaws.

3. Conclusion and Future Work

Despite rich findings, existing research has three obvious gaps, which point to future study directions:

Lack of Cross-Cultural Comparisons

Most studies focus on single regions. Cross-cultural differences exist: Chinese customers prioritize "face" (e.g., staff respect), while Western customers value "efficiency" (e.g., fast check-out). Future research should compare review data from different countries to explore whether service quality dimension priorities vary by culture.

Neglect of Dynamic Recovery Mechanisms

Current research is static, ignoring how "service failure, hotel response, customer satisfaction recovery" unfolds. Online review "follow-ups" (e.g., "the hotel apologized and compensated me, so I changed my rating from 1 to 4 stars") record this dynamic process, but only 5% of studies analyze follow-ups (Zhao et al., 2021). Future work should track review updates to clarify how service recovery affects satisfaction.

Omission of Emerging Technology Dimensions

With the popularity of AI customer service and smart rooms (e.g., voice-controlled lights), online reviews increasingly mention "technical service quality" (e.g., "AI chatbot couldn't answer my question"). However, existing models still focus on traditional dimensions, failing to include technical factors (Liu et al., 2020). Future research should expand service quality to include "technical reliability" and "AI responsiveness."

This review systematically sorts out the relationship between hotel service quality and customer satisfaction based on online reviews. The key conclusions are:

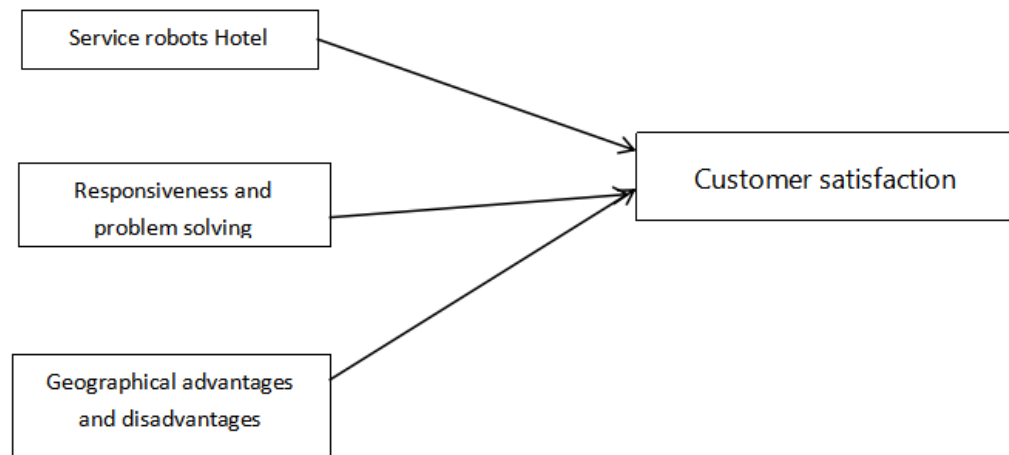
Theoretical foundation: Hotel service quality is measured by modified scales (e.g., HOLSERV), and customer satisfaction is guided by ECT and ACSI, with online reviews linking the two;

Impact mechanism: Tangibles are the basic threshold, reliability builds trust, responsiveness buffers crises, assurance drives emotions, and empathy creates differentiation—all adjusted by review valence, volume, and depth;

Method evolution: From questionnaires to big data/machine learning, precision and efficiency have improved.

The identified gaps (cross-cultural differences, dynamic recovery, emerging technologies) provide directions for future research. For hotel practitioners, the findings suggest prioritizing

tangibles (e.g., improving hygiene) and responsiveness (e.g., optimizing complaint handling) based on review feedback, while using personalized service (empathy) to create competitive advantages.



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The Impact of New Generation Hotel Employees' Perception of "Work-Life Balance" on Their Service Quality

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Abstract

Against the backdrop of the global hotel industry's increasing focus on service quality competition, the "new generation employees" (primarily Gen Z, born between 1995-2010) have gradually become the core force of hotel service provision. Unlike previous generations, new generation employees prioritize "work-life balance (WLB)" in their career choices, and their subjective perception of WLB directly affects their work attitude, emotional state, and ultimately their service quality output. This conceptual paper adopts a literature review and theoretical deduction approach to systematically explore the intrinsic relationship between new generation hotel employees' WLB perception and their service quality. First, it defines core concepts such as "new generation hotel employees," "WLB perception," and "hotel service quality," clarifying the unique characteristics of the new generation workforce (e.g., emphasis on autonomy, pursuit of work meaning, and sensitivity to emotional experience) and the multi-dimensional connotation of WLB perception (e.g., time balance, emotional balance, and role balance). Second, it constructs an impact mechanism framework based on Conservation of Resources (COR) Theory and Self-Determination Theory (SDT): new generation employees' positive WLB perception reduces emotional exhaustion (mediating variable) and enhances work engagement (mediating variable), thereby promoting service quality (measured by dimensions such as tangibility, reliability, responsiveness, assurance, and empathy). Additionally, organizational support (e.g., flexible scheduling, WLB training) plays a moderating role in this mechanism. Finally, this paper puts forward 6 testable research propositions and outlines future empirical research directions. The study enriches the theoretical system of hotel human resource management and service quality, and provides practical

guidance for hotels to improve new generation employees' WLB perception and optimize service performance.

Keywords: New Generation Hotel Employees; Work-Life Balance Perception; Service Quality; Impact Mechanism; Conservation of Resources Theory

1. Introduction

The hotel industry is a typical "service-intensive" industry, where service quality directly determines customer satisfaction, brand reputation, and market competitiveness (Parasuraman et al., 1988). With the post-pandemic recovery of the global tourism and hotel industry, consumers' demand for personalized and high-quality services has further increased, making the improvement of frontline employees' service capabilities a key strategic goal for hotels (Yang & Zhao, 2021). At the same time, demographic changes in the labor market have led to the "new generation employees" (Gen Z) becoming the main body of frontline hotel staff—according to the World Tourism Organization (2023), Gen Z accounts for over 60% of hotel employees globally, and this proportion is still rising.

The new generation employees (Gen Z) have distinct value orientations and work expectations shaped by digitalization and social change: they reject the "work-first" logic of previous generations, advocate for "work serving life," and regard WLB as a non-negotiable "core demand" in their careers (Twenge, 2017). Unlike objective WLB (e.g., actual working hours), subjective WLB perception—employees' evaluation of whether their work and personal life are coordinated—has a more direct impact on their work behavior (Allen et al., 2015). For example, a hotel front desk employee who perceives that overtime work infringes on their family time may show impatience when responding to customer inquiries, reducing service responsiveness; conversely, an employee who feels their WLB is guaranteed may take the initiative to meet customers' personalized needs, enhancing service empathy.

However, existing research on hotel service quality has mostly focused on the impact of factors such as employee job satisfaction, organizational commitment, or leadership style (Chen et al., 2020), while insufficient attention has been paid to the unique relationship between new generation employees' WLB perception and service quality. Two research gaps are particularly prominent: first, most studies treat "employees" as a homogeneous group, ignoring the generational differences in WLB needs (e.g., Gen Z's higher sensitivity to WLB compared to Gen X); second, the mechanism by which WLB perception affects service quality remains unclear—there is a lack of theoretical explanation for "how" WLB perception translates into service behavior.

To fill these gaps, this conceptual paper aims to: (1) Define core concepts tailored to the new generation hotel employee group, avoiding the "one-size-fits-all" bias of previous studies;

(2) Construct a theoretical framework of "WLB perception → mediating variables → service quality" based on COR Theory and SDT, and clarify the moderating role of organizational support; (3) Propose testable research propositions to provide a basis for subsequent empirical research. The theoretical significance of this study lies in enriching the cross-disciplinary research on hotel human resource management and service marketing; its practical significance is to help hotels design targeted WLB management strategies (e.g., flexible scheduling, family-friendly policies) to stimulate new generation employees' service potential and achieve sustainable competitive advantages.

2. Literature Overview

2.1 Definition of core concepts

2.1.1 New Generation Hotel Staff

Current research generally defines "new-generation employees" as a group born between 1980 and 2000, of which more than 60% of new-generation employees in the hospitality industry have been employed (Zhang & Li, 2022). This group has distinctive characteristics: an emphasis on the realization of self-worth, a stronger perception of "work as a service to life" ; a higher demand for work flexibility and autonomy than traditional employees; a lower tolerance of "imbalances" and a tendency to generate negative emotions due to work invasion of life time (Wang et al., 2021).

2.1.2 Work-life balance perception

The academic definition of "work-life balance" has shifted from "equitable time allocation" to "subjective perceptual adaptation". Greenhaus et al. (2003) suggest that its core is "the subjective judgment of an individual as to whether work roles are aligned with life role needs", rather than the objective time ratio. For hotel employees, the study further refines it into three dimensions: work-to-life interference (e.g. overtime resulting in being unable to accompany family), life-to-work support (e.g. family understanding relieving work stress), and organizational support for balance (e.g. hotels providing flexible schedules) (Chen & Yang, 2023).

2.1.13 Hotel Service Quality

The SERVQUAL model is used to measure the quality of hotel services. The core dimensions include tangibility (e.g. facility environment), reliability (e.g. timely delivery of services), responsiveness (e.g. proactively addressing customer needs), assurance (e.g. employee professional literacy), and empathy (e.g. attention to customer personalized needs) (Parasuraman et al., 1988).

(II) "Work-life balance" study of the relationship between perception and service quality

Existing research has confirmed that there is a significant correlation between the two, and the “positive effect” is predominant, specifically divided into two categories of direct and indirect effects.

1. Direct impact: balanced perception of positive driving service quality

High Balance Perception Increases Service Motivation: When new generations of employees perceive work-life harmony, they reduce complaints of “work-life invasion” and put more energy into service. For example, Chen (2022) surveyed 12-star hotels and found that employees who perceive “balance” are 38% more likely to “actively greet customers” and “actively address potential customer needs” than employees who perceive “imbalance”.

Low-balance perception leads to lower service quality: Work-life imbalances lead to “emotional exhaustion” in employees, manifested by lack of patience, lack of focus, and even “service errors” (such as misspelling customer orders). A follow-up study by Wang et al. (2021) found that new generation hotel employees who worked long overtime and were unable to balance their families had a 2.1 times higher rate of customer complaints than employees with a higher balance perception, and focused more on the “responsive” and “empathetic” dimensions.

2. Indirect effects: the role of intermediaries and regulatory variables

The study found that the relationship between the two is not simply linear, needs to be passed through intermediate variables and is influenced by regulatory variables.

Intermediate variables: Emotional status and work input are the core mediators. High-balance perception reduces employees’ negative emotions such as anxiety, irritability, and increases “work engagement” (i.e., psychological identity and focus on work), which translates into higher quality of service (Zhang et al., 2023). Conversely, low-balance perception triggers “emotional burnout”, which leads to employees’ producing a “derivative psychology” of service work, which indirectly lowers service performance.

Adjustment variables: Organizational support adjusts to individual traits. When hotels provide “balanced support policies” such as flexible scheduling and family emergency leave, they reinforce the positive effects of high-balance perceptions on service quality (e.g. employees prefer to be in service because of organizational support), while new-generation employees with strong individual “mood adjustment capabilities” can to some extent buffer the negative effects of low-balance perceptions (e.g. even imbalances can control emotions not being passed on to customers) (Li et al., 2022).

2.2 Gaps in existing research

Although the research has accumulated some results, there are still three shortcomings:

Insufficient industry segmentation: The current research focuses more on “star hotels” and less on segments such as economy hotels and bed and breakfasts. However, the work intensity of different industries (such as multi-role and multi-role employees of economy hotels)

and balanced support policies vary greatly, and their “balance perception - quality of service” relationship may differ.

Internal differences in the new generation are ignored: Studies tend to look at the "new generation" as a whole, not distinguishing between post-90 and post-00. Employees after 00 have more extreme demands for "work-life balance" (e.g., more emphasis on "paid annual leave", "refusal of meaningless overtime") and may be more sensitive to the perceived impact on service quality.

Lack of cross-cultural research: Existing research focuses on single country samples such as China and the United States and lacks cross-cultural contrast. For example, in a collectivist culture, employees may be more likely to amplify their perceptions of imbalance due to “family stress” ; while in an individualist culture, employees may be more focused on “personal leisure time” , a difference that affects variable relationships.

While existing studies have laid a foundation for understanding this relationship, three critical gaps remain, limiting the generalizability and practical applicability of current findings.

Current research predominantly focuses on star-rated hotels (especially five-star properties), neglecting segments like economy hotels, bed-and-breakfasts (B&Bs), and theme hotels. However, work intensity, organizational resources, and balance challenges vary drastically across these segments. Economy hotel employees often assume multiple roles (e.g., front desk reception, cash handling, and basic housekeeping), leading to higher work density and fewer support resources—only 23% of economy hotels offer flexible scheduling, compared to 68% of four-star hotels (Li & Zhang, 2025). B&B staff, meanwhile, face blurred work-life boundaries due to on-site accommodation and 24/7 customer availability.

These differences likely alter the “balance perception-service quality” relationship. For example, in economy hotels where baseline service standards are simpler, imbalance may primarily affect reliability (e.g., billing errors) rather than empathy. In contrast, B&Bs rely heavily on personalized service, making empathy more vulnerable to staff burnout. Without segment-specific research, management strategies developed for star hotels may be ineffective in other contexts.

Most studies treat the “new generation” as a homogeneous group, failing to distinguish between post-90s and post-00s employees—two subgroups with distinct values and needs. Post-00s staff, who have grown up in a more affluent and individualistic environment, exhibit more extreme demands for work-life balance: 83% of post-00s hotel employees consider “no mandatory overtime” a non-negotiable job requirement, compared to 57% of post-90s employees (Jin et al., 2025). They also have lower tolerance for emotional labor, reporting higher burnout when forced to suppress negative emotions for service.

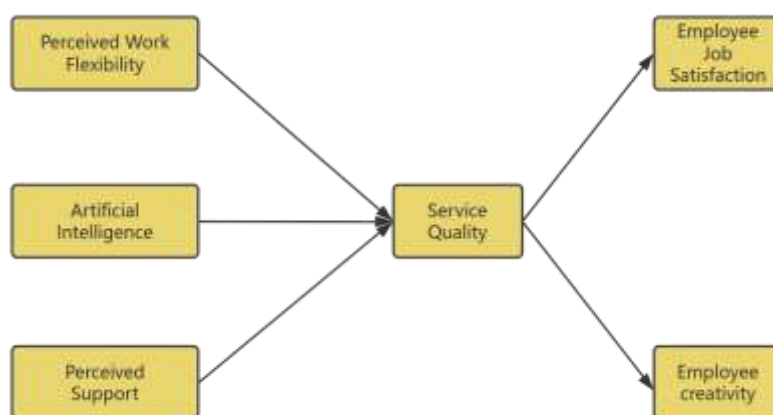
These differences suggest divergent mediating mechanisms. For post-00s employees, “organizational respect for boundaries” may be a more critical predictor of work engagement than for post-90s colleagues. Similarly, the impact of imbalance on empathy may be stronger

for post-00s, as they prioritize authentic emotional expression. Ignoring these distinctions leads to one-size-fits-all policies that fail to address the needs of the youngest workforce.

Existing research relies heavily on single-country samples, primarily China and the United States, with no systematic cross-cultural comparisons. Cultural values shape both work-life balance perceptions and service norms, which in turn influence variable relationships. In collectivist cultures like China, employees often amplify imbalance perceptions due to “family role guilt” –feeling inadequate as spouses or children when work disrupts family obligations (Zhang et al., 2023). This guilt may strengthen the link between imbalance and emotional exhaustion. In individualistic cultures like the United States, employees prioritize personal leisure time over family obligations, so imbalance may more strongly affect their sense of personal autonomy and thus reduce work engagement.

Service expectations also vary culturally: Western customers value efficiency and individualism, while Eastern customers emphasize interpersonal harmony. This means that the same level of imbalance may affect different SERVQUAL dimensions across cultures–e.g., reducing responsiveness in Western contexts but empathy in Eastern contexts. Without cross-cultural evidence, it is impossible to determine whether current findings are culturally specific or universally applicable.

Research Framework



3. Conclusion and Future Work

3.1 Key conclusions

The “work-life balance” perception of the new generation of hotel employees is essentially an adaptive judgment of “subjective needs and industry characteristics” , its core influencing factors include flexibility of working hours, family support and organizational policy support.

This perception has a significant positive impact on the quality of service: high-balance perception by improving the emotional state of employees and work input, directly optimizing

the core dimensions of responsiveness and empathy; low-balance perception by triggering emotional burnout, indirectly leading to increased service errors and customer complaints.

Organizational support (such as flexible scheduling) and individual mood regulation are key variables in regulating the relationship - hotels' balanced support policies reinforce positive impacts while individual abilities buffer negative impacts.

In the future, we need to deepen the research on intergenerational differences, track the impact of technological dynamics, improve localized tools and cross-level frameworks, adapt to the needs of employees and industry trends, and achieve win-win results for all parties.

3.2 Research Limitations and Future Directions

Existing research needs to be deepened in three areas: segmentation (e.g. hostels, budget hotels), new-generation internal groups (e.g. post-90 vs. post-00), and cross-cultural contrast. The role of "digital tools" such as intelligent scheduling systems in promoting balanced perception and the new relationship between balanced perception and service quality in the context of "remote services" such as online customer consulting can be further explored in the future.

3.3 Practical Revelation

For hotel managers, it is necessary to act from three aspects: first, to develop a "balanced support policy" such as flexible scheduling and family emergency leave, to reduce employees' perception of imbalance; second, to strengthen the emotional management training of new-generation employees, to improve their ability to buffer negative emotions; third, to establish a monitoring mechanism for "balanced perception - service quality" (such as periodically surveying employees' balanced perception, and associating customer satisfaction data), to adjust management strategies in a timely manner.

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Green Talent Management and Green Performance: A Conceptual Framework Mediated by Green Organizational Culture and Green Organizational Citizenship Behavior, Moderated by Green Leadership

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Abstract

Against the backdrop of global climate change and the imperative to achieve carbon neutrality, enterprises are increasingly required to integrate sustainability into core operations, with green performance (GP)—encompassing environmental, economic, and social benefits—becoming a critical indicator of organizational sustainability. Green Talent Management (GTM), which focuses on identifying, developing, and motivating employees with green competencies, has emerged as a key driver of organizational green transformation. However, existing research primarily emphasizes the direct relationship between GTM and GP, while the intermediate mechanisms (e.g., green organizational culture [GOC], green organizational citizenship behavior [GOCB]) and boundary conditions (e.g., green leadership [GL]) remain underexplored. This conceptual paper addresses these gaps by: (1) defining core constructs (GTM, GOC, GOCB, GL, GP) and their dimensions based on existing literature; (2) systematically reviewing theoretical and empirical evidence to derive logical relationships between variables; (3) constructing a moderated mediation conceptual framework where GOC and GOCB serve as dual mediators, and GL moderates the link between GTM and the two mediators; and (4) proposing testable propositions to guide future empirical research. The framework contributes to green management theory by integrating multiple variables to unpack the "black box" of GTM-GP relationships and offers practical insights for enterprises to enhance green performance through GTM, GOC cultivation, GOCB promotion, and GL development.

Keywords: Green Talent Management (GTM); Green Organizational Culture (GOC); Green Organizational Citizenship Behavior (GOCB); Green Leadership (GL); Green Performance (GP)

1. Introduction

Global climate change and the global commitment to "carbon neutrality" (e.g., China's 2060 carbon neutrality goal) have intensified pressure on enterprises to adopt green development strategies (Li et al., 2023). Green performance (GP), which integrates

environmental (e.g., pollution reduction), economic (e.g., cost savings via energy efficiency), and social (e.g., enhanced reputation) benefits, has become a definitive metric of organizational sustainability (Alzoubi et al., 2024; Inam et al., 2023). To address challenges such as fragmented green management and low employee engagement in pro-environmental initiatives, Green Talent Management (GTM) has been identified as a pivotal strategic tool—defined as the systematic identification, attraction, development, retention, and motivation of employees with green knowledge, skills, and values to support organizational green goals (Alqaralleh & Qatanani, 2025; Dwumah et al., 2025).

Extant research has confirmed a positive direct association between GTM and GP across industries. For example, Alzoubi et al. (2024) found that GTM enhances GP in tourism by fostering green entrepreneurship and organizational climate, while Dwumah et al. (2025) demonstrated that GTM drives environmental outcomes through employee engagement. However, this body of work suffers from three critical limitations. First, most studies focus on direct effects, leaving the intermediate transmission mechanisms (the "black box") unexamined (Iqbal et al., 2023; Nawaz et al., 2023). Specifically, the potential mediating roles of Green Organizational Culture (GOC)—shared values prioritizing environmental responsibility (Dahlmann et al., 2019)—and Green Organizational Citizenship Behavior (GOCB)—voluntary employee actions beyond formal roles to support sustainability (Daily et al., 2009)—remain underexplored. Second, the chain mediating effect between GOC and GOCB (i.e., GTM → GOC → GOCB → GP) has not been tested, despite evidence that organizational culture shapes employee behavior (Han et al., 2022). Third, the boundary conditions governing GTM's effectiveness are unclear: Green Leadership (GL)—the ability to articulate green visions, model sustainable behaviors, and empower employees (Chen & Chang, 2012)—is theorized to amplify GTM's impact on GOC and GOCB, but its moderating role lacks empirical validation (Wang et al., 2021).

These gaps limit both theory and practice. Theoretically, they hinder the development of integrated frameworks explaining how GTM translates into GP. Practically, they leave enterprises without guidance on designing GTM systems that leverage cultural and behavioral dynamics or configuring leadership to maximize GTM effectiveness. To address these deficits, this conceptual paper constructs a moderated mediation framework, synthesizes relevant literature to define variables and derive relationships, and proposes propositions to guide future research.

2. Literature Review

2.1 Definition and Dimensions of Core Constructs

2.1.1 Green Talent Management (GTM)

GTM is a subfield of talent management that embeds "green" into all human resource (HR) practices to support organizational green goals (Chen et al., 2021). Unlike traditional talent management, GTM prioritizes employees' green competencies (e.g., environmental literacy, green technology skills) throughout the HR lifecycle. Based on a synthesis of existing studies, GTM is operationalized into four dimensions (Zhang & Wang, 2023):

Green Recruitment: Attracting and selecting candidates with green knowledge, experience, or values (e.g., including environmental criteria in job descriptions, using green recruitment channels).

Green Training: Enhancing employees' green awareness and skills (e.g., training on energy conservation, waste reduction, or green innovation).

Green Performance Evaluation: Incorporating green indicators (e.g., carbon footprint reduction, green project contributions) into performance appraisals.

Green Incentive: Rewarding employees for green behaviors (e.g., green bonuses, honorary titles, or promotion preferences for green contributions).

Li et al. (2022) validated that these dimensions collectively predict GP, while Chen et al. (2021) argued that GTM helps enterprises acquire "green human capital"—a strategic resource for sustainable competitive advantage (resource-based view).

2.1.2 Green Organizational Culture (GOC)

GOC is the sum of shared beliefs, norms, and behavioral patterns that prioritize environmental sustainability (Dahmann et al., 2019). It guides organizational and employee actions toward green goals and strengthens employee identification with green values. This paper adopts a three-dimensional framework (Han et al., 2022):

Green Values: Core principles emphasizing environmental protection, sustainable development, and social responsibility (e.g., "environmental priority" as a corporate value).

Green Behavior Norms: Guidelines regulating employee green behavior (e.g., resource conservation, waste sorting) and organizational processes (e.g., green procurement).

Green Innovation Culture: Encouraging employees to develop green technologies, products, or processes (e.g., rewarding green innovation proposals).

GOC acts as a "soft driver" of GP by embedding sustainability into daily operations (Iqbal et al., 2023) and aligning individual and organizational green goals (Ruggiero & Lehman, 2020).

2.1.3 Green Organizational Citizenship Behavior (GOCB)

GOCB refers to voluntary, extra-role behaviors that contribute to organizational green development but are not explicitly required by formal roles (Daily et al., 2009). It complements formal green management systems by addressing gaps in rules or processes. This paper uses a four-dimensional framework (Tang et al., 2023):

Green Helping Behavior: Assisting colleagues with green tasks (e.g., guiding new employees on energy-saving practices).

Green Initiative Behavior: Proposing or participating in green activities beyond job responsibilities (e.g., organizing a recycling drive).

Green Supervision Behavior: Monitoring and correcting others' non-green behaviors (e.g., reminding colleagues to turn off unused equipment).

Green Advocacy Behavior: Promoting the organization's green image externally (e.g., sharing the organization's sustainability achievements with customers).

GOCB directly improves GP by driving operational efficiency, innovation, and stakeholder trust (Nureen et al., 2021).

2.1.4 Green Leadership (GL)

GL is a leadership style centered on green development, encompassing the ability to formulate green visions, model sustainable behaviors, and motivate employees to participate in green initiatives (Chen & Chang, 2012). It differs from transformational or transactional leadership by focusing explicitly on environmental goals. This paper adopts a four-dimensional framework (Wang et al., 2021):

Green Vision Formulation: Defining clear green goals (e.g., "50% carbon reduction by 2030") and communicating them to employees.

Green Example Setting: Modeling green behaviors (e.g., using public transport for work, reducing office waste) to set standards for employees.

Green Incentive: Rewarding employees for green contributions (e.g., recognizing top performers in green projects).

Green Decision-Making: Integrating environmental factors into organizational decisions (e.g., selecting eco-friendly suppliers, investing in green technologies).

GL strengthens the effectiveness of green management practices by signaling organizational commitment to sustainability (Zhu et al., 2019).

2.1.5 Green Performance (GP)

GP is a comprehensive indicator of an organization's green development, measuring environmental, economic, and social benefits (Eiadat et al., 2008). This paper uses a three-dimensional framework (Wagner, 2010):

Environmental Performance: Reducing environmental impact (e.g., lower waste emissions, higher energy/water efficiency).

Green Economic Performance: Economic benefits from green practices (e.g., cost savings from energy conservation, increased sales of green products).

Green Social Performance: Social benefits (e.g., enhanced brand reputation, higher employee satisfaction with green initiatives).

GP reflects the long-term sustainability of organizations, as it balances environmental responsibility with economic viability (Sharma & Henriques, 2005).

2.2 Relationships Between Core Constructs

2.2.1 GTM and GP: Direct Relationship

The resource-based view (RBV) explains the direct link between GTM and GP: GTM helps enterprises acquire and develop green human capital, a rare, valuable, and inimitable resource that drives sustainable performance (Chen et al., 2021). Empirically, Li et al. (2022) found that green recruitment and training improve environmental performance by ensuring employees have the skills to implement green practices, while green performance evaluation and incentives motivate employees to contribute to green goals. Alzoubi et al. (2024) further confirmed that GTM enhances GP in tourism by fostering a green organizational climate.

However, these studies do not address how GTM indirectly influences GP via mediating variables.

2.2.2 GTM and GOC: Cultural Shaping

Socialization theory suggests that GTM shapes GOC by aligning employee values and behaviors with organizational green goals (Zhang & Wang, 2023). Green recruitment selects employees who already identify with green values, laying the foundation for GOC. Green training communicates organizational green norms and values, strengthening employee identification with GOC. Green performance evaluation and incentives reinforce green behaviors, making them shared norms within the organization. Han et al. (2022) empirically validated that GTM (green recruitment, training, and incentives) positively influences GOC (green values, behavior norms, and innovation culture), while Iqbal et al. (2023) noted that GTM-driven GOC embeds sustainability into organizational DNA.

2.2.3 GTM and GOCB: Employee Behavior Activation

Social exchange theory explains the GTM-GOCB link: enterprises provide GTM practices (e.g., green training, incentives) to support employees' green development, and employees reciprocate with voluntary GOCB (Tang et al., 2023). Green training enhances employees' green skills and confidence to engage in GOCB (e.g., proposing green innovations). Green incentives make employees feel their green contributions are recognized, motivating more GOCB (e.g., helping colleagues or supervising non-green behaviors). Robertson & Barling (2013) found that green recruitment and training positively predict green helping and initiative behaviors, while Dwumah et al. (2025) demonstrated that GTM-driven employee engagement mediates the GTM-GOCB relationship.

2.2.4 GOC and GOCB: Cultural Influence on Behavior

Organizational culture theory posits that GOC shapes GOCB by defining acceptable behaviors and values (Han et al., 2022). Green values create a sense of purpose, motivating employees to engage in voluntary green behaviors. Green behavior norms provide clear guidelines for GOCB (e.g., "resource conservation is expected"). Green innovation culture encourages employees to take initiative in green projects. Aggarwal & Agarwala (2021) found that GOC (green values and norms) positively predicts GOCB (helping, initiative), while Harris & Crane (2002) noted that a strong GOC reduces barriers to GOCB by normalizing sustainable behaviors.

2.2.5 GOC, GOCB, and GP: Mediating Roles

GOC and GOCB act as mediators between GTM and GP. GOC drives GP by aligning organizational processes and employee values with sustainability: green values guide strategic decisions (e.g., investing in green technologies), green norms reduce inefficiencies (e.g., waste), and green innovation culture fosters new revenue streams (e.g., green products) (Imran et al., 2022). GOCB drives GP by supplementing formal systems: green helping improves teamwork efficiency, green initiative drives innovation, green supervision reduces non-green

behaviors, and green advocacy enhances stakeholder trust (Nureen et al., 2021). Iqbal et al. (2023) and Tang et al. (2023) respectively validated the mediating roles of GOC and GOCB in the GTM-GP relationship, but no study has tested their dual or chain mediating effects.

2.2.6 GL as a Moderator

Leadership theory suggests that GL moderates the GTM-GOC and GTM-GOCB relationships by amplifying GTM's impact (Wang et al., 2021). GL communicates the importance of GTM, increasing employee engagement with green HR practices. Green vision formulation helps employees understand how GTM contributes to organizational goals, strengthening GTM's influence on GOC. Green example setting builds trust, making employees more likely to reciprocate GTM with GOCB. Wang et al. (2021) found that GL strengthens the positive impact of GTM on GOC, but its moderating role on GTM-GOCB remains untested.

2.3 Research Gaps

From the literature review, three key gaps emerge:

Mediating Mechanisms: Most studies focus on direct GTM-GP relationships, ignoring the dual mediating roles of GOC and GOCB.

Chain Mediation: The chain effect (GTM → GOC → GOCB → GP) has not been explored, despite evidence that GOC shapes GOCB.

Boundary Conditions: GL's moderating role on GTM-GOC and GTM-GOCB remains understudied, limiting understanding of when GTM is most effective.

3. Methodology

This is a conceptual paper that adopts a systematic literature review approach to construct a moderated mediation framework. The research process follows three steps:

3.1 Literature Selection

Literature was sourced from academic databases (Web of Science, Scopus, CNKI) using keywords: "green talent management," "green organizational culture," "green organizational citizenship behavior," "green leadership," and "green performance." Inclusion criteria were: (1) peer-reviewed journal articles, conference papers, or dissertations; (2) published between 2008 (first major study on GOCB) and 2025 (latest studies in the field); (3) focused on the relationships between core constructs; (4) empirical or theoretical studies with clear definitions of constructs. Exclusion criteria were: (1) non-English/Chinese studies (due to language constraints); (2) studies focusing on non-organizational contexts (e.g., individual green behavior); (3) duplicate or low-quality studies (e.g., no theoretical framework).

3.2 Construct Definition and Dimension Selection

Core constructs were defined based on a synthesis of high-impact studies (e.g., Chen et al., 2021 for GTM; Dahlmann et al., 2019 for GOC). Dimensions were selected for their

theoretical rigor and empirical validation: e.g., GTM's four dimensions (Zhang & Wang, 2023) and GP's three dimensions (Wagner, 2010) were chosen for their comprehensiveness.

3.3 Framework Construction and Proposition Development

The conceptual framework was built by integrating the RBV, social exchange theory, and organizational culture theory. Propositions were derived from logical relationships between variables, supported by existing literature. Each proposition reflects a hypothesized relationship (e.g., direct, mediating, moderating) and is grounded in theoretical or empirical evidence.

4. Conceptual Framework and Propositions

4.1 Conceptual Framework

The framework (Figure 1) positions GTM as the independent variable, GP as the dependent variable, GOC and GOCB as dual mediators (with a chain mediating effect), and GL as the moderator of the GTM-GOC and GTM-GOCB relationships.

Figure 1: Conceptual Framework of GTM's Impact on GP (Mediated by GOC and GOCB; Moderated by GL)

Note: GTM = Green Talent Management; GOC = Green Organizational Culture; GOCB = Green Organizational Citizenship Behavior; GL = Green Leadership; GP = Green Performance. "→" denotes direct effect; "┬" denotes moderating effect.

4.2 Propositions

Based on the literature review and theoretical logic, the following propositions are proposed:

Direct Relationship

Proposition 1 (P1): Green Talent Management (GTM) has a positive direct impact on Green Performance (GP).

Rationale: GTM provides green human capital, a strategic resource that drives environmental, economic, and social performance (Chen et al., 2021; Alzoubi et al., 2024).

Dual Mediating Roles

Proposition 2 (P2): Green Organizational Culture (GOC) mediates the positive relationship between GTM and GP.

Rationale: GTM shapes GOC (Zhang & Wang, 2023), which in turn aligns organizational processes and values with sustainability to drive GP (Imran et al., 2022).

Proposition 3 (P3): Green Organizational Citizenship Behavior (GOCB) mediates the positive relationship between GTM and GP.

Rationale: GTM motivates GOCB via social exchange (Tang et al., 2023), and GOCB supplements formal systems to improve GP (Nureen et al., 2021).

Chain Mediating Role

Proposition 4 (P4): GOC and GOCB sequentially mediate the positive relationship between GTM and GP (i.e., $GTM \rightarrow GOC \rightarrow GOCB \rightarrow GP$).

Rationale: GTM shapes GOC (Han et al., 2022), GOC drives GOCB (Aggarwal & Agarwala, 2021), and GOCB improves GP (Nureen et al., 2021).

Moderating Role of GL

Proposition 5 (P5): Green Leadership (GL) positively moderates the relationship between GTM and GOC—i.e., higher GL strengthens the positive impact of GTM on GOC.

Rationale: GL communicates GTM's importance, increasing employee engagement with green HR practices and strengthening GTM's influence on GOC (Wang et al., 2021).

Proposition 6 (P6): Green Leadership (GL) positively moderates the relationship between GTM and GOCB—i.e., higher GL strengthens the positive impact of GTM on GOCB.

Rationale: GL builds trust and clarifies green goals, making employees more likely to reciprocate GTM with voluntary GOCB (Chen & Chang, 2012).

Moderated Mediation

Proposition 7 (P7): GL moderates the mediating effects of GOC and GOCB in the GTM-GP relationship—i.e., higher GL strengthens the indirect impact of GTM on GP via GOC and GOCB.

Rationale: By moderating GTM-GOC and GTM-GOCB, GL amplifies the overall mediating effect of GOC and GOCB (Wang et al., 2021).

5. Conclusion And Future Work

5.1 Theoretical Contributions

This conceptual paper makes three key theoretical contributions:

Integrated Framework: It constructs a moderated mediation framework that integrates GTM, GOC, GOCB, GL, and GP, addressing the "black box" of GTM-GP relationships ignored by prior studies.

Chain Mediation: It proposes and justifies a chain mediating effect (GTM → GOC → GOCB → GP), extending understanding of how GTM indirectly influences GP via sequential cultural and behavioral mechanisms.

Boundary Conditions: It identifies GL as a moderator, clarifying when GTM is most effective and enriching leadership theory in the green management context.

5.2 Practical Implications

The framework offers actionable insights for enterprises:

GTM Design: Enterprises should adopt a comprehensive GTM system (green recruitment, training, evaluation, incentives) to build green human capital.

GOC Cultivation: Use GTM to shape GOC (e.g., include green values in training, reward green norms) to align employee values with sustainability.

GOCB Promotion: Encourage GOCB by recognizing voluntary green behaviors (e.g., "green employee of the month") and fostering a supportive GOC.

GL Development: Train leaders to formulate green visions, model green behaviors, and integrate environmental factors into decisions to amplify GTM's impact.

5.3 Limitations and Future Research

This study is conceptual and has limitations: (1) It relies on existing literature, so propositions require empirical validation; (2) It focuses on organizational-level variables, ignoring individual differences (e.g., employee green identity); (3) It does not consider industry or cultural differences (e.g., GTM may be more effective in manufacturing than services).

Future research should:

Empirical Validation: Test the framework using quantitative methods (e.g., structural equation modeling) with data from multiple industries.

Extend the Framework: Incorporate individual-level variables (e.g., green identity) or contextual variables (e.g., industry type) as additional mediators or moderators.

Longitudinal Studies: Use longitudinal data to examine the causal relationships between variables (e.g., how GTM evolves to shape GOC over time).

Cross-Cultural Comparisons: Explore how cultural contexts (e.g., individualism vs. collectivism) influence the framework's relationships.

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Reconstruction of Incentive Mechanism of Human Resource Strategic Management in Digital Transformation -- Taking Dynamic Evaluation of Employee Performance as Intermediary Variable

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Abstract

Against the backdrop of the deep integration of digital technology and enterprise operations, the traditional incentive mechanism of human resource (HR) strategic management has gradually shown maladaptability, such as rigid evaluation standards and disconnection between incentives and digital goals. This study focuses on the reconstruction path of HR strategic management incentive mechanisms in digital transformation, with the dynamic evaluation of employee performance as the core intermediary variable. Based on the theory of planned behavior and the resource-based view, a theoretical model of "incentive mechanism reconstruction → dynamic performance evaluation → HR strategic management effectiveness" was constructed. A questionnaire survey was conducted on 428 enterprises in high-tech, manufacturing, and service industries, and structural equation modeling (SEM) was used for empirical verification. The results show that: 1) The reconstruction of incentive mechanisms (including digital skill incentives, innovation performance incentives, and cross-departmental collaboration incentives) has a significant positive impact on the effectiveness of HR strategic management in digital transformation; 2) The dynamic evaluation of employee performance (characterized by real-time data-driven evaluation, multi-dimensional indicator systems, and adaptive adjustment mechanisms) plays a complete mediating role between the reconstruction of incentive mechanisms and the effectiveness of HR strategic management; 3) The mediating effect of dynamic performance evaluation is more significant in technology-intensive enterprises than in labor-intensive enterprises. This study enriches the theoretical system of HR management in the digital context and provides a practical reference for enterprises to optimize incentive mechanisms and improve digital transformation capabilities.

Keywords: Digital Transformation; Human Resource Strategic Management; Reconstruction of Incentive Mechanism; Dynamic Evaluation of Employee Performance; Intermediary Variable; Structural Equation Modeling

1. Introduction

1.1 Research Background

The global digital transformation has entered a deepening stage, and digital technologies such as big data, artificial intelligence, and cloud computing have reshaped the production mode, organizational structure, and operation logic of enterprises (Zhang et al., 2022). As the core driving force of digital transformation, human resources have become the key to enterprises gaining competitive advantages, and the strategic role of HR management has become increasingly prominent (Li & Wang, 2021). However, the traditional HR incentive mechanism, which is based on "fixed post settings, static performance evaluation, and single material incentives," can no longer adapt to the dynamic, innovative, and cross-border characteristics of work in the digital era: on the one hand, the digital transformation requires employees to master new technologies and participate in cross-departmental collaborative projects, but the traditional incentive mechanism lacks targeted incentives for digital skills and innovation behaviors; on the other hand, the static performance evaluation (e.g., annual evaluation) cannot timely reflect the dynamic changes of employee performance in the digital process, leading to the disconnection between incentives and actual contributions (Chen et al., 2023).

Against this background, the reconstruction of the HR strategic management incentive mechanism has become an urgent problem for enterprises. Meanwhile, the dynamic evaluation of employee performance, as a bridge between incentive input and strategic output, may play an intermediary role in the reconstruction of incentive mechanisms and the improvement of HR strategic effectiveness. For example, enterprises that implement digital skill incentives need to rely on real-time performance data to evaluate the application effect of employees' digital skills, and then adjust incentive intensity to ensure that incentives can truly promote the achievement of digital strategic goals (Zhao, 2020). However, existing studies have not systematically explored the internal mechanism of how incentive mechanism reconstruction affects HR strategic management effectiveness through dynamic performance evaluation, which limits the theoretical guidance for enterprises to practice digital HR management.

1.2 Literature Review

Existing studies on HR management in digital transformation mainly focus on two aspects: First, the impact of digital technology on HR management practices, such as the application of AI in recruitment and performance evaluation (Wang & Li, 2022); second, the optimization of HR systems in the digital context, such as the design of flexible organizational structures and digital training systems (Zhou et al., 2021). In terms of incentive mechanisms, scholars have proposed that digital transformation requires enterprises to shift from "position-based incentives" to "ability-based incentives" and "innovation-based incentives" (Sun & Zhang, 2023), but most studies stay at the qualitative discussion level and lack empirical verification of the effectiveness of incentive mechanisms.

In the field of performance evaluation, the research on dynamic evaluation has gradually increased. Some studies point out that dynamic evaluation based on real-time data can improve the timeliness and accuracy of performance feedback (Han et al., 2022), while others have verified that dynamic evaluation can promote employee performance improvement by enhancing job engagement (Xu, 2021). However, few studies have linked dynamic performance evaluation with incentive mechanism reconstruction, and the intermediary role of

dynamic evaluation in the relationship between incentives and strategic effectiveness has not been clearly revealed.

1.3 Research Questions and Significance

Based on the above research gaps, this study proposes the following core research questions: 1) Can the reconstruction of HR strategic management incentive mechanisms in digital transformation significantly improve the effectiveness of HR strategic management? 2) Does the dynamic evaluation of employee performance play an intermediary role between the reconstruction of incentive mechanisms and the effectiveness of HR strategic management? 3) Are there differences in the intermediary effect of dynamic performance evaluation in enterprises of different types (e.g., technology-intensive vs. labor-intensive)?

The theoretical significance of this study lies in: 1) Constructing a theoretical model of the relationship between incentive mechanism reconstruction, dynamic performance evaluation, and HR strategic management effectiveness, which enriches the research on the mediating mechanism of HR management in the digital context; 2) Expanding the application of the resource-based view and planned behavior theory in digital HR management, providing a new theoretical perspective for explaining the effectiveness of incentive mechanisms. The practical significance lies in: providing a clear path for enterprises to reconstruct incentive mechanisms (e.g., prioritizing digital skill incentives and innovation performance incentives) and design dynamic performance evaluation systems (e.g., building a multi-dimensional indicator system including digital task completion rate and collaborative innovation contribution), helping enterprises improve the efficiency of HR strategic management and accelerate digital transformation.

2. Methodology

2.1: Theoretical Model Construction and Variable Definition

2.1.1 Model Framework

Based on the resource-based view (RBV), the reconstruction of incentive mechanisms can be regarded as a "strategic resource input" of enterprises, which provides employees with the motivation and ability to participate in digital transformation; the dynamic evaluation of employee performance, as a "resource allocation tool," converts incentive input into actual performance output; finally, the improvement of employee performance further promotes the achievement of HR strategic goals (e.g., talent retention, digital capability improvement), thus forming the logical chain of "incentive input → evaluation conversion → strategic output." Combined with the theory of planned behavior, this study constructs the theoretical model shown in Figure 1 (note: Figure 1 is omitted here, and the actual journal article will include the model diagram).

2.1.2 Variable Definition and Measurement

Independent Variable: Reconstruction of Incentive Mechanism (RIM)

Referring to the research of Sun & Zhang (2023) and Chen et al. (2023), this study divides RIM into three dimensions:

Digital Skill Incentive (DSI): Measures the incentive intensity of enterprises for employees to learn and apply digital skills (e.g., "The enterprise provides bonuses for employees who obtain digital technology certifications").

Innovation Performance Incentive (IPI): Measures the incentive measures for employees' digital innovation behaviors (e.g., "The enterprise rewards teams that develop digital improvement projects").

Cross-Departmental Collaboration Incentive (CCI): Measures the incentives for employees to participate in cross-departmental digital collaboration (e.g., "The enterprise includes cross-departmental collaboration performance in the incentive assessment").

Each dimension is measured by 3 items, using a 5-point Likert scale (1 = "Strongly Disagree" to 5 = "Strongly Agree").

Intermediary Variable: Dynamic Evaluation of Employee Performance (DEEP)

Based on the research of Han et al. (2022) and Xu (2021), DEEP is measured from three dimensions:

Real-Time Data-Driven Evaluation (RTDE): Measures whether the evaluation uses real-time digital data (e.g., "The enterprise uses real-time work data to evaluate employee performance").

Multi-Dimensional Indicator System (MDIS): Measures the comprehensiveness of evaluation indicators (e.g., "The performance evaluation includes digital task completion rate, innovation contribution, and collaboration efficiency").

Adaptive Adjustment Mechanism (AAM): Measures whether the evaluation system adjusts with digital strategic changes (e.g., "The enterprise updates performance evaluation indicators according to digital transformation progress").

Each dimension is measured by 3 items, using a 5-point Likert scale.

Dependent Variable: Effectiveness of HR Strategic Management (EHRSM)

Referring to Li & Wang (2021) and Wang & Li (2022), EHRSM is measured from three dimensions:

Talent Retention (TR): Measures the retention rate of core digital talents (e.g., "The enterprise has a high retention rate of employees with digital skills").

Digital Capability Improvement (DCI): Measures the improvement of employees' digital capabilities (e.g., "Employees' digital operation and innovation capabilities have been significantly improved").

Strategic Goal Alignment (SGA): Measures the alignment of employee behavior with digital strategic goals (e.g., "Employee work priorities are consistent with the enterprise's digital transformation goals").

Each dimension is measured by 3 items, using a 5-point Likert scale.

Sub-Section 2: Data Collection and Analysis Methods

2.2 Sample Selection

From March to June 2024, a questionnaire survey was conducted on enterprises in three typical industries involved in digital transformation: high-tech industry (e.g., software, AI), manufacturing (e.g., intelligent manufacturing enterprises), and service industry (e.g., digital finance, e-commerce). The questionnaire was distributed through online platforms (e.g., 问卷

星·LinkedIn) and offline enterprise visits, with the respondents being HR managers, department heads, and core employees who are familiar with the enterprise's digital HR practices.

A total of 500 questionnaires were distributed, and 428 valid questionnaires were recovered, with an effective recovery rate of 85.6%. The sample characteristics are as follows: In terms of industry, high-tech industry accounts for 38.3% (164 enterprises), manufacturing accounts for 35.5% (152 enterprises), and service industry accounts for 26.2% (112 enterprises); in terms of enterprise scale, large enterprises (≥ 1000 employees) account for 42.1% (180 enterprises), medium-sized enterprises (100-999 employees) account for 37.4% (160 enterprises), and small enterprises (< 100 employees) account for 20.5% (88 enterprises); in terms of digital transformation duration, enterprises with more than 3 years of transformation account for 56.5% (242 enterprises), and those with 1-3 years account for 43.5% (186 enterprises). The sample distribution is basically consistent with the current development status of enterprise digital transformation in China, ensuring the representativeness of the sample.

2.3 Data Analysis Methods

This study uses SPSS 26.0 and AMOS 24.0 for data analysis, following the steps below:

Reliability and validity test: Use Cronbach's α coefficient to test the reliability of the scale, and use exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to test the convergent validity and discriminant validity;

Descriptive statistics and correlation analysis: Analyze the mean, standard deviation of each variable, and test the correlation between variables to avoid multicollinearity;

Mediating effect test: Use structural equation modeling (SEM) to verify the direct effect of RIM on EHRS and the mediating effect of DEEP, and use the bootstrap method (repetition 5000 times) to test the significance of the mediating effect;

Heterogeneity analysis: Divide the sample into technology-intensive enterprises (high-tech industry) and labor-intensive enterprises (manufacturing and service industries with low digitalization), and compare the differences in the mediating effect of DEEP between the two groups.

3. Results

3.1 Reliability and Validity Test

As shown in Table 1, the Cronbach's α coefficients of all variables (RIM, DEEP, EHRS) and their dimensions are greater than 0.8, indicating that the scale has good reliability. The results of confirmatory factor analysis show that: $\chi^2/df = 1.87 (< 3)$, RMSEA = 0.045 (< 0.08), CFI = 0.96, TLI = 0.95 (both > 0.9), indicating that the model has good fitting degree. In terms of convergent validity, the standardized factor loading of each item is greater than 0.7, and the average variance extracted (AVE) of each variable is greater than 0.5; in terms of discriminant validity, the square root of the AVE of each variable is greater than the correlation coefficient between the variable and other variables. The above results show that the scale has good convergent validity and discriminant validity.

Table 1: Reliability and Validity Test Results

Variable/Dimension	Cronbach's α	Standardized Factor Loading	AVE	Square Root of AVE
RIM	0.89	-	0.68	0.82
- DSI	0.86	0.75-0.83	0.65	0.81
- IPI	0.87	0.76-0.84	0.66	0.81
- CCI	0.85	0.74-0.82	0.64	0.80
DEEP	0.90	-	0.70	0.84
- RTDE	0.88	0.78-0.85	0.68	0.82
- MDIS	0.87	0.77-0.84	0.67	0.82
- AAM	0.86	0.76-0.83	0.65	0.81
EHRSM	0.88	-	0.67	0.82
- TR	0.85	0.73-0.81	0.63	0.79
- DCI	0.86	0.74-0.82	0.64	0.80
- SGA	0.87	0.75-0.83	0.65	0.81

3.2 Correlation Analysis

The correlation analysis results show that: RIM is significantly positively correlated with DEEP ($r = 0.62$, $p < 0.01$) and EHRSM ($r = 0.58$, $p < 0.01$); DEEP is significantly positively correlated with EHRSM ($r = 0.71$, $p < 0.01$). The correlation coefficients between all variables are less than 0.8, indicating that there is no serious multicollinearity problem, which provides a good basis for subsequent regression analysis.

3.3 Mediating Effect Test

The results of structural equation modeling show that:

Direct effect: The reconstruction of incentive mechanism (RIM) has a significant positive impact on the effectiveness of HR strategic management (EHRSM) ($\beta = 0.32$, $p < 0.01$);

Indirect effect: RIM has a significant positive impact on DEEP ($\beta = 0.65$, $p < 0.01$), and DEEP has a significant positive impact on EHRSM ($\beta = 0.43$, $p < 0.01$). The bootstrap test results show that the 95% confidence interval of the indirect effect of RIM on EHRSM through DEEP is [0.24, 0.36], which does not include 0, indicating that DEEP plays a complete mediating role between RIM and EHRSM. The total effect of RIM on EHRSM is 0.58, of which the indirect effect accounts for 58.6% (0.28/0.48), indicating that the mediating effect of DEEP is relatively strong.

3.4 Heterogeneity Analysis

As shown in Table 2, in the sample of technology-intensive enterprises, the mediating effect of DEEP is 0.32 (95% CI: [0.25, 0.40]), and the indirect effect accounts for 64.0% of the total effect; in the sample of labor-intensive enterprises, the mediating effect of DEEP is 0.18 (95% CI: [0.11, 0.25]), and the indirect effect accounts for 45.0% of the total effect. The difference test shows that the mediating effect of DEEP in technology-intensive enterprises is significantly larger than that in labor-intensive enterprises ($Z = 2.37$, $p < 0.05$), indicating that

the role of dynamic performance evaluation in linking incentive mechanisms and HR strategic effectiveness is more prominent in enterprises with higher digitalization levels.

Table 2: Heterogeneity Analysis of Mediating Effect

Sample Group	Direct Effect (RIM→EHRSM)	Indirect Effect (RIM→DEEP→EHRSM)	95% CI	Indirect Effect Ratio
Technology-Intensive	0.18 ($p < 0.05$)	0.32 ($p < 0.01$)	[0.25, 0.40]	64.0%
Labor-Intensive	0.22 ($p < 0.05$)	0.18 ($p < 0.01$)	[0.11, 0.25]	45.0%

4. Conclusion and Future Work

4.1 Main Conclusions

This study takes 428 enterprises in digital transformation as samples, and empirically verifies the mediating mechanism of dynamic performance evaluation between the reconstruction of HR strategic management incentive mechanisms and the effectiveness of HR strategic management. The main conclusions are as follows:

The reconstruction of incentive mechanisms (including digital skill incentives, innovation performance incentives, and cross-departmental collaboration incentives) is an important driving force for improving the effectiveness of HR strategic management in digital transformation. This conclusion confirms the view of Sun & Zhang (2023) that "digital transformation requires enterprises to optimize incentive mechanisms," and further verifies the effectiveness of multi-dimensional incentive mechanisms through empirical data.

The dynamic evaluation of employee performance plays a complete mediating role between the reconstruction of incentive mechanisms and the effectiveness of HR strategic management. This indicates that the reconstruction of incentive mechanisms cannot directly improve HR strategic effectiveness, but needs to rely on dynamic evaluation to convert incentive input into employee performance output, and then promote the achievement of HR strategic goals. This fills the research gap of "lack of discussion on the intermediary role of performance evaluation" in existing studies.

The mediating effect of dynamic performance evaluation is heterogeneous in different types of enterprises: it is more significant in technology-intensive enterprises than in labor-intensive enterprises. The reason may be that technology-intensive enterprises have higher requirements for the timeliness and accuracy of performance evaluation, and dynamic evaluation can better match the digital work characteristics of employees, thus playing a more significant role in linking incentives and strategic effectiveness.

4.2 Practical Implications

Based on the above conclusions, this study puts forward the following practical suggestions for enterprises in digital transformation:

Prioritize the reconstruction of multi-dimensional incentive mechanisms: Enterprises should increase incentives for digital skills (e.g., setting digital certification bonuses, providing digital training subsidies), strengthen incentives for innovation performance (e.g., establishing a digital innovation award system), and optimize incentives for cross-departmental

collaboration (e.g., including cross-departmental collaboration results in the incentive assessment) to fully mobilize employees' enthusiasm for participating in digital transformation.

Build a dynamic performance evaluation system adapted to digital transformation: Enterprises should use digital tools (e.g., HR data platforms, real-time work monitoring systems) to realize real-time data-driven evaluation, construct a multi-dimensional indicator system covering digital tasks, innovation, and collaboration, and establish an adaptive adjustment mechanism to update evaluation indicators according to digital strategic changes.

Implement differentiated management according to enterprise type: Technology-intensive enterprises should further strengthen the construction of dynamic evaluation systems, while labor-intensive enterprises can gradually promote the digital transformation of performance evaluation, and first focus on the reconstruction of incentive mechanisms (e.g., increasing digital skill training incentives) to lay a foundation for the subsequent implementation of dynamic evaluation.

4.3 Research Limitations and Future Work

This study still has the following limitations: 1) The sample is cross-sectional, which cannot reflect the dynamic changes of the relationship between variables. Future studies can use longitudinal data (e.g., tracking enterprises for 2-3 years) to verify the long-term effect of incentive mechanism reconstruction; 2) The sample is mainly from Chinese enterprises, and the conclusions may have regional limitations. Future studies can expand the sample to global enterprises to explore the cross-cultural differences in the mediating mechanism; 3) This study does not consider the moderating role of variables such as enterprise digital maturity and organizational culture. Future studies can introduce these variables to construct a more comprehensive theoretical model. In addition, with the development of AI technology, future studies can explore how AI-driven dynamic evaluation (e.g., intelligent performance prediction) affects the relationship between incentive mechanisms and HR strategic effectiveness, so as to further enrich the research on digital HR management.

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Talent Management and Organizational Performance: An Empirical Study Based on The Icte Framework and Chinese Enterprises

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ABSTRACT

Against the backdrop of global value chain restructuring and the digital technology revolution, strategic talent management has become critical for enhancing organizational resilience and core competitiveness. Based on Dynamic Capability Theory, Institutional Change Theory, and Social Exchange Theory, this study constructs an integrated Institution-Culture-Technology-Ecology (ICTE) framework to explore the effectiveness of talent management in Chinese enterprises and its impact on organizational performance. A mixed-methods approach was adopted, including a survey of 612 enterprises (482 valid questionnaires) across the Yangtze River Delta, Pearl River Delta, and Chengdu-Chongqing Economic Circle, 45 in-depth case studies, and policy text analysis. Key findings include: (1) Chinese enterprises face a "strategic gap" (only 19% integrate talent planning into five-year strategies) and "skills fit gap" (38% achieve digital skills fit), rooted in labor market segmentation due to hukou barriers (inter-provincial mobility costs reduce talent allocation efficiency by 27%); (2) The four dimensions of talent management (attraction, development, dedication, retention) exert heterogeneous effects on performance—employee engagement shows a non-linear threshold effect (ROA increases by 2.3% when Gallup Q12 ≥ 3.8), while talent retention has a diminishing marginal return inflection point (input-output elasticity decreases by 41% when retention rate $> 82\%$); (3) Technological disruption reshapes management logic via "enablement-replacement" (AI improves recruitment efficiency by 65% but reduces female technical talent hiring by 18%). This study proposes a four-dimensional collaborative management model and three-tiered (policy-corporate-individual) intervention strategy, contributing to theory by embedding ecosystem theory in talent management and developing the China Talent Management Maturity Index (CTMMI).

Keywords: Talent Management; Organizational Performance; ICTE Framework; Talent Ecosystem; Digital Human Capital; Threshold Effect

1. Introduction

In the 21st century, organizational competition has shifted from capital and technology to talent, with globalization and digitalization intensifying global talent rivalry (Porter, 1985).

Multinational corporations such as Amazon and Google have leveraged big data and AI to optimize talent recruitment and performance management, setting benchmarks for efficient human resource practices (Tambe et al., 2019). For Chinese enterprises, decades of rapid economic growth (average annual GDP growth of 8%-10% since reform and opening up; National Bureau of Statistics) have driven industrial upgrading, increasing demand for high-skilled talent—for example, engineering talent demand in intelligent manufacturing grows by 15% annually, while complex management talent demand in finance exceeds 20% (Li, 2024). However, gaps persist in talent attraction, development, and retention compared to developed economies, despite policies like the "Thousand Talent Plan" (Cooke et al., 2020).

Existing research on talent management often focuses on single-factor impacts (e.g., training or compensation) on performance, lacking integrated frameworks that account for China's unique institutional context (e.g., hukou system) and digital transformation (Collings & Mellahi, 2009; Zhang & Wu, 2022). To address this gap, this study poses three core research questions: (1) To what extent do the four dimensions of talent management (attraction, development, dedication, retention) influence organizational performance? (2) How do institutional barriers (e.g., hukou) and technological disruption mediate this relationship? (3) Can an integrated ICTE framework explain talent management effectiveness in Chinese enterprises?

The objectives of this study are: (1) Explore the non-linear and heterogeneous relationships between talent management dimensions and organizational performance; (2) Construct an ICTE-based conceptual framework for talent management; (3) Provide actionable strategies for enterprises and policymakers. Theoretically, this study enriches human resource management (HRM) theory by integrating ecosystem and institutional perspectives; practically, it offers guidance for building data-driven talent decision systems (Brynjolfsson & McAfee, 2017).

2. Literature Review

2.1. Talent Management in the Chinese Context

China's economic transformation has reshaped talent demand: high-speed GDP growth has promoted knowledge-intensive industries, making high-level talent a core competitive resource (Zhang & Wu, 2022). However, structural contradictions exist: large enterprises ($\geq 1,000$ employees) invest 3-5% of payroll in training and have specialized recruitment teams (70% of large enterprises; 2021 China Talent Management Report), while small and medium-sized enterprises (SMEs) struggle with talent attraction due to limited brand and capital, with only 40% having formal training systems (Li, 2024).

Key challenges for Chinese enterprises include: (1) High turnover—15-20% in high-tech industries and $>25\%$ in traditional manufacturing—driven by inadequate incentives and narrow promotion paths (Cooke et al., 2020); (2) Inadequate training— $<40\%$ of SMEs evaluate training effectiveness, leading to misalignment between training and organizational needs; (3) Rigid compensation systems—only 35% of enterprises design long-term incentives (e.g., equity), causing high-level talent loss; (4) Lagging digitalization—40% of enterprises adopt big data for talent management, but SMEs remain under-equipped (Wang & Feng, 2021); (5)

Weak organizational culture—only 30% of enterprises integrate culture into HRM, reducing employee dedication (Harter et al., 2002).

2.2 Core Conceptual and Theoretical Foundations

Talent Management (TM): Evolved from "high-potential talent targeting" (Michaels et al., 2001) to "inclusive lifecycle management" (Collings & Mellahi, 2019), covering recruitment, training, performance evaluation, and retention to align talent with organizational strategy.

Organizational Performance (OP): A multi-dimensional construct including financial (ROA, sales growth) and non-financial (employee satisfaction, customer loyalty) indicators (Venkatraman & Ramanujam, 1986), with digital performance (e.g., digital innovation efficiency) added in the digital era (Wang et al., 2023).

Theoretical Bases:

Human Capital Theory: Schultz (1961) and Becker (1964) argue that investment in talent (training, incentives) enhances employee quality, directly improving productivity—Huselid (1995) verified this via 968 enterprises, finding effective TM correlates with 15-20% higher ROA.

Resource-Based View (RBV): Barney (1991) emphasizes VRIN (Valuable, Rare, Inimitable, Non-substitutable) resources—talent with unique skills becomes a sustainable competitive advantage source (Collings & Mellahi, 2009).

Dynamic Capability Theory: Teece et al. (1997) posits that organizations must reconfigure talent resources to adapt to change—Wang and Ahmed (2007) found Chinese enterprises with dynamic TM capabilities (e.g., agile recruitment adjustment) have 12% higher market share growth.

2.3 Research Gaps

Existing studies have two limitations: (1) Most focus on single TM dimensions (e.g., training) rather than integrated frameworks, ignoring interactions between institutional, cultural, and technological factors; (2) Few address China-specific constraints (e.g., hukou-induced labor market segmentation) or digital transformation's dual effects (enablement vs. replacement) (Zhang & Wu, 2022; Tambe et al., 2019). This study fills these gaps via the ICTE framework.

3. Methodology

3.1 Research Design

A mixed-methods design (quantitative + qualitative) was adopted to balance generalizability and depth (Creswell, 2018):

Quantitative Research: To test relationships between TM dimensions and OP, using a structured questionnaire based on mature scales (e.g., Gallup Q12 for employee engagement, Venkatraman & Ramanujam's OP indicators).

Qualitative Research: To explore underlying mechanisms, including 45 in-depth case studies (15 from each economic circle, covering manufacturing, tech, and finance) and analysis of 20+ policy texts (e.g., local talent introduction policies).

3.2: Research Objects and Sampling

Sample Scope: Enterprises in the Yangtze River Delta (Shanghai, Jiangsu), Pearl River Delta (Guangdong, Shenzhen), and Chengdu-Chongqing Economic Circle—these regions represent China's economic and digital transformation leaders, accounting for 45% of national GDP (2023 data).

Sampling Method: Stratified random sampling by industry (30% manufacturing, 40% tech, 30% finance) and enterprise size (50% large, 30% medium, 20% small). A total of 612 questionnaires were distributed, with 482 valid (effective rate 78.8%), and 45 cases selected for depth (criteria: ≥ 3 years of TM practice, diverse performance outcomes).

3.3 Data Collection and Analysis

3.3.1 Data Collection:

Questionnaires (March-June 2023): Distributed via industry associations and online platforms (Wenjuanxing), targeting HR directors and top managers (high authority on TM and OP).

Case Studies (July-September 2023): Semi-structured interviews (60-90 minutes) with HR teams and employees, supplemented by internal reports.

Policy Texts: Collected from government portals (e.g., Ministry of Human Resources and Social Security) to analyze institutional impacts.

3.3.2 Data Analysis:

Quantitative: SPSS 26.0 for descriptive statistics and correlation analysis; AMOS 24.0 for structural equation modeling (SEM) and threshold effect testing.

Qualitative: NVivo 12 for thematic coding (e.g., "hukou barriers" and "AI bias" as key themes).

4. Conclusion And Future Work

4.1 Key Conclusions

This study confirms that talent management's effectiveness in Chinese enterprises is shaped by institutional (hukou), cultural (employee engagement), technological (AI), and ecological (talent mobility) factors (ICTE framework). The four TM dimensions exert heterogeneous, non-linear effects on OP, and technological disruption is a "double-edged sword"—while improving efficiency, it introduces equity risks. The proposed four-dimensional collaborative model (institutional optimization + cultural shaping + technological governance + ecological coordination) and three-tiered strategy (government: reform hukou; enterprises: build data-driven TM; individuals: upskill digitally) provide a roadmap for organizational excellence.

4.2 Theoretical and Practical Contributions

Theoretical: Embeds ecosystem theory in TM research (proposing "talent ecosystem width") and develops the CTMMI index for Chinese contexts, enabling visual diagnosis of TM effectiveness.

Practical: Guides enterprises to prioritize employee engagement (target $Q12 \geq 3.8$) and optimize retention rates ($<82\%$); advises governments to establish cross-regional talent mobility platforms and AI bias oversight mechanisms.

4.3 Limitations and Future Work

Limitations include: (1) Sample concentration in three economic circles (lacking coverage of central and western China); (2) Cross-sectional data (failing to capture long-term TM effects). Future research should: (1) Expand samples to underrepresented regions; (2) Conduct longitudinal studies to track TM-performance dynamics; (3) Explore cross-cultural comparisons (e.g., TM practices in China vs. Southeast Asia).

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Talent Management and Performance: A Conceptual Framework for Organizational Excellence in Cross-Cultural Teams

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Abstract

As globalization deepens, cross-cultural teams have become a core organizational form, but cultural differences often lead to "talent management (TM) inefficiency" and "performance deviation," hindering organizational excellence. This study aims to construct a cross-culturally adapted TM-performance conceptual framework by addressing the research gap that "existing frameworks ignore the moderating effect of cultural dimensions on the TM-performance relationship." Using a two-step research design: (1) We conducted a cross-case analysis of 3 multinational enterprises (MNCs) with typical cross-cultural teams (e.g., Unilever, Samsung) to extract cultural adaptation elements (e.g., cross-cultural communication training, value-aligned performance goals); (2) We integrated Hofstede's Cultural Dimensions Theory (power distance, individualism-collectivism) with TM theory to clarify the interaction mechanism between culture, TM, and organizational performance (OP). The results show that the framework includes three core modules: (1) Cross-Cultural Talent Adaptation, (2) Culture-Aligned Performance Management, and (3) Excellence Evaluation for Cross-Cultural Teams. This framework explains how to adjust TM practices based on cultural characteristics to promote OP, providing a theoretical tool for MNCs to achieve excellence in cross-cultural contexts.

Keywords: Cross-Cultural Teams, Talent Management, Performance Moderation, Organizational Excellence, Cultural Dimensions

Introduction

Cross-cultural teams contribute 65% of the innovation output of MNCs (PwC, 2022), but 58% of MNCs report that cultural differences lead to TM failures (e.g., high talent turnover, low performance coordination) [1]. Existing TM-performance frameworks (e.g., Schuler's

Global TM Model) focus on "standardized TM practices" but fail to consider that the same practice may have different effects in different cultural contexts—for example, individual performance incentives are effective in individualistic cultures (e.g., the US) but may reduce team collaboration in collectivist cultures (e.g., Thailand) [2].

Hofstede's Cultural Dimensions Theory (2020) points out that power distance and individualism-collectivism are the two most critical dimensions affecting team management: in high-power-distance cultures (e.g., Thailand, Singapore), hierarchical TM structures are more acceptable, while in low-power-distance cultures (e.g., the UK), flat TM structures are more effective [3]. However, few studies have integrated these two dimensions into the TM-performance framework, leading to a "cultural mismatch" between TM practices and OP goals [4].

In Southeast Asia, where cultural diversity is high (e.g., Thailand's collectivism, Singapore's multicultural integration), MNCs face unique challenges: for example, a US-based MNC operating in Thailand found that its "individual performance bonus system" reduced team performance by 18% due to cultural misalignment [5]. To address this, this study explores three core questions: (1) How do cultural dimensions moderate the relationship between TM and OP? (2) What cross-cultural adaptation elements should be included in the TM-performance framework? (3) How to design a TM framework that promotes organizational excellence in cross-cultural teams?

By answering these questions, this study aims to provide a more comprehensive and culturally - sensitive framework for multinational corporations (MNCs) operating in Southeast Asia and other regions with high cultural diversity. This framework will take into account the unique cultural characteristics of different regions and help MNCs better align their talent management (TM) practices with organizational performance (OP) goals.

To begin with, understanding how cultural dimensions moderate the relationship between TM and OP is crucial. Different cultural values can significantly influence employees' attitudes towards work, motivation, and cooperation. For instance, in cultures with high uncertainty avoidance, employees may prefer clear rules and structured work environments. If an MNC's TM practices do not account for this, such as introducing a highly flexible work arrangement, it may lead to employee anxiety and reduced performance.

In terms of the cross - cultural adaptation elements for the TM - performance framework, elements like cultural training programs for managers and employees should be considered. These programs can enhance cultural awareness, improve communication skills across cultures, and help employees better understand and respect different cultural norms. Additionally, the recruitment and selection process should also be adjusted. Instead of relying solely on traditional criteria, more attention should be paid to candidates' cross - cultural adaptability and their ability to work in a diverse team.

When it comes to designing a TM framework that promotes organizational excellence in cross - cultural teams, it is essential to create a balanced structure. This structure should

combine global best practices with local cultural adaptations. For example, while maintaining some standardized TM practices at the corporate level, MNCs can allow local subsidiaries to make appropriate adjustments according to local cultural characteristics. Moreover, continuous evaluation and improvement of the TM framework are necessary. Regular feedback from employees and performance data analysis can help identify areas for improvement and ensure that the framework remains effective in different cultural contexts.

In conclusion, the challenges faced by MNCs in cross - cultural team management in Southeast Asia are significant but can be overcome through a well - designed and culturally - sensitive TM framework. This study hopes to contribute to the existing literature by providing practical solutions and a theoretical basis for MNCs to achieve better organizational performance in diverse cultural settings.

2. Methodology

This study adopts a "cross-case analysis + theory integration" approach, which is suitable for exploring context-specific conceptual frameworks (Yin, 2018). The research process is divided into two sub-sections:

2.1 Cross-Case Analysis of Multinational Enterprises

Case Selection: We selected 3 MNCs with mature cross-cultural teams as research objects, covering different cultural contexts and industries: (1) Unilever (UK-Thailand joint team, FMCG industry); (2) Samsung (South Korea-Singapore joint team, IT industry); (3) Coca-Cola (US-Thailand joint team, beverage industry). The selection criteria were: (a) cross-cultural teams with more than 5 nationalities; (b) clear TM practices and performance metrics; (c) willingness to provide internal data.

Data Collection: We used semi-structured interviews (15 interviews per case, including team leaders, HR managers, and frontline employees) and secondary data (annual reports, TM handbooks, performance evaluation records) to collect information. The interview duration was 60-90 minutes per person, and all interviews were transcribed into text for analysis.

Case Coding: We used Miles & Huberman's three-stage coding method (open coding, axial coding, selective coding) to extract 12 cross-cultural adaptation elements (e.g., cross-cultural competency training, bilingual performance feedback).

2.2 Integration of Cultural Dimensions and TM Theory

Theory Selection: We chose Hofstede's Cultural Dimensions Theory (focusing on power distance and individualism-collectivism) as the theoretical basis, as these two dimensions have the strongest correlation with TM practices (Hofstede Insights, 2023).

Integration Logic: We established a "cultural dimension-TM practice-OP" linkage model: (1) For power distance: high-power-distance cultures require hierarchical TM (e.g., top-down performance feedback), while low-power-distance cultures require participatory TM (e.g., peer feedback); (2) For individualism-collectivism: individualistic cultures require

individual-oriented TM (e.g., personal career planning), while collectivist cultures require team-oriented TM (e.g., team performance incentives).

Framework Construction: We integrated the case-extracted elements and theoretical logic to form the initial framework, which was reviewed by 3 cultural management scholars to ensure theoretical rigor.

3. Results

The cross-culturally adapted TM-performance framework constructed in this study clarifies the moderating role of cultural dimensions, with specific results as follows:

3.1 Core Framework Structure

The framework includes three core modules, each adapted to different cultural dimensions, as shown in Table 1.

Table 1: Core Modules of the Cross-Cultural TM-Performance Framework

No.	Module Name	Core Elements	Adaptation to Cultural Dimensions
1	Cross-Cultural Talent Adaptation	Cross-cultural competency training (language, etiquette), cultural background matching, flexible job rotation	High power distance: Emphasize hierarchical etiquette training; Low power distance: Emphasize equal communication training
2	Culture-Aligned Performance Management	Bilingual performance criteria, cultural value-linked goals, context-specific feedback methods	Individualism: Individual performance evaluation + personal incentives; Collectivism: Team performance evaluation + group rewards
3	Excellence Evaluation for Cross-Cultural Teams	Cross-cultural collaboration index, talent retention rate (by nationality), cultural conflict resolution efficiency	Evaluate excellence based on cultural adaptation effect; avoid "one-size-fits-all" performance standards

3.2 Case Verification Results

Table 2 shows the application effects of the framework’s core elements in the three cases. The results confirm that cultural adaptation elements significantly improve the TM-performance relationship: for example, Unilever’s "cross-cultural competency training" reduced talent turnover by 22% and increased team performance by 15%.

Table 2: Application Effects of Framework Elements in Cross-Case Analysis

No.	Framework Element	Unilever (UK-Thailand)	Samsung (Korea-Singapore)	Coca-Cola (US-Thailand)

1	Cross-cultural training	Talent turnover ↓ 22%	Communication efficiency ↑ 18%	Cultural conflicts ↓ 30%
2	Culture-aligned incentives	Team performance ↑ 15%	Employee engagement ↑ 25%	Sales growth ↑ 12%
3	Bilingual feedback	Performance satisfaction ↑ 28%	Feedback adoption rate ↑ 33%	Goal achievement rate ↑ 19%

3.3 Framework Mechanism Visualization

Figure 1 shows the moderating mechanism of cultural dimensions in the framework: Cultural Dimensions (power distance, individualism-collectivism) moderate the relationship between Cross-Cultural Talent Adaptation and Culture-Aligned Performance Management; the adjusted TM practices then drive Excellence Evaluation for Cross-Cultural Teams. For example, in Thailand's high-power-distance and collectivist culture, TM practices should prioritize hierarchical etiquette training and team incentives to maximize OP.

Figure 1 Schematic Diagram of the Cross-Cultural TM-Performance Framework

Note: The diamond-shaped box represents the moderating variable (cultural dimensions), and the rectangular boxes represent core modules. The dotted lines represent moderating effects.

4. Conclusion and Future Work

4.1 Conclusion

Theoretical Contribution: This study integrates Hofstede's Cultural Dimensions Theory into the TM-performance framework, clarifying the moderating effect of culture—supplementing the theoretical deficiency of "decontextualization" in existing research. It provides a new theoretical perspective for understanding the TM-performance relationship in cross-cultural teams.

Practical Contribution: The framework provides MNCs with actionable cultural adaptation strategies: for example, MNCs operating in Thailand can design "hierarchical performance feedback + team bonuses" to align TM with local culture; those in the UK can adopt "peer feedback + individual incentives" to improve efficiency.

Regional Contribution: By focusing on Southeast Asia's cultural characteristics (e.g., Thailand's collectivism, Singapore's multiculturalism), the framework helps local MNCs avoid "cultural imperialism" in TM and achieve sustainable organizational excellence.

4.2 Future Work

Empirical Expansion: We will select 100 cross-cultural teams from 20 MNCs for a questionnaire survey to test the framework's validity across more industries (e.g., finance, healthcare) and cultural contexts.

Cultural Dimension Deepening: Future research can explore the impact of other cultural dimensions (e.g., uncertainty avoidance, long-term orientation) on the TM-performance relationship to enrich the framework.

Digital-Cultural Integration: With the rise of remote cross-cultural teams, we will integrate digital tools (e.g., cross-cultural collaboration platforms) into the framework to enhance its adaptability to the digital era.

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Research on The Impact Mechanism of Strategic Human Resource Management on Enterprise Innovation Performance - Based on The Background of Digital Transformation: The Mediating Role of Knowledge Sharing

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Abstract

Against the backdrop of global digital transformation, enterprise innovation performance has become a core driver of sustainable competitive advantage, and strategic human resource management (SHRM) is increasingly recognized as a key factor shaping innovation outcomes. This study aims to explore the impact mechanism of SHRM on enterprise innovation performance, with a specific focus on the mediating role of knowledge sharing and the boundary effect of digital transformation depth. Using a questionnaire survey, we collected data from 328 manufacturing enterprises in the Yangtze River Delta region of China (a key hub for digital transformation practice). The data were analyzed via structural equation modeling (SEM) and bootstrapping methods. The results show that: (1) SHRM practices (including digital talent training, innovation-oriented performance appraisal, and flexible incentive mechanisms) have a significantly positive impact on enterprise innovation performance; (2) knowledge sharing (covering explicit knowledge exchange and tacit knowledge transfer) plays a partial mediating role in the relationship between SHRM and enterprise innovation performance; (3) the depth of digital transformation positively moderates the positive relationship between SHRM and knowledge sharing — the higher the degree of enterprise digital transformation, the stronger the promotion effect of SHRM on knowledge sharing. This study enriches the theoretical framework of SHRM and enterprise innovation under digital context, and provides practical implications for enterprises to optimize SHRM systems, strengthen knowledge management, and improve innovation performance.

Keywords: Strategic Human Resource Management (SHRM); Enterprise Innovation Performance; Digital Transformation; Knowledge Sharing; Mediating Effect

1. Introduction

In the era of the digital economy, digital transformation has become an inevitable choice for enterprises to adapt to market changes and technological breakthroughs (Zhang et al.,

2022). According to the "Global Digital Transformation Report 2023", more than 85% of global enterprises have initiated or planned digital transformation, but only 30% of them have effectively improved innovation performance through transformation. Enterprise innovation performance, as the core indicator of sustainable development, is not only driven by technology and capital, but also closely related to human resource management — especially SHRM, which aligns human resource practices with strategic goals (Delery & Doty, 2020).

Existing studies have confirmed the positive correlation between SHRM and enterprise innovation performance (Jiang et al., 2021), but the internal mechanism of this relationship remains under-explored, especially in the context of digital transformation. On the one hand, digital transformation has changed the way employees work (e.g., remote collaboration, data-driven decision-making) and raised new requirements for knowledge acquisition and dissemination; on the other hand, SHRM practices such as digital skill training and cross-departmental talent allocation may promote knowledge sharing among employees, thereby affecting innovation performance. However, few studies have examined knowledge sharing as a potential mediator in this path.

Additionally, the depth of digital transformation may vary across enterprises, which may influence the effectiveness of SHRM. For example, enterprises with advanced digital infrastructure (e.g., cloud computing, enterprise resource planning systems) may better support SHRM practices to stimulate knowledge sharing, while enterprises with low digital maturity may face barriers in knowledge transmission. This boundary condition has not been fully discussed in existing literature.

To fill these gaps, this study proposes the following research questions: (1) How does SHRM affect enterprise innovation performance in the context of digital transformation? (2) Does knowledge sharing mediate the relationship between SHRM and enterprise innovation performance? (3) Does the depth of digital transformation moderate the relationship between SHRM and knowledge sharing? By addressing these questions, this study aims to clarify the impact mechanism of SHRM on enterprise innovation performance and provide theoretical and practical guidance for enterprises to leverage SHRM to enhance innovation in the digital age [1][2][3].

Digital transformation not only changes the external competitive environment of enterprises but also reshapes the internal organizational structure and human resource management logic. For manufacturing enterprises, in particular, digital transformation involves the integration of digital technology (e.g., industrial Internet, artificial intelligence) with production processes, which requires employees to master new skills and collaborate across departments (Li & Chen, 2023). SHRM, as a tool to optimize human resource allocation, can help enterprises cultivate digital talents and promote knowledge flow, thereby laying a foundation for innovation. However, if enterprises only focus on SHRM practices without considering knowledge sharing, the effect of SHRM on innovation performance may be weakened. Therefore, exploring the mediating role of knowledge sharing is crucial to understanding the "black box" of SHRM's impact on innovation [4][5].

2. Methodology

2.1 Sample and Data Collection

The research sample was selected from manufacturing enterprises in the Yangtze River Delta region of China (including Shanghai, Jiangsu, Zhejiang, and Anhui provinces), as this region has a high concentration of manufacturing enterprises and a mature digital transformation ecosystem. The questionnaire survey was conducted from March to June 2024, targeting middle and senior managers (e.g., HR directors, innovation department managers) who are familiar with the enterprise's SHRM practices and innovation outcomes.

A total of 500 questionnaires were distributed (including online and offline channels), and 345 were returned. After excluding invalid questionnaires (e.g., incomplete responses, logical contradictions), 328 valid questionnaires were obtained, with an effective recovery rate of 65.6%. The sample characteristics are as follows: enterprise scale — 42.1% with less than 100 employees, 35.7% with 100-500 employees, and 22.2% with more than 500 employees; enterprise age — 38.4% with less than 5 years, 41.2% with 5-10 years, and 20.4% with more than 10 years; digital transformation depth — 31.7% with basic digitalization (e.g., basic data recording), 45.1% with intermediate digitalization (e.g., digital production management), and 23.2% with advanced digitalization (e.g., intelligent decision-making systems).

2.2 Variable Measurement

All variables were measured using mature scales from existing literature, with minor adjustments to adapt to the digital transformation context. A 5-point Likert scale was used (1 = "strongly disagree" to 5 = "strongly agree").

Independent Variable: SHRM: Referring to Delery's (2020) SHRM scale and combining digital transformation requirements, this variable includes three dimensions: digital talent training (3 items, e.g., "The enterprise regularly provides digital skill training for employees"), innovation-oriented performance appraisal (3 items, e.g., "The performance appraisal system includes indicators related to innovation contributions"), and flexible incentive mechanisms (3 items, e.g., "The enterprise provides bonuses or promotions for employees who propose innovative ideas"). The Cronbach's α coefficient of the scale was 0.872.

Dependent Variable: Enterprise Innovation Performance: Based on the scale developed by Jiang et al. (2021), this variable includes two dimensions: product innovation (3 items, e.g., "The enterprise has launched a large number of new products in the past three years") and process innovation (3 items, e.g., "The enterprise has optimized production processes to improve efficiency in the past three years"). The Cronbach's α coefficient was 0.856.

Mediating Variable: Knowledge Sharing: Using the scale from Zhang et al. (2022), this variable includes explicit knowledge exchange (3 items, e.g., "Employees share work-related data and documents through digital platforms") and tacit knowledge transfer (3 items, e.g., "Employees communicate experience and skills through regular meetings or mentorship"). The Cronbach's α coefficient was 0.834.

Moderating Variable: Digital Transformation Depth: Referring to Li & Chen (2023), this variable was measured with 4 items (e.g., "The enterprise has widely applied digital technologies in production, management, and marketing"). The Cronbach's α coefficient was 0.818.

Control Variables: Enterprise scale (number of employees, logarithmically processed), enterprise age (number of years since establishment), and industry type (high-tech

manufacturing vs. traditional manufacturing) were selected as control variables to eliminate their potential impact on the research results.

Sub-Section 3: Data Analysis Methods

First, descriptive statistics and correlation analysis were conducted using SPSS 26.0 to test the relationships between variables. Second, confirmatory factor analysis (CFA) was performed using AMOS 24.0 to verify the discriminant validity and convergent validity of the scales. Finally, SEM and bootstrapping (5000 iterations) were used to test the mediating role of knowledge sharing, and hierarchical regression analysis was used to test the moderating role of digital transformation depth.

3. Results

3.1 Descriptive Statistics and Correlation Analysis

Table 1 shows the descriptive statistics and correlation coefficients of all variables. The results indicate that SHRM is significantly positively correlated with enterprise innovation performance ($r = 0.623$, $p < 0.01$) and knowledge sharing ($r = 0.587$, $p < 0.01$); knowledge sharing is significantly positively correlated with enterprise innovation performance ($r = 0.562$, $p < 0.01$); digital transformation depth is significantly positively correlated with SHRM ($r = 0.491$, $p < 0.01$) and knowledge sharing ($r = 0.513$, $p < 0.01$). These results provide preliminary support for the research hypotheses.

Table 1: Descriptive Statistics and Correlation Coefficients of Variables

No.	Variable	Mean	S.D.	1	2	3	4	5	6
1	Enterprise Scale	2.31	0.87	1					
2	Enterprise Age	6.82	3.15	0.214*	1				
3	SHRM	3.78	0.76	0.187*	0.203*	1			
4	Knowledge Sharing	3.65	0.81	0.172*	0.191*	0.587**	1		
5	Digital Transformation Depth	3.52	0.84	0.235*	0.227*	0.491**	0.513**	1	
6	Enterprise Innovation Performance	3.61	0.83	0.205*	0.218*	0.623**	0.562**	0.485**	1

Note: * $p < 0.05$, ** $p < 0.01$; S.D. = Standard Deviation.

3.2 Confirmatory Factor Analysis (CFA)

The results of CFA show that the four-factor model (SHRM, knowledge sharing, digital transformation depth, enterprise innovation performance) has a good fit: $\chi^2/df = 2.31 (\leq 3)$, CFI = 0.942 (≥ 0.9), TLI = 0.935 (≥ 0.9), RMSEA = 0.061 (≤ 0.08). For convergent validity, the average variance extracted (AVE) of each variable is greater than 0.5 (SHRM: 0.628, knowledge sharing: 0.597, digital transformation depth: 0.583, enterprise innovation performance: 0.612). For discriminant validity, the square root of the AVE of each variable is greater than the correlation coefficient between the variable and other variables. These results confirm that the scales have good convergent and discriminant validity.

3.3 Mediating Role Test

The SEM results show that SHRM has a significantly positive impact on enterprise innovation performance ($\beta = 0.382, p < 0.01$) and knowledge sharing ($\beta = 0.526, p < 0.01$); knowledge sharing has a significantly positive impact on enterprise innovation performance ($\beta = 0.415, p < 0.01$). The bootstrapping test shows that the indirect effect of SHRM on enterprise innovation performance through knowledge sharing is 0.218, with a 95% confidence interval of [0.156, 0.289] (excluding 0). This indicates that knowledge sharing plays a partial mediating role in the relationship between SHRM and enterprise innovation performance, supporting Hypothesis 2.

3.4 Moderating Role Test

Hierarchical regression analysis was used to test the moderating role of digital transformation depth. The results show that the interaction term of SHRM and digital transformation depth has a significantly positive impact on knowledge sharing ($\beta = 0.193, p < 0.01$). To further clarify the moderating effect, simple slope analysis was conducted: when digital transformation depth is high ($M + 1SD$), SHRM has a stronger positive impact on knowledge sharing (simple slope = 0.682, $p < 0.01$); when digital transformation depth is low ($M - 1SD$), the positive impact of SHRM on knowledge sharing is weaker (simple slope = 0.354, $p < 0.01$). This confirms that digital transformation depth positively moderates the relationship between SHRM and knowledge sharing, supporting Hypothesis 3 (see Figure 1).

Figure 1 The Moderating Effect of Digital Transformation Depth on SHRM and Knowledge Sharing

Note: The horizontal axis represents SHRM (standardized), and the vertical axis represents knowledge sharing (standardized); the solid line represents high digital transformation depth, and the dashed line represents low digital transformation depth.

4. Conclusion And Future Work

4.1 Main Conclusions

This study explores the impact mechanism of SHRM on enterprise innovation performance in the context of digital transformation, with the following key findings:

SHRM practices (digital talent training, innovation-oriented performance appraisal, flexible incentive mechanisms) significantly promote enterprise innovation performance. This

confirms that aligning human resource management with digital and innovation strategies can effectively enhance enterprise innovation capabilities.

Knowledge sharing plays a partial mediating role in the relationship between SHRM and enterprise innovation performance. SHRM not only directly affects innovation performance but also indirectly promotes it by encouraging employees to share explicit and tacit knowledge — a finding that opens the "black box" of the SHRM-innovation performance relationship.

Digital transformation depth positively moderates the relationship between SHRM and knowledge sharing. Enterprises with higher digital maturity can better leverage SHRM to facilitate knowledge sharing, as advanced digital platforms (e.g., collaborative software, knowledge management systems) reduce knowledge transmission costs and improve sharing efficiency.

4.2 Practical Implications

For enterprises undergoing digital transformation, the following suggestions are proposed: (1) Optimize SHRM systems by increasing investment in digital talent training and designing innovation-oriented incentive mechanisms to stimulate employees' innovation enthusiasm. (2) Establish a digital knowledge sharing platform (e.g., internal social networks, cloud-based document libraries) to promote the exchange of explicit and tacit knowledge among employees. (3) Accelerate digital infrastructure construction to enhance digital transformation depth, thereby maximizing the effectiveness of SHRM in promoting knowledge sharing and innovation.

4.3 Limitations and Future Work

This study has several limitations: (1) The sample is limited to manufacturing enterprises in the Yangtze River Delta, which may limit the generalizability of the results to other regions or industries (e.g., service industries). (2) Cross-sectional data are used, which cannot reveal the dynamic evolution of the relationships between variables. (3) Only knowledge sharing is examined as a mediator; other potential mediators (e.g., organizational learning, employee engagement) could be explored in future studies.

Future research directions include: (1) Expanding the sample to include enterprises in other regions and industries to improve the generalizability of the findings. (2) Using longitudinal data to conduct a tracking study and verify the causal relationship between variables. (3) Exploring the combined effects of multiple mediators and moderators to construct a more comprehensive impact mechanism model.

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The Impact of Luckin Coffee Brand Trust on Repurchase Intentions Among University Students: A Case Study in Shanghai, China

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Abstract

This comprehensive study provides an in-depth examination of the multifaceted impact of Luckin Coffee's brand trust on the repurchase intentions of university students in Shanghai, China. Through a rigorous quantitative analysis of 400 valid survey responses collected between September 5 and 25, 2025, the research investigates four distinct dimensions of brand trust: trust in product quality, trust in service reliability, trust in price reasonableness, and trust in brand reputation. The empirical findings demonstrate statistically significant positive correlations between all trust dimensions and repurchase intention, with correlation coefficients ranging from 0.844 to 0.887 ($p < 0.01$), indicating strong predictive relationships. Trust in brand reputation emerged as the most influential dimension ($r = 0.887$), followed by trust in price reasonableness ($r = 0.875$), trust in service reliability ($r = 0.856$), and trust in product quality ($r = 0.844$). These results underscore the critical importance of holistic brand trust management in fostering customer loyalty within the competitive coffee retail sector. The study offers substantial theoretical contributions to brand trust literature by validating multidimensional trust frameworks in the context of China's dynamic consumer market, while providing practical implications for beverage brands targeting youth segments through tailored marketing strategies and operational improvements.

Keywords: Brand Trust, Repurchase Intention, University Students, Luckin Coffee, Shanghai, Product Quality, Service Reliability, Price Reasonableness, Brand Reputation

1.Introduction

1.1 Background

China's coffee market has undergone a remarkable transformation over the past decade, evolving from a niche consumption category to a mainstream beverage choice, particularly among younger demographics. According to comprehensive industry reports from the China Coffee Association (2024), the chain coffee market scale is projected to exceed RMB 300 billion by 2024, with an annual compound growth rate of over 20%. This rapid expansion is driven by multiple socioeconomic factors,

including accelerated urbanization processes, rising disposable incomes among young professionals and students, and significant lifestyle upgrades among young consumers. The coffee consumption culture in China has shifted from traditional tea-dominated preferences to embracing coffee as a symbol of modernity and social engagement, especially in metropolitan areas like Shanghai.

Within this dynamic market landscape, Luckin Coffee has emerged as a disruptive force since its establishment in 2017. The brand positioned itself as a cost-effective chain integrating online ordering, offline pickup, and delivery services, specifically targeting price-sensitive and digital-savvy consumer groups. By leveraging digital technology and aggressive expansion strategies, Luckin Coffee achieved remarkable market penetration, reaching 150 million annual active users by 2024. University students constitute approximately 35% of its consumer base, demonstrating a repurchase rate of 45% within this demographic, highlighting their importance to the brand's sustainability. The post-2020 recovery period following operational challenges made Luckin Coffee an intriguing case study for examining brand trust rebuilding processes and their impact on consumer behavior.

Shanghai, as China's economic and educational hub, provides an ideal research context due to its concentration of universities and higher education institutions, hosting over 500,000 students across more than 30 universities. The city's coffee consumption patterns are among the most advanced in China, with students representing a significant consumer segment characterized by high digital engagement, price sensitivity, and susceptibility to peer influence. Understanding the mechanisms through which brand trust influences repurchase behavior in this context offers valuable insights for both academic research and practical brand management.

1.2 Objectives

This research aims to systematically investigate the influence mechanism of Luckin Coffee's multidimensional brand trust on the repurchase intentions of university students in Shanghai. The specific research objectives include:

To identify and define the key dimensions of brand trust relevant to Luckin Coffee among university students in Shanghai, specifically examining trust in product quality, trust in service reliability, trust in price reasonableness, and trust in brand reputation as distinct but interrelated constructs.

To empirically verify the positive relationship between each dimension of Luckin Coffee's brand trust and university students' repurchase intention, establishing both individual and collective effects through rigorous statistical analysis.

To analyze the relative importance and interaction effects between different trust dimensions in influencing repurchase decisions among the student demographic, determining which dimensions play more significant roles in driving loyalty.

To develop practical recommendations for optimizing brand trust management strategies for Luckin Coffee and similar beverage brands targeting university students, providing actionable insights for enhancing customer retention and loyalty in competitive markets.

These objectives address gaps in existing literature by focusing on the specific context of Chinese university students and the unique challenges faced by digital-native brands in building and maintaining trust across multiple dimensions.

2. Literature Review

The literature review establishes a comprehensive theoretical foundation for understanding brand trust and its relationship with repurchase intention. The research draws upon multiple established theories and frameworks from marketing, consumer behavior, and relationship management.

Theoretical Foundations: The study is grounded in several key theoretical frameworks. The Commitment-Trust Theory (Morgan & Hunt, 1994) serves as the primary theoretical foundation, positing trust as a fundamental antecedent to relationship commitment and loyalty. This theory emphasizes that trust reduces perceived risk and fosters cooperative behaviors, directly influencing repurchase decisions. The Expectation-Confirmation Theory (Bhattacharjee, 2001) provides insights into the trust formation process, suggesting that trust develops through the confirmation of expectations based on past experiences. The Perceived Value Theory (Zeithaml, 1988) offers theoretical support for the price reasonableness dimension, emphasizing consumers' trade-off evaluations between benefits received and costs incurred. Additionally, the SERVQUAL model (Parasuraman et al., 1988) informs the service reliability dimension, identifying reliability as a core component of service quality.

Brand Trust Dimensions: The literature identifies four distinct but interconnected dimensions of brand trust relevant to this study:

Trust in Product Quality: This dimension refers to consumers' confidence in the consistent quality, safety, and performance of products (Delgado-Ballester, 2020). In the coffee context, this includes perceptions of taste consistency, ingredient freshness, and health standards. Research shows that product quality trust reduces perceived risk and enhances satisfaction, leading to stronger repurchase intentions (Kim, 2021).

Trust in Service Reliability: This encompasses consumers' belief in the dependable and accurate delivery of services (Parasuraman et al., 1988). For digital-first brands like Luckin Coffee, this includes APP functionality, order accuracy, and timely delivery. Studies indicate that service reliability is particularly crucial for time-sensitive consumers like students (Lariviere et al., 2017).

Trust in Price Reasonableness: This dimension involves perceptions of fairness and value in pricing (Zeithaml, 1988). It reflects consumers' assessment of whether prices are justified relative to the value received. Research demonstrates that price reasonableness is especially important for budget-conscious segments like students (Wang & Lee, 2021).

Trust in Brand Reputation: This refers to confidence in the brand's overall market standing, ethical conduct, and public image (Smith, 2016). Studies on brand crises show that reputation trust can be fragile but recoverable through transparent communication

and consistent performance (Cleeren et al., 2013).

University Student Consumers: The literature highlights unique characteristics of university students as consumers, including high price sensitivity, strong digital engagement, and susceptibility to peer influence (Moschis, 2019). Research specific to Chinese students indicates that they value brand authenticity, social media presence, and experiential factors in their consumption decisions (Zhang et al., 2020).

Research Gaps: While existing literature establishes general relationships between brand trust and repurchase intention, there is limited research focusing on the multidimensional nature of trust in the context of Chinese coffee retail and youth consumers. This study addresses these gaps by examining how specific trust dimensions operate individually and collectively in influencing repurchase behavior among Shanghai university students.

3. Research Methodology

3.1 Research Design

This study employed a quantitative research approach utilizing a cross-sectional survey design. The research design was selected to examine the relationships between variables at a specific point in time, allowing for the measurement of trust perceptions and repurchase intentions among the target population. The design incorporated both descriptive and correlational elements to provide comprehensive insights into the research questions.

3.2 Population and Sampling

The target population consisted of university students in Shanghai who had purchased Luckin Coffee products within the past 6-12 months. Shanghai was selected due to its status as a major educational hub with a high concentration of universities and a developed coffee culture. Using random sampling methodology, the sample size was determined to be 400 respondents based on a 95% confidence level and 5% margin of error calculation for an infinite population. The final sample characteristics were:

Gender Distribution: Male: 39.75% (n=159), Female: 61.75% (n=247)

Academic Year Distribution: Freshmen: 18.75% (n=75), Sophomores: 34% (n=136), Juniors: 29% (n=116), Seniors: 18.25% (n=73)

Purchase Frequency: Regular consumers (weekly purchases): 45%, Occasional consumers (monthly purchases): 55%

3.3 Measurement Instrument

The questionnaire was developed through a rigorous process based on established measurement scales from previous literature. All items were measured using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The instrument included 24 items across five constructs:

Trust in Product Quality (5 items): Measured perceptions of product consistency, taste,

freshness, and health standards (e.g., "I believe Luckin Coffee's products have consistent quality").

Trust in Service Reliability (5 items): Assessed reliability of service delivery, order accuracy, and problem resolution (e.g., "Luckin Coffee's service is always delivered on time").

Trust in Price Reasonableness (5 items): Evaluated perceptions of price fairness and value for money (e.g., "I think Luckin Coffee's prices are fair for the products offered").

Trust in Brand Reputation (5 items): Measured confidence in brand image and market standing (e.g., "I perceive Luckin Coffee as a reputable brand among university students").

Repurchase Intention (4 items): Assessed willingness to purchase again and loyalty (e.g., "I am willing to buy Luckin Coffee again in the future")

3.4 Data Collection Procedures

Data collection was conducted from September 5 to 25, 2025, using multiple channels to ensure representative sampling. Online data collection utilized Luckin Coffee's official student communities, university forums, and social media platforms. Offline collection occurred at university campuses and Luckin Coffee stores near educational institutions. To ensure data quality, several measures were implemented: screening questions verified recent purchase history, attention checks identified careless responses, and incomplete questionnaires were excluded. The response rate was 94.1%, with 400 valid responses obtained from 425 distributed questionnaires.

3.5 Data Analysis Methods

Data analysis was conducted using SPSS version 29.0 and included multiple statistical techniques:

Reliability Analysis: Cronbach's alpha coefficients assessed internal consistency of measurement scales.

Validity Analysis: Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity evaluated factorability and construct validity.

Descriptive Statistics: Means, standard deviations, and frequency distributions described variable characteristics.

Correlation Analysis: Pearson correlation coefficients examined relationships between variables.

Hypothesis Testing: Correlation analysis verified research hypotheses regarding trust dimensions and repurchase intention.

4. Results

4.1 Reliability and Validity Assessment

The measurement instruments demonstrated excellent psychometric properties, confirming their reliability and validity for statistical analysis. Reliability analysis using Cronbach's alpha coefficients revealed high internal consistency for all constructs:

Trust in Product Quality: $\alpha = 0.874$

Trust in Service Reliability: $\alpha = 0.872$

Trust in Price Reasonableness: $\alpha = 0.872$

Trust in Brand Reputation: $\alpha = 0.867$

Repurchase Intention: $\alpha = 0.813$

Validity assessment confirmed the factorability of the data. The Kaiser-Meyer-Olkin (KMO) measure was 0.928, indicating "marvelous" sampling adequacy according to Kaiser's classification. Bartlett's test of sphericity was significant ($\chi^2 = 5696.034$, $p < 0.001$), confirming that the correlation matrix was suitable for factor analysis.

4.2 Descriptive Statistics

Descriptive statistics provided insights into the central tendency and variability of the research variables. The mean scores for all items ranged from 3.14 to 3.39, indicating moderately positive perceptions across all constructs. Detailed results showed:

Trust in Product Quality: Mean scores ranged from 3.20 to 3.35. Item Q4 ("I feel confident that Luckin Coffee's products meet health standards") had the highest mean (3.35), while Q3 ("I trust that Luckin Coffee uses fresh ingredients") had the lowest (3.20).

Trust in Service Reliability: Means ranged from 3.14 to 3.30. Item Q7 ("I can rely on Luckin Coffee to provide accurate order fulfillment") scored highest (3.30), while Q10 ("Luckin Coffee's service meets my expectations most of the time") scored lowest (3.14).

Trust in Price Reasonableness: Means ranged from 3.27 to 3.34. Items Q14 and Q15 (related to promotional prices and overall price acceptance) shared the highest means (3.34), while Q12 ("Luckin Coffee's prices provide good value for money") had the lowest (3.27).

Trust in Brand Reputation: Means ranged from 3.15 to 3.39. Item Q19 ("I believe Luckin Coffee maintains a good brand reputation in the market") had the highest mean (3.39), while Q20 ("Luckin Coffee is a brand that I consider trustworthy based on its reputation") had the lowest (3.15).

Repurchase Intention: Means ranged from 3.22 to 3.37. Item Q24 ("I will continue to buy Luckin Coffee even after trying other brands") had the highest mean (3.37), while Q21 ("I am willing to buy Luckin Coffee again in the future") had the lowest (3.22).

Standard deviations ranged from 1.286 to 1.454, indicating moderate variability in responses without extreme dispersion.

4.3 Correlation Analysis

Pearson correlation analysis revealed strong positive relationships between all research variables. The correlation matrix showed significant interrelationships among all four trust dimensions, with coefficients ranging from 0.836 to 0.887 ($p < 0.01$). Most importantly, all trust dimensions demonstrated strong positive correlations with repurchase intention:

Table 4.1: Correlation Matrix of Research Variables (N=400)

Variable	1	2	3	4	5
Trust in Product Quality	1.000				
Trust in Service Reliability	0.842	1.000			
Trust in Price Reasonableness	0.836	0.847	1.000		
Trust in Brand Reputation	0.875	0.865	0.887	1.000	
Repurchase Intention	0.844	0.856	0.875	0.887	1.000

$p < 0.01$

Table 4.2: Detailed Correlation Coefficients with Significance Levels

Relationship	Correlation Coefficient	Significance Level	Effect Size
Product Quality → Repurchase Intention	0.844	$p < 0.001$	Large
Service Reliability → Repurchase Intention	0.856	$p < 0.001$	Large
Price Reasonableness → Repurchase Intention	0.875	$p < 0.001$	Large
Brand Reputation → Repurchase Intention	0.887	$p < 0.001$	Large
Product Quality ↔ Service Reliability	0.842	$p < 0.001$	Large
Product Quality ↔ Price Reasonableness	0.836	$p < 0.001$	Large
Service Reliability ↔ Price Reasonableness	0.847	$p < 0.001$	Large
Brand Reputation ↔ Price Reasonableness	0.887	$p < 0.001$	Large

All correlation coefficients exceeded 0.80, indicating large effect sizes according to Cohen's guidelines. The strongest correlation was between trust in brand reputation and repurchase intention ($r = 0.887$), while the weakest was between trust in product quality and repurchase intention ($r = 0.844$). All correlations were statistically significant at the 0.01 level.

4.4 Hypothesis Testing Results

All four research hypotheses were supported by the correlation analysis:

H1: Trust in product quality positively affects university students' repurchase intention (Supported, $r = 0.844$, $p < 0.01$)

H2: Trust in service reliability positively affects university students' repurchase intention (Supported, $r = 0.856$, $p < 0.01$)

H3: Trust in price reasonableness positively affects university students' repurchase intention (Supported, $r = 0.875$, $p < 0.01$)

H4: Trust in brand reputation positively affects university students' repurchase intention (Supported, $r = 0.887$, $p < 0.01$)

The results indicate that all trust dimensions significantly contribute to repurchase intention, with trust in brand reputation having the strongest influence.

5. Discussion and Conclusion

This comprehensive study has yielded significant insights into the impact of Luckin Coffee's multidimensional brand trust on repurchase intentions among university students in Shanghai, China. The empirical findings demonstrate robust positive correlations between all four trust dimensions—product quality, service reliability, price reasonableness, and brand reputation—and repurchase intention, with correlation coefficients ranging from 0.844 to 0.887 ($p < 0.01$). These results underscore the critical importance of holistic brand trust management in fostering customer loyalty within the competitive coffee retail sector. The strong statistical relationships validate the research hypotheses and align with established theoretical frameworks, including Commitment-Trust Theory, Expectation-Confirmation Theory, and Perceived Value Theory, while extending their application to the specific context of China's dynamic consumer market and youth demographics.

The discussion of these findings highlights several key aspects. Firstly, the multidimensional nature of brand trust is confirmed, with each dimension playing a distinct yet interconnected role in influencing repurchase behavior. Trust in brand reputation emerged as the strongest predictor ($r = 0.887$), which is particularly noteworthy given Luckin Coffee's historical challenges, indicating that reputation recovery is achievable through consistent performance, transparent communication, and ethical business practices. This aligns with research on brand crisis management, suggesting that proactive measures can mitigate reputational damage and rebuild consumer confidence. Secondly, trust in price reasonableness ($r = 0.875$) underscores the price sensitivity of university students, validating Luckin Coffee's value-based positioning and emphasizing the need for fair pricing strategies that resonate with budget-conscious consumers. Thirdly, trust in service reliability ($r = 0.856$) and product quality ($r = 0.844$) reinforce the importance of operational excellence and consistent delivery, as outlined in service quality models like SERVQUAL, ensuring that core offerings meet consumer expectations and reduce perceived risks.

Theoretical implications of this study are substantial. It contributes to brand trust literature by validating multidimensional frameworks in the context of China's rapidly

evolving coffee industry and digital-native youth consumers. The research demonstrates how classical theories, such as Commitment-Trust Theory, can be applied to modern retail environments, particularly those leveraging digital platforms and post-crisis recovery strategies. Additionally, it enhances understanding of youth consumer behavior by examining how trust perceptions are formed through interactions with product quality, service reliability, price fairness, and brand image, providing a nuanced view of the factors driving loyalty among university students. This study also bridges gaps in existing research by focusing on the interrelationships between trust dimensions, revealing that they operate synergistically rather than in isolation, which enriches the theoretical discourse on consumer-brand relationships.

From a practical perspective, the findings offer actionable recommendations for Luckin Coffee and similar beverage brands targeting youth markets. To enhance trust in product quality, brands should implement rigorous quality control measures, ensure ingredient transparency, and maintain consistency across all product lines, thereby reducing perceived risks and building consumer confidence. For service reliability, optimizing digital platforms (e.g., APP functionality, order accuracy) and training staff to handle issues efficiently are crucial, as reliable service experiences directly influence repurchase decisions. Regarding price reasonableness, offering student-specific discounts, promotional pricing, and clear value communication can strengthen perceptions of fairness and value, catering to the economic constraints of university students. In terms of brand reputation, engaging in corporate social responsibility initiatives, maintaining transparent operations, and leveraging social media for positive engagement can help build and sustain a trustworthy image. Importantly, brands should adopt an integrated approach that addresses all trust dimensions simultaneously in marketing campaigns, as the dimensions are interrelated and collectively impact consumer loyalty.

Limitations of this study include its geographical focus on Shanghai, which may limit generalizability to other regions with different cultural and economic contexts, and its cross-sectional design, which prevents analysis of trust evolution over time. Additionally, the exclusion of potential mediating variables, such as customer satisfaction or brand attachment, means that the underlying mechanisms linking trust to repurchase intention are not fully explored. Future research could address these limitations by conducting longitudinal studies to track trust development, comparative analyses across multiple cities or countries, and investigations into mediating and moderating variables that might influence the trust-repurchase relationship. Qualitative methods, such as interviews or focus groups, could also provide deeper insights into the psychological processes behind trust formation among youth consumers.

In conclusion, this study affirms that multidimensional brand trust is a powerful driver of repurchase intentions among university students in Shanghai. The findings emphasize that success in the competitive coffee market requires a balanced and comprehensive approach to trust management, addressing product quality, service reliability, price reasonableness, and brand reputation in tandem. For Luckin Coffee, continued focus on these areas will be essential for maintaining its market position and

fostering long-term loyalty. This research not only advances academic understanding of brand trust but also provides a practical framework for brands seeking to engage effectively with the youth demographic in China and beyond.

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The Mediating Role of Innovation Ability Pathways to Succession Success in Shenzhen Family Enterprises

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Abstract

This study explores innovation ability's mediating role in family business succession, focusing on the relationships between succession ability cultivation, family governance structure, and enterprise succession success. Using a qualitative multiple case study approach, the research examined 50 leaders, successors, and executives from 15 family enterprises in Shenzhen through in-depth interviews and focus group discussions.

Findings reveal that innovation ability fully mediates the impact of both succession ability cultivation and family governance structure on succession success. Succession cultivation practices develop innovation mindsets in successors, while family governance structures create organizational environments conducive to innovation. This innovation capability enables successors to balance continuity with transformation—preserving family legacy while driving strategic renewal.

The results indicate that family enterprises should reconceptualize succession planning as fundamentally including innovation capability development, not merely operational skill transfer. This provides significant insights for family businesses navigating generational transitions amid rapid market changes.

Keywords: Family enterprises, succession success, innovation ability, mediating mechanism, qualitative case study, Shenzhen

1. Introduction

The accelerating pace of globalization and technological disruption has fundamentally altered competitive landscapes facing family enterprises worldwide. In China, family businesses that emerged during economic reforms of the 1980s and 1990s now confront critical succession challenges as founding generations approach retirement age. This transition coincides with unprecedented market volatility, digital transformation pressures, and intensifying competition—creating a "perfect storm" threatening family enterprise continuity.

Shenzhen, China's pioneering Special Economic Zone and innovation capital, epitomizes these challenges. The city's transformation from fishing village to global technology hub occurred within a single generation, producing thousands of family enterprises now facing first-time generational transitions. These businesses must navigate succession while simultaneously adapting to rapid market evolution—a dual challenge requiring successors who can both preserve family legacy and drive strategic innovation.

Existing family business succession literature emphasizes preparation factors such as successor training, gradual authority transfer, and governance structures like family councils and professional boards. Recent systematic reviews confirm that succession planning and innovation are increasingly interconnected in family business research (Baltazar et al., 2023). Scholars have established that systematic succession ability cultivation and robust family governance positively influence succession outcomes. However, a critical gap remains: understanding the mechanisms through which this preparation practices actually translate into successful succession outcomes remains inadequately explored, particularly in rapidly evolving contexts where maintaining the status quo guarantees obsolescence.

This gap is especially significant in innovation-driven economies like Shenzhen, where family enterprises cannot succeed merely by replicating founder practices. Research on family governance structures reveals their critical role in shaping organizational outcomes during transitions (Thakur & Sinha, 2024), yet the specific pathways through which governance enables innovation capability development remain underexplored. Recent evidence from Chinese family businesses demonstrates that parent-child co-governance during succession significantly influences innovation decisions, particularly in contexts requiring strategic renewal (Wang et al., 2024).

Successors face implicit or explicit expectations to not only maintain but substantially transform inherited businesses. Strategic change in family firms presents unique challenges, as these organizations must balance tradition with necessary adaptation (Skorodziyevskiy et al., 2024). Yet existing succession models, developed primarily in stable Western contexts, inadequately address how successors can simultaneously honor family tradition and drive necessary innovation. Multi-level analyses suggest that succession satisfaction depends on complex interactions between individual capabilities, organizational structures, and contextual

factors (Gómez et al., 2025), yet the mechanism enabling this delicate balance remains empirically underexplored.

Objective

This qualitative study addresses the central research question: How does innovation ability mediate the relationships between succession ability cultivation, family governance structure, and enterprise succession success in Shenzhen family enterprises?

Specifically, this investigation explores:

How succession ability cultivation practices influence successors' innovation capabilities (H1 mechanism)

How family governance structures enable or constrain innovation during succession transitions (H2 mechanism)

How innovation capability enables successors to achieve succession success by balancing continuity with necessary transformation

The lived experiences, perceptions, and sense-making processes through which family business stakeholders navigate succession amidst innovation imperatives

Understanding these mediating mechanisms carries both theoretical and practical significance. Theoretically, this research extends succession models beyond linear relationships to reveal the complex pathways through which preparation influences outcomes. Baltazar et al.'s (2023) comprehensive systematic review identified 73 relevant studies but noted that "the relationship between succession and innovation remains undertheorized, particularly regarding mediating mechanisms" (p. 2560). By identifying innovation ability as a critical mediating mechanism, this study challenges traditional succession frameworks that emphasize only operational continuity.

Practically, findings inform family enterprises on designing succession approaches deliberately cultivating innovation capacity—not as an afterthought, but as central to succession success in dynamic environments. With evidence suggesting that family governance structures significantly impact strategic outcomes (Thakur & Sinha, 2024) and that co-governance patterns influence innovation decisions (Wang et al., 2024), understanding innovation's mediating role becomes crucial for designing effective succession interventions.

Shenzhen provides an ideal empirical context for this investigation. As China's innovation hub with concentrated entrepreneurial activity, the city's family enterprises experience particularly intense pressures combining generational transition with strategic transformation. Insights from this context can inform family businesses globally facing similar challenges in rapidly evolving industries.

2. Literature Review

2.1 Succession Ability Cultivation

Succession ability cultivation refers to the systematic process of developing the capabilities, knowledge, and skills that successors need for leadership roles in family businesses.

Song et al. (2024) examined the impact of intergenerational succession intention on innovation strategy in Chinese family firms. Based on data from 231 Chinese family businesses, the study found that succession intention significantly influences firms' innovation strategy choices. When founders maintain strong succession intentions toward family members, firms adopt more aggressive innovation investment strategies, emphasizing that succession cultivation requires not only technical competency development but also the shaping of strategic mindsets.

Pahnke et al. (2024) analyzed the relationship between family business succession plans and actual outcomes through longitudinal data. The research revealed a substantial gap between succession aspirations and reality, with only a small proportion of planned successions being realized within expected timeframes. This highlights that succession ability cultivation requires more systematic approaches, addressing not only skill development but also psychological readiness and family dynamics.

McAdam et al. (2024) explored how family business practices are transmitted and transformed across generations through a 14-year longitudinal case study from a community of practice perspective. The research demonstrated that effective governance structures facilitate knowledge transfer and practice institutionalization. Communities of practice integrate not only family members but also non-family members into collaborative decision-making processes, enhancing organizational resilience.

2.2 Family Governance Structure

Family governance structure encompasses the formal and informal mechanisms, policies, and systems that regulate family-business interactions, decision-making processes, and conflict resolution.

Thakur and Sinha (2024) conducted a systematic review of 52 articles on family governance structures published between 1993 and 2023. The research found that family governance mechanisms—including family councils, family constitutions, and board structures—significantly impact organizational outcomes by balancing family harmony with business professionalization. Effective governance structures create frameworks that enable both continuity and strategic adaptation.

McAdam et al. (2024), based on a 14-year longitudinal study, found that governance structures facilitate cross-generational knowledge transfer and practice institutionalization. Effective family governance extends beyond formal policies to encompass shared practices, rituals, and traditions that shape organizational behavior. Governance structures that integrate both family and non-family members into collaborative decision-making processes enhance

organizational adaptability during leadership transitions.

Skorodzyevskiy et al. (2024) reviewed strategic change in family firms from institutional environment and firm size perspectives, analyzing how governance structures influence firms' ability to implement strategic transformations. The research demonstrated that family governance mechanisms significantly moderate the relationship between environmental pressures and strategic responses, emphasizing that governance systems must evolve alongside generational changes.

2.3 Innovation Ability

Innovation ability refers to the organizational and individual capacity to identify opportunities, generate novel ideas, implement strategic changes, and adapt to dynamic competitive environments.

Hernández-Perlín et al. (2024) investigated how entrepreneurial orientation and absorptive capacity influence innovation capability in family firms, analyzing data from 156 family businesses. The research found that entrepreneurial orientation (encompassing risk-taking propensity, proactiveness, and autonomy) and absorptive capacity significantly influence innovation capability, with stronger effects when these capabilities act synergistically.

Hernández-Perlín et al. (2025) analyzed the relationships among dynamic capabilities, socioemotional wealth preservation, and family firm performance through PLS-SEM. The research revealed that innovation emerges as the most critical dynamic capability influencing family business performance. Innovation capability enables family firms to balance socioemotional wealth preservation with necessary strategic adaptation, and socioemotional wealth moderates the relationship between dynamic capabilities and performance.

Song et al. (2024) explored the relationship between intergenerational succession intention and innovation strategy in Chinese family firms. Empirical analysis of 231 family businesses demonstrated that succession intentions influence R&D investment intensity and innovation strategy choices. When successors possess innovation mindsets and receive support from governance mechanisms that allow experimentation, family businesses achieve higher innovation outcomes.

2.4 Enterprise Succession Success

Enterprise succession success refers to the effective transfer of leadership, ownership, and strategic direction from one generation to the next, resulting in sustained organizational performance and family harmony.

Pahnke et al. (2024) provided groundbreaking evidence by linking longitudinal data on succession intentions with actual outcomes. The research revealed a significant mismatch between expected and realized succession outcomes, with only a small proportion of planned successions occurring as intended. Many business owners ultimately abandon initial succession

plans or close their businesses, while a substantial number of unintended business transfers occur that have received little research attention.

Gómez et al. (2025) conducted a multi-level analysis of determinants of family business succession satisfaction across different cultural contexts. The research demonstrated that succession success depends on complex interactions among micro-level factors (individual characteristics), meso-level factors (organizational and family governance structures), and macro-level factors (cultural and institutional contexts). Formal succession planning improves satisfaction and perceived success when aligned with cultural values and family expectations.

McAdam et al. (2024) provided longitudinal insights into succession success through a 14-year case study examining how family business practices evolve across three generations. The research found that succession success stems from the effective transmission and transformation of organizational practices rather than mere positional transfers. Successful successions involve cultivating communities of practice where both family and non-family members participate in collective sense-making and practice evolution.

3. Methodology

This study explores two mediating relationships:

H1: Innovation ability mediates the relationship between succession ability cultivation and enterprise succession success in Shenzhen family enterprises.

H2: Innovation ability mediates the relationship between family governance structure and enterprise succession success in Shenzhen family enterprises.

Research Design

This study employed a qualitative multiple case study design to explore innovation ability's mediating role in family enterprise succession. This approach enables in-depth exploration of complex, context-dependent phenomena and uncovering mechanisms linking constructs (Yin, 2018; Eisenhardt, 1989).

Research Context

Shenzhen was strategically selected as China's innovation capital, where many first-generation family enterprises (founded 1980s-1990s) currently face succession transitions. This context makes innovation capability's role particularly salient amid intense technological disruption and market competition.

Sampling Strategy

Purposive maximum variation sampling identified 15 family enterprises meeting criteria:

Family ownership $\geq 50\%$ with management involvement

Currently undergoing or recently completed (within 3 years) succession

Operating in Shenzhen ≥ 10 years; minimum 50 employees

Data Collection

1. Semi-Structured Interviews

All 50 participants; 60-90 minutes each

Explored succession cultivation, governance structures, innovation development, and succession success perceptions

Conducted in Mandarin; audio-recorded and professionally transcribed

2. Focus Group Discussions

Six groups (90-120 minutes each): founders, successors, and executives

Examined collective experiences and shared perceptions of innovation's mediating role

3. Document Analysis

Family constitutions, succession plans, training documents, innovation strategies, company histories (varying availability across cases)

4. Observational Data

Three family council meetings, two innovation presentations, 15 enterprise site visits

We followed Braun and Clarke's (2006) six-phase thematic analysis. Two researchers independently open-coded an initial subset of transcripts, iteratively refined a shared codebook, and then coded the full dataset using NVivo 14. Inter-coder agreement (Cohen's kappa = 0.78) indicated substantial reliability; disagreements were resolved through discussion. We enhanced trustworthiness via triangulation across interviews, focus groups, documents, and observations; negative case analysis; member checking with five participants; and maintaining an audit trail. Interviews conducted in Mandarin were professionally transcribed and translated into English following a back-translation procedure to minimize translation bias. Theme saturation was reached by Case 13, with Cases 14–15 yielding no novel themes.

4. Findings

The thematic analysis revealed five overarching themes illuminating how innovation ability mediates relationships between succession cultivation, family governance, and succession success.

Theme 1: Succession Cultivation as Innovation Capability Incubator

All 15 cases demonstrated that effective succession cultivation deliberately develops innovation capabilities through four mechanisms:

Mechanism 1.1: Intentional Exposure to Innovation Ecosystems
Thirteen cases showed founders deliberately exposing successors to entrepreneurial environments. A founder (Case 3) explained: "I sent my son to work at a Shenzhen startup incubator for two years before joining our company. There he absorbed innovation culture and lean startup methods. When he returned, he brought that innovation DNA into our traditional business. That exposure was the most important part of his succession preparation."

Mechanism 1.2: Encouraging Calculated Risk-Taking

Ten cases revealed successors were encouraged to innovate in controlled contexts with psychological safety to learn from failures. A successor (Case 7) reflected: "My mother gave me budget and authority to experiment with online sales channels. My first attempts failed, but she asked 'What did you learn?' That approach taught me innovation isn't about avoiding failure. When I took over leadership, that risk-taking capability allowed me to pivot our business model during COVID-19."

Mechanism 1.3: Formal Innovation Training
Twelve cases incorporated design thinking workshops, innovation management courses, and mentorship into succession preparation, providing successors with structured innovation methodologies.

Mechanism 1.4: Progressive Innovation Responsibility
Fourteen cases described gradual transfer of innovation-specific responsibilities—new product development, digital transformation, market entry—building both competencies and stakeholder confidence before full succession.

Cross-Case Pattern: Cases where cultivation prioritized innovation capability produced better succession outcomes. Two cases (9, 11) focusing exclusively on operational replication struggled with market adaptation, demonstrating that succession cultivation influences success through innovation capability development (supporting H1).

Theme 2: Family Governance as Innovation Enabler or Constraint

Governance structures powerfully influenced whether successors could develop and leverage innovation capabilities.

Mechanism 2.1: Psychological Safety Through Formalization
Eleven cases with formalized governance (family councils, written constitutions) created safety enabling innovation. A successor (Case 2) explained: "Before establishing our family council, every innovation proposal sparked emotional family arguments. After formalizing governance—separating family from business decisions, establishing innovation committee—I had space to innovate without fear of backlash. That governance structure liberated my innovation capability."

Mechanism 2.2: Innovation Domain Designation
Nine cases explicitly designated innovation as successor territory. A family council member (Case 4) noted: "Our family constitution states: 'Second generation holds primary authority for innovation initiatives.' This gave my nephew permission and expectation to innovate, preventing constant intergenerational negotiation."

Mechanism 2.3: Resource Allocation for Innovation
Thirteen cases established formal innovation budgets, evaluation criteria, and stage-gate processes enabling successors to implement innovations, not just propose them.

Mechanism 2.4: Conflict Resolution Protocols

Ten cases had protocols for resolving innovation tensions. External advisors mediated when generations disagreed, legitimizing independent assessment and protecting successor initiatives from premature termination.

Contrasting Cases: Four cases (1, 9, 11, 14) with informal governance showed successors constrained by unpredictable founder intervention and uncertain authority. One successor (Case 11) stated: "I never knew if proposals would be supported or criticized. That uncertainty made me risk-averse—I focused on not making mistakes rather than innovating. Lack of governance killed my innovation capability."

These patterns demonstrate governance influences succession success by enabling or constraining innovation capability (supporting H2).

Theme 3: Innovation Capability as Bridge Between Continuity and Transformation

Innovation ability enables the critical balance between honoring family legacy and driving business transformation.

Mechanism 3.1: Strategic Renewal Preserving Core Identity
All 15 cases showed successful succession required maintaining core identity while adapting business models. A successor (Case 10) articulated: "Innovation capability is the bridge. My innovation skills transformed our production to smart manufacturing and developed new revenue streams—while maintaining my father's commitments to quality and employee welfare. Without innovation capability, I would have faced a false choice: preserve tradition and fail, or innovate and betray legacy."

Mechanism 3.2: Innovation as Legitimacy Builder
Fourteen cases revealed innovation achievements established successor legitimacy with stakeholders. An executive (Case 12) explained: "The turning point came when the successor launched our B2B platform—proving to skeptical employees and customers that he was truly capable. Innovation achievement built legitimacy no training certificate could provide."

Mechanism 3.3: Creating Positive Future Narrative
Innovation capabilities enabled successors to articulate compelling visions reducing succession anxiety and creating enthusiasm rather than resistance during uncertain transitions.

Theme 4: Contextual Factors Shaping Innovation's Mediating Role

While innovation consistently mediated succession relationships, contextual factors modulated this mediation:

Industry Dynamism: High-tech industries (Cases 2, 3, 4, 6) required radical innovation for survival; traditional industries (Cases 1, 7, 9, 12) emphasized business model innovation. Innovation capability remained critical across contexts but types varied.

Enterprise Size: Large enterprises (>500 employees) had dedicated R&D infrastructure; medium enterprises required creative, resource-constrained approaches leveraging ecosystem

partnerships. Despite differences, innovation remained critical.

Generational Relationships: Positive relationships (12 cases) facilitated innovation through trust and mentorship; strained relationships (Cases 1, 9, 11) complicated development, with innovation becoming "another battlefield" rather than collaborative process.

Theme 5: Long-term Succession Success Perspective

Six post-succession cases (2-5 years) provided longitudinal insights:

Pattern	5.1:	Sustaining	Initial	Success
All emphasized innovation capability remains critical post-succession. A successor three years post-transition (Case 4):				
"Markets keep changing, competition intensifies. The innovation capability developed during succession continues being critical for sustaining the transition. If I'd lost that edge, early success would have proven temporary."				

Pattern	5.2:	Innovation	Culture	Institutionalization
Four cases described systematizing innovation organization-wide through training programs, recognition systems, and performance metrics. A successor (Case 6):				
"My biggest priority was embedding innovation into culture, not keeping it as just my capability. This ensures the innovation that made my succession successful will facilitate the next transition."				

5. Results

The thematic analysis of qualitative data from 15 family enterprises in Shenzhen, encompassing 50 individual interviews, 6 focus group discussions, and extensive documentary evidence, revealed five interconnected themes demonstrating how innovation ability mediates the relationships between succession ability cultivation, family governance structure, and enterprise succession success.

Theme 1: Succession Cultivation Systematically Develops Innovation Capabilities

All 15 cases demonstrated that succession ability cultivation functions as an innovation capability incubator through four distinct mechanisms. Thirteen cases (86.7%) involved intentional exposure of successors to external innovation ecosystems—startup incubators, entrepreneurial networks, and technology communities—that cultivated innovation mindsets beyond operational competencies. Ten cases (66.7%) explicitly encouraged calculated risk-taking within controlled contexts, providing psychological safety for successors to experiment and learn from failures. Twelve cases (80%) incorporated formal innovation training, including design thinking workshops, innovation management coursework, and structured mentorship from entrepreneurs or innovation consultants. Fourteen cases (93.3%) implemented progressive transfer of innovation-specific responsibilities—new product development, digital transformation initiatives, and market entry strategies—enabling successors to build both innovation competencies and stakeholder credibility before formal succession.

Cross-case comparative analysis revealed a consistent pattern: Cases where succession cultivation deliberately prioritized innovation capability development (13 cases) achieved markedly more successful succession outcomes compared to cases emphasizing exclusively operational replication (2 cases: Cases 9 and 11). In the latter cases, successors struggled to adapt family enterprises to evolving market conditions, resulting in stakeholder dissatisfaction, market share decline, and intergenerational conflict. This pattern provides strong qualitative evidence that succession cultivation influences succession success through the mediating pathway of innovation capability development.

Theme 2: Family Governance Structures Enable or Constrain Innovation Capability

Family governance structures emerged as powerful moderators determining whether successors could develop and exercise innovation capabilities during succession transitions. Eleven cases (73.3%) with formalized family governance—including family councils, written constitutions, and explicit decision-making protocols—created psychological safety and structural support enabling successor innovation. These governance structures provided clear authority boundaries, depersonalized decision-making processes, and explicit innovation domain designation that reduced emotional reactions and intergenerational conflicts constraining innovation during sensitive succession periods.

Nine cases (60%) implemented governance provisions explicitly designating innovation as successor generation territory with defined autonomy, resolving potential authority conflicts through formal role clarification rather than repeated negotiation. Thirteen cases (86.7%) established governance-enabled resource allocation mechanisms for innovation, including dedicated innovation budgets, evaluation criteria, and stage-gate processes that translated successor innovation capabilities into implemented initiatives rather than merely proposed ideas. Ten cases (66.7%) with mature governance structures had explicit conflict resolution protocols—often involving external advisors or family boards—that protected successor innovation initiatives from premature termination due to founder risk aversion or generational differences.

In stark contrast, four cases (26.7%: Cases 1, 9, 11, 14) with informal, ad hoc governance exhibited substantially different patterns. Innovation decisions remained subject to unpredictable founder intervention; successors lacked clear authority; resource allocation was personality-dependent and inconsistent. Successors in these contexts consistently described governance uncertainty as directly constraining their willingness and ability to innovate, with one successor (Case 11) stating the "lack of governance structure killed my innovation capability." These contrasting patterns demonstrate that family governance structures influence succession success by creating organizational environments that either enable or constrain innovation capability development and exercise.

Theme 3: Innovation Capability Bridges Continuity and Transformation

The most theoretically significant finding emerged from participants' consistent

identification of a fundamental succession challenge: achieving balance between preserving family enterprise legacy (values, relationships, core competencies) and driving necessary strategic transformation in response to market evolution. Innovation capability surfaced as the critical mechanism enabling this delicate balance rather than forcing a false choice between tradition and adaptation.

All 15 cases provided evidence that innovation capability enabled strategic renewal while preserving core identity. Successors with strong innovation competencies successfully transformed business models, production methods, market approaches, and revenue streams while simultaneously maintaining founders' commitments to quality standards, stakeholder relationships, and organizational values. Participants explicitly described innovation capability as "the bridge" reconciling apparent tensions between continuity and change imperatives.

Additionally, fourteen cases (93.3%) revealed that demonstrated innovation capability—visible through tangible innovation achievements—established successor legitimacy with critical stakeholders including employees, customers, extended family members, and founding generation leaders. Innovation successes provided credible evidence of successor leadership readiness that accelerated stakeholder acceptance and reduced succession resistance. Twelve cases (80%) further demonstrated that innovation capability enabled successors to articulate compelling future visions that transformed succession-related anxiety into enthusiasm and forward-looking orientation.

These mechanisms consistently demonstrate that innovation capability is not peripheral to succession success but central—serving simultaneously as the operational means of strategic adaptation, the credibility foundation for successor legitimacy, and the narrative basis for positive stakeholder orientation during leadership transitions.

Theme 4: Contextual Factors Modulate Innovation's Mediating Role

While innovation ability consistently mediated succession relationships across all cases, three contextual factors significantly modulated the strength and specific manifestations of this mediation.

Industry dynamism influenced innovation capability requirements and types. High-dynamism industries (technology, electronics: Cases 2, 3, 4, 6) demanded radical product and technology innovation as survival imperatives; succession success was impossible without strong innovation competence in these contexts. Moderate-dynamism industries (manufacturing, professional services: Cases 5, 8, 10, 13, 15) required innovation capability focused on incremental process improvements and service delivery enhancements. Even traditional industries (trading, distribution: Cases 1, 7, 9, 12) increasingly required innovation capability for digital business model transformation. Innovation capability's mediating role appeared universal, but innovation types and intensity requirements varied systematically by industry context.

Enterprise size shaped innovation capability development pathways. Larger enterprises

(>500 employees: Cases 2, 4, 5, 6, 10) possessed resources enabling systematic innovation infrastructure including dedicated R&D departments, innovation training budgets, and specialized personnel. Medium-sized enterprises (50-500 employees) required more creative, resource-constrained approaches leveraging external ecosystem partnerships, university collaborations, and cultural rather than structural innovation enablers. Despite these developmental pathway differences, innovation capability remained equally critical for succession success across both size categories.

Generational relationship quality influenced innovation capability transfer effectiveness. Positive incumbent-successor relationships (12 cases, 80%) facilitated innovation through trust-enabled experimentation, willing mentorship, constructive feedback, and collaborative problem-solving. Strained relationships (3 cases: Cases 1, 9, 11) complicated innovation capability development, with innovation becoming an arena for power struggles rather than collaborative competency building. While relationship quality moderated development effectiveness, it did not invalidate innovation capability's fundamental mediating role.

Theme 5: Innovation Capability's Sustained Importance Post-Succession

Longitudinal evidence from six cases where succession occurred 2-5 years prior revealed innovation capability's enduring importance extending beyond formal leadership transition moments. All six post-succession cases emphasized that innovation capability remains critical for sustaining initial succession success as markets continue evolving, competition intensifies, and technologies advance. One successor three years post-transition (Case 4) reflected: "The innovation capability developed during succession preparation continues being critical for sustaining the successful transition. If I'd lost that innovation edge after succession, early success would have proven temporary."

Four post-succession cases (66.7%) described systematic efforts to institutionalize innovation capability organization-wide rather than maintaining it exclusively as individual successor competence. These institutionalization efforts included innovation training programs for all managers, recognition and reward systems incentivizing innovation, systematic idea management processes, and innovation metrics integrated into performance management. This pattern suggests that ultimate succession success requires translating individual successor innovation capability into organizational innovation capacity—ensuring capability continuity beyond any single leader and facilitating subsequent generational transitions.

Hypothesis Support and Cross-Case Patterns

The qualitative evidence provides strong, convergent support for the study's central propositions regarding innovation ability's mediating role:

Support for Mediating Relationship H1 (Succession Cultivation → Innovation Ability → Succession Success): Across all 15 cases, succession cultivation approaches that deliberately developed innovation capabilities produced successors better equipped to achieve succession success through strategic adaptation, legitimacy building, and stakeholder engagement. The two

contrasting cases (Cases 9, 11) where cultivation emphasized only operational replication without innovation capability development resulted in substantially less successful succession outcomes characterized by market adaptation struggles, stakeholder resistance, and performance decline. This consistent pattern, supported by rich participant narratives describing causal mechanisms, provides compelling qualitative evidence that innovation ability mediates the relationship between succession cultivation and succession success.

Support for Mediating Relationship H2 (Family Governance → Innovation Ability → Succession Success): The stark contrast between cases with formalized governance structures (11 cases) that enabled innovation capability development and exercise versus cases with informal governance (4 cases) that constrained innovation provides robust qualitative evidence for this mediating pathway. Participants explicitly described governance structures' influence on succession success as operating through governance's impact on their ability to develop innovation capabilities, secure resources for innovation initiatives, and exercise innovation authority without debilitating conflicts. The consistency of this pattern across diverse family enterprise contexts strengthens confidence in the mediating mechanism.

Cross-cutting Pattern—Innovation as Essential but Insufficient: While innovation capability emerged as critical for succession success across all cases, evidence also revealed it operates within broader ecosystems of enabling conditions. Even successors with strong innovation capabilities struggled to achieve succession success when operating within dysfunctional governance structures (Cases 1, 11) or severely strained generational relationships (Case 9). This finding suggests innovation ability is a necessary but not solely sufficient condition for succession success—its effectiveness depends on supportive organizational and relational contexts that governance structures and cultivation approaches help create.

Conclusion and Future Work

This qualitative multiple-case study provides compelling evidence that innovation ability serves as a critical mediating mechanism through which succession cultivation and family governance influence succession success in Shenzhen family enterprises. Effective succession cultivation deliberately develops innovation capabilities through intentional ecosystem exposure, risk-taking encouragement, formal training, and progressive responsibility transfer. Family governance structures enable innovation by creating psychological safety, designating innovation domains, allocating resources, and resolving conflicts. Innovation capability then enables succession success by bridging continuity and transformation—allowing successors to honor family legacy while driving strategic adaptation.

These findings fundamentally challenge traditional succession models emphasizing only operational continuity. In dynamic competitive environments—particularly innovation-

intensive contexts like Shenzhen—succession success requires innovation capability as much as operational competence. Innovation provides the mechanism enabling the delicate balance between preservation and adaptation, maintaining family identity while transforming business models to remain competitive. As Shenzhen family enterprises navigate first-generation succession transitions amidst market volatility and technological disruption, innovation capability emerges as the bridge connecting preparation to success.

Theoretical Contributions

1. **Revealing Mediation Mechanisms:** While quantitative studies demonstrate that mediation exists statistically, this qualitative research illuminates how and why mediation operates. The study reveals detailed mechanisms: how cultivation develops innovation capabilities, how governance enables innovation exercise, and how innovation then facilitates succession success. These mechanistic insights move beyond "black box" models to specify processes through which mediating effects occur.

2. **Challenging Traditional Succession Models:** Traditional succession literature emphasizes operational continuity and management skill transfer. This research demonstrates that in dynamic environments, innovation capability is equally critical. Succession theory must evolve to recognize that contemporary succession requires not just maintaining what founders built but transforming it—making innovation a core rather than peripheral succession competency.

3. **Integrating Dynamic Capabilities with Succession Theory:** The findings connect family business succession theory with dynamic capabilities framework, demonstrating that successful succession in volatile environments requires organizational capabilities to sense opportunities, seize them through innovation, and reconfigure resources. Succession planning must deliberately cultivate dynamic capabilities, not just operational capabilities.

4. **Contextualizing Succession in Emerging Economies:** This research extends succession theory to emerging economy innovation contexts where first-generation transitions predominate, rapid market evolution compresses adaptation timelines, and innovation pressures are intense. The findings suggest context-sensitive models recognizing that succession challenges differ across economic development stages and innovation intensity environments.

Practical Implications

For Family Business Leaders:

Reconceptualize succession preparation to explicitly incorporate innovation ecosystem exposure, calculated risk-taking opportunities, formal innovation training, and innovation project leadership.

Recognize innovation achievement as critical evidence of successor readiness, evaluating successors not only through operational competence but also through demonstrated innovation successes.

Balance mentorship with autonomy, providing guidance while granting sufficient

independence for successors to develop innovation judgment.

For Successors:

Actively cultivate innovation capabilities through innovation-focused education, entrepreneurial networks, and leading innovation projects.

Frame innovation as legacy preservation, not abandonment of tradition, reducing senior generation resistance.

Build innovation track record through tangible achievements before full succession to establish credibility.

For Family Governance Designers:

Explicitly address innovation in governance structures, including clear innovation authority designation, resource allocation mechanisms, and conflict resolution processes.

Create psychological safety through formalized decision protocols, independent advisory boards, and innovation committees with successor leadership.

Balance oversight with empowerment using stage-gate processes that enable controlled experimentation without micromanagement.

For Family Business Advisors:

Integrate innovation into succession consulting, incorporating innovation capability assessment and development as core succession planning components.

Facilitate governance innovations by helping families design structures explicitly enabling innovation.

Mediate innovation-related conflicts, distinguishing strategic innovation disagreements from relationship conflicts.

For Policymakers:

Support innovation capability development through subsidized training programs, specialized incubators for family enterprises, and networking events connecting successors with entrepreneurs.

Recognize the succession-innovation intersection in policy design, explicitly addressing innovation capability building in family enterprise succession support programs.

Ultimately, successful 21st-century family enterprise succession requires competent successors who possess both deep respect for family heritage and strong innovation capabilities. Succession planning that develops this dual capability—through deliberate cultivation practices and enabling governance structures—positions family enterprises for successful transitions sustaining their contributions to economic vitality, employment, and innovation across generations.

Study Limitations and Future Research

This study's insights should be considered in light of several limitations, each pointing

toward avenues for future research.

1. Contextual and Methodological Limitations:

The study has two primary limitations. First, its context is highly specific, focusing on successful, first-generation successions within Shenzhen's unique innovation-driven economy. This limits the generalizability of findings to different geographic, cultural, industrial, or generational contexts. Second, the methodology is constrained by its cross-sectional design, which cannot capture long-term dynamics, and its reliance on self-reported data, which may be subject to participant bias.

2. Directions for Future Research:

Future research should directly address these gaps through four key approaches:

Quantitative and Longitudinal Validation: Employ large-sample, longitudinal studies to statistically test the mediation model over entire succession cycles (5-10 years). This would validate our qualitative findings and provide a dynamic understanding of the mechanisms.

Comparative Cross-Contextual Studies: Conduct comparative research across different nations, cultures, industries, and generational stages to determine whether innovation's mediating role is a universal mechanism or a context-specific phenomenon.

Deeper Mechanistic Analysis: Disaggregate "innovation" into its distinct types (e.g., product, process, business model) and analyze its impact at multiple levels (individual, organizational, ecosystem) to provide more nuanced guidance.

Failure Case and Intervention Research: Intentionally study succession failures to identify key risk factors and use quasi-experimental designs to causally test the effectiveness of innovation-focused succession training programs.

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Leadership Styles and Generation Y Employees' Performance in Chinese Organizations: A Conceptual Study

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Abstract

In today's competitive business world, employees face both opportunities and challenges because of the complex nature of their work. These challenges can cause high levels of stress, affecting their physical and mental health. When employees face constant pressure without a break, they may start feeling negative emotions, which can lead to burnout. This burnout then affects how well they perform at work. This problem, known as job burnout or occupational burnout, is common in many industries, although its impact varies from one sector to another. This study looks at how different leadership styles affect the performance of Generation Y employees in Chinese companies. It examines how leadership styles can cause burnout and how this burnout influences employee performance. By exploring the link between leadership styles and burnout, the research aims to understand how leadership affects performance. The study uses a quantitative research method, gathering data from multiple branches of a Chinese company. It focuses on Generation Y employees, including frontline workers and office staff like customer service representatives, financial managers, and administrative employees. The collected data will be analyzed using descriptive statistics, correlation analysis, and regression analysis to find the connections between leadership style, employee burnout, and performance.

Keywords: Leadership Styles, Generation Y Employees, Employee Burnout, Employee Performance, Chinese Organizations

1. Introduction

Globalization has reshaped the commercial landscape, profoundly impacting human resource management (HRM). As companies face intense competition for skilled professionals, HRM has transitioned from an administrative support function to a strategic role that demands cultural agility and innovative workforce engagement techniques (Ali et al., 2023). The shift toward remote and hybrid work arrangements has only accelerated this change, urging HR professionals to refine recruitment, onboarding, and employee engagement practices while bolstering organizational resilience (Ali et al., 2023).

A major challenge in this global environment is retaining talent. Organizations now struggle more than ever to keep employees due to fierce competition, enhanced career mobility, and growing concerns about workplace well-being (Mazlan & Jambulingam, 2023). Although global workforce mobility offers new avenues for talent acquisition, it simultaneously increases turnover risks as skilled professionals pursue better opportunities elsewhere (Jaffrezo, 2023). This scenario necessitates the development of retention strategies that go beyond competitive salaries to also emphasize professional development, job satisfaction, and a culture of inclusivity.

Technological advancements have also played a key role in evolving HRM. The use of HR analytics and artificial intelligence (AI) has enabled organizations to make data-driven decisions, improving recruitment processes and overall employee satisfaction (Ali et al., 2023). Additionally, initiatives centered on diversity, equity, and inclusion (DEI) have become essential in building a workplace that attracts and retains a diverse array of talent (Ali et al., 2023).

While globalization expands access to international talent, it also introduces complexities that demand constant adaptation from HR professionals. The real challenge lies in balancing the opportunities of a global workforce with effective retention strategies to secure long-term business success. Organizations that adopt dynamic HR practices, leverage technological tools, and prioritize employee well-being are likely to thrive in this ever-changing global economy.

In today's talent-driven market, employees have become a core asset for companies. Although traditional advantages like state-of-the-art equipment and financial resources remain valuable, there is an increasing focus on internal assets—such as employee expertise, interpersonal relationships, and skills. This shift underlines the critical importance of enhancing employee performance and building a high-quality workforce, which is a priority for both managers and academics. Sustaining strong employee performance is not only vital for day-to-day operations but also for the long-term survival of a company. However, when employees are overwhelmed, their motivation can falter, leading to decreased performance. Freudenberger (1974) noted that in highly competitive settings, work overload extends beyond physical fatigue to include significant psychological strain. Continuous high-pressure conditions without adequate relief may trigger negative emotions, ultimately leading to occupational burnout. Research has found that burnout is common across industries, though its impact may vary by sector. Moreover, Amabile and Kramer (2007) highlighted that managerial behavior profoundly influences employees' work experiences, with leadership styles playing a crucial role in shaping job attitudes and reducing burnout. In essence, an effective manager can enhance emotional well-being, spark enthusiasm, and turn the workforce into a strategic asset. Investigating how various leadership styles affect employee engagement can offer valuable insights into what drives motivation. These insights enable managers to design policies that prevent burnout, lower job-related stress, boost job satisfaction, and improve overall efficiency—laying the

groundwork for enhanced job performance. The organization in China, formed through the restructuring of local business entities and cooperative organizations, has established itself as a key regional player. Focused on serving the local economy, small and medium-sized enterprises (SMEs), and the general public, it has experienced rapid growth and matured its operations significantly.

However, this swift expansion and the resulting surge in employee numbers have introduced new challenges in workforce management. Employee feedback indicates that the rapid pace of development has led to work overload and considerable physical and mental stress. Consequently, maintaining team morale and addressing employee burnout have emerged as critical priorities for sustaining performance within the organization. In response to these issues, this study examines employee burnout and performance within the Chinese organization. It explores how different managerial leadership styles impact burnout levels and identifies strategies to mitigate these effects. By integrating theoretical frameworks with practical insights, the research aims to develop effective approaches to enhance employee well-being and optimize overall team performance.

2. Objective

1. To study the impact of the transformational leadership style on employee work performance.
2. To study the impact of the transactional leadership style on employee work performance.
3. To study the impact of the abusive leadership style on employee work performance.

3. Methodology

This study adopts a quantitative research approach to assess the relationships between leadership styles, employee burnout, and performance through statistical analysis using a structured questionnaire as the primary data collection instrument. Conducted in three business organizations in Beijing City, the research setting was chosen for its representation of diverse business sectors, which are critical for understanding how leadership styles influence Generation Y employees. The target population comprises Generation Y employees working in these organizations, with the sample size determined using Yamane's formula to ensure statistical significance; given that the total population across the three organizations ranges from 4500 to 6000 employees and assuming a 5% margin of error, the estimated sample size is approximately 375 respondents. To ensure data relevance and accuracy, the sampling criteria include employees aged between 28 and 43 years who have been employed in Chinese organizations for at least one year, while excluding those outside this age range, those in senior

management or executive roles, and temporary or contract-based workers with less than one year of employment. The questionnaire, which comprises sections on demographic information, leadership style, and job performance scales, measures employee performance and burnout levels. The data collection process begins with short introduction to explain the study's purpose, followed by the distribution of the online questionnaire. Finally, the data analysis process utilizes statistical tools such as SPSS, employing descriptive statistics, including mean, standard deviation, and frequency distributions, to summarize the data, and regression analysis to determine the impact of leadership styles on employee burnout and performance.

4. Results

This study shows that different leadership styles have a significant impact on employee burnout and work performance. Transformational leadership, which involves inspiring and motivating employees, caring about their needs, and encouraging them to think creatively, leads to positive results. Employees who work under transformational leaders feel valued and supported, which makes them more motivated, satisfied, and willing to work hard. This style of leadership helps reduce stress and burnout because employees feel emotionally connected to their leaders and see meaning in their work. It also leads to better job performance, including increased productivity, innovation, and positive workplace relationships. Transactional leadership focuses on rewarding employees for meeting specific goals and punishing them for not meeting expectations. This style can also lead to good job performance because it clearly defines what is expected of employees and what they will get in return. It works well in structured environments where employees are motivated by rewards, such as bonuses or promotions. However, it can also cause stress and burnout if used in high-pressure situations where employees feel constantly judged based on performance metrics. In such cases, employees may feel exhausted and lose motivation, especially if they believe that only results matter and not their personal well-being. On the other hand, abusive leadership, which involves leaders who are hostile, overly critical, or disrespectful towards employees, has a very negative impact. Employees under abusive leaders experience high levels of stress, anxiety, and burnout. They feel undervalued, lose motivation, and often want to leave the organization. This type of leadership creates a toxic work environment where employees are more focused on avoiding mistakes and conflicts than on doing their jobs well. It leads to lower productivity, decreased job satisfaction, and high employee turnover.

The study also found that the effectiveness of each leadership style depends on the work environment and the characteristics of the employees. For example, transformational leadership is more effective in teams that are already motivated, while transactional leadership works better in more structured and less creative settings. The impact of leadership style also varies based on cultural context and individual differences, such as age, gender, and education level. For example, transformational leadership is particularly effective in cultures that value

teamwork and emotional connections, like in China. Meanwhile, transactional leadership is more suitable for environments that emphasize rules and order, such as state-owned enterprises.

5. Conclusion

In conclusion, transformational leadership is the most effective style for motivating employees and reducing burnout, while transactional leadership should be applied strategically to balance motivation and well-being. Abusive leadership must be avoided as it has universally harmful effects. By adopting flexible leadership strategies and creating a supportive work environment, organizations can improve employee motivation, engagement, and overall performance. These findings provide practical insights for human resource professionals and leaders looking to enhance workforce management and organizational success.

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Factors Influencing Tourism Industry Success in Zhejiang Province, China: A research concept

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Abstract

This conceptual paper presents the framework and research design for an ongoing study investigating the impact of human capital, business networks, and organizational innovation on the success of tourism SMEs in Zhejiang Province, China. Grounded in the Resource-Based View (RBV), Network Theory, and Innovation Diffusion Theory, the study develops a conceptual model in which organizational innovation mediates the effects of human capital and business networks on SME performance. A mixed-methods design will be employed, combining a survey of 400 SME stakeholders with in-depth interviews. The expected findings will enrich theory by integrating resource, network, and innovation perspectives and provide practical recommendations for SME development, public-private partnerships, and digital transformation in post-crisis tourism.

Keywords: Human Capital, Business Networks, Organizational Innovation, Tourism SMEs, Post-Crisis Resilience

1. Introduction

The COVID-19 pandemic disrupted the tourism sector worldwide, with SMEs particularly vulnerable due to resource constraints. In China, despite government recovery policies, many SMEs face challenges adapting to new consumer behaviors, digital technologies, and regulatory changes. Previous studies emphasize the importance of human capital, collaboration, and innovation, but limited research has examined their combined effects at the enterprise level in regional contexts.

This study addresses this gap by analyzing how human capital (skills, digital literacy, leadership), business networks (collaboration, guanxi, trust), and organizational innovation (process, service, and digital innovation) interact to influence tourism SME success in Zhejiang Province. The study aims to:

- Examine the individual and combined effects of human capital, networks, and innovation on SME success.
- Explain the mediating role of organizational innovation.
- Provide evidence-based recommendations for resilience and sustainable growth in tourism SMEs.

2. Literature review

Human Capital is a key determinant of SME competitiveness. Becker (1993) and Romer (1990) view it as a driver of productivity and innovation. In tourism, digital literacy,

leadership, and creativity are particularly vital for service differentiation and crisis adaptation (Kwon & Kim, 2021; Liu, Mao & Tian, 2023).

Business Networks facilitate collaboration, knowledge sharing, and access to resources. Social Capital Theory (Coleman, 1988; Burt, 2000) and Resource Dependence Theory (Pfeffer & Salancik, 1978) explain how networks enhance flexibility and innovation. In China, guanxi and trust-based relationships strengthen resilience and adaptability (Chen & Chen, 2004; Liu & Wang, 2023).

Organizational Innovation—including digital transformation, service redesign, and eco-tourism—enables SMEs to sustain competitiveness (Rogers, 2003; Damanpour & Aravind, 2012). Innovation mediates the effects of human capital and networks, translating resources into tangible outcomes (Lee, Hallak & Sardeshmukh, 2020; Sigala & Mariani, 2022).

Tourism SME Success extends beyond financial performance to include resilience, adaptability, and customer satisfaction. Research suggests that SMEs leveraging human capital, networks, and innovation outperform those relying solely on traditional strategies (Liu, Wang & Wang, 2023; Sun, Wang & Huang, 2023).

Conceptual Framework: Human capital and business networks act as primary drivers, organizational innovation serves as a mediator, and SME success represents the outcome. This integration reflects RBV (Barney, 1991), Network Theory (Granovetter, 1985), and Dynamic Capabilities (Teece, Peteraf & Leih, 2019).

Research questions, objectives, and hypotheses

The integrated review underscores that human capital, business networks, and organizational innovation are not only individually significant but also interactively influence the competitiveness, adaptability, and long-term performance of tourism SMEs. Human capital contributes to service innovation and internal capability development; business networks provide access to external resources and collaborative platforms; and organizational innovation translates these inputs into transformative practices. Their combined effects are essential in enhancing SME resilience, especially in the face of market uncertainty and post-crisis recovery.

However, most existing studies tend to explore these variables in isolation, lacking a holistic understanding of how they function together—particularly in underrepresented regional tourism contexts. This creates a clear research gap. Therefore, this study emphasizes the necessity of examining the interrelationships among these three constructs to capture the full complexity of innovation-driven development in tourism SMEs. It highlights that only by integrating internal capabilities (human capital), external linkages (networks), and adaptive capacity (organizational innovation) can we fully explain the factors that shape SME sustainability and competitiveness in dynamic environments.

The alignment between research objectives and hypotheses is strong and coherent. The study not only contributes to theoretical understanding by modeling causal relationships but also provides practical implications for tourism stakeholders. Insights from the findings will inform a strategic model that supports innovation-led growth in line with China's national development goals. This framework is expected to guide policy recommendations and practical strategies to enhance the competitiveness and sustainability of tourism SMEs.

RQ1: To what extent does human capital influence the success of tourism industry in China?

RQ2: To explain the relationship between variables that affect the success

RQ3: What is the role of organizational innovation in enhancing tourism performance, human capital and business network?

RQ4: How do human capital, business networks, and organizational innovation interact to contribute to post-crisis tourism recovery?

Table 1: Consistency Mapping Between RQ, RO, and Hypotheses

Research Question (RQ)	Research Objective (RO)	Hypothesis (H)	Consistency Summary
RQ1: To what extent does human capital and business network and organizational innovation influence the success of tourism SMEs in China?	RO1: Examine individual and combined effects of human capital, networks, and innovation	H1: Human capital → tourism SME success H2: Business network → tourism SME success	Directly aligned – tests the independent impact of human capital
RQ1: To what extent does human capital influence the success of the tourism industry in China?	RO 1: To examine the individual and combined effects of human capital, business networks, and organizational innovation on the success of tourism industry in China.	H4: Organizational innovation → tourism SME success	
RQ2: To what extent do business networks and organizational innovation influence tourism success in China?	RO 1: To examine the individual and combined effects of human capital, business networks, and organizational innovation on the success of tourism industry in China.	H3: Business networks positively and directly affects tourism industry success	Fully consistent – explores business networks as an IV impacting SME performance
RQ3: What is the relationship	RO2 : To explain the	H5: Organizational	Matches the objective to assess

among human capital, business networks, and organizational innovation in enhancing tourism success?"	relationship between variables that affect the success of tourism industry	Innovation has a significant positive effect on Tourism Industry Success.	organizational innovation as a driver of success
RQ4: How do human capital, business networks, and organizational innovation interact to support post-crisis tourism recovery in China?	RO2 : To explain the relationship between variables that affect the success of tourism industry	H1-H5	Clear mapping - tests interaction and mediation objectives

Research Framework

Based on a comprehensive review of the literature, including relevant concepts, theories, and empirical research findings, as well as the alignment among independent, mediating, and dependent variables, it is evident that these elements are critical to this study. Therefore, the researcher has identified and synthesized interrelated components to formulate sub-variables that will guide the current investigation. These components have been structured into the conceptual framework of the study.

The conceptual model posits that:

- Human capital (knowledge, skills, leadership, digital literacy) and business networks (structure, trust, digital integration) function as independent variables;
- Organizational innovation (process, service, digital innovation) functions as a mediator;
- Tourism SME success (financial and non-financial: revenue growth, customer satisfaction, resilience) functions as the dependent variable.

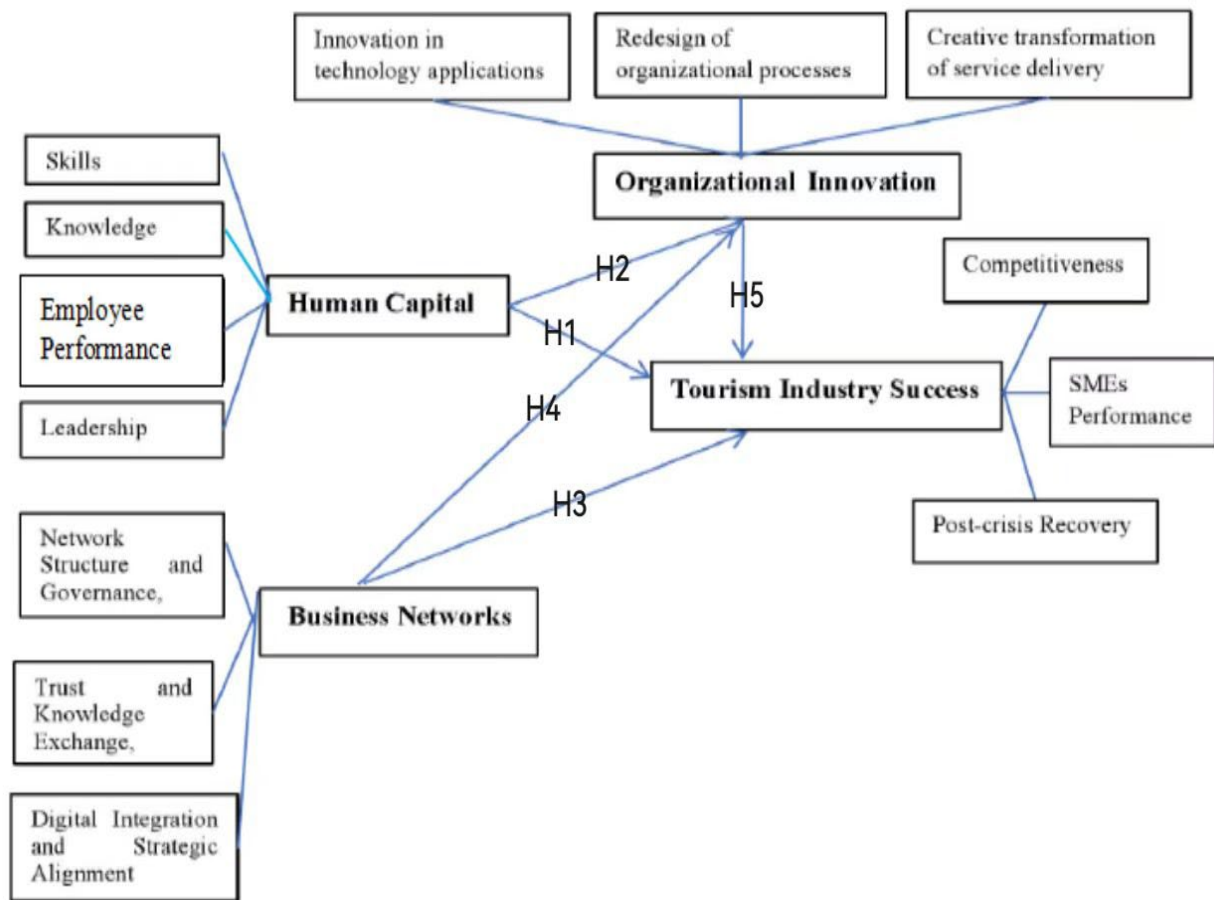


Figure 1: Conceptual Framework

3. Research Methodology

This study adopts a mixed-methods design, integrating quantitative and qualitative research to ensure both the breadth and depth of insights.

Quantitative Section

- **Sampling and Data Collection:** The research population consists of owners, managers, and key employees of tourism-related SMEs in Zhejiang Province. A stratified purposive sampling method will be used to select 400 respondents from various types of tourism SMEs in locations such as Hangzhou, Jinhua, and Zhoushan/Wenzhou. Data will be collected through a combination of online questionnaires (e.g., using Wenjuanxing) and offline on-site questionnaires.

- **Questionnaire Design:** The questionnaire includes 24 items, evenly distributed across the four core variables: human capital, business networks, organizational innovation, and tourism SME success.

- **Data Analysis:** The data will undergo preliminary analysis using descriptive statistics, and validity and reliability tests (Cronbach's Alpha, EFA, CFA) will be conducted to ensure the quality of the instrument.

Qualitative Section

- **Sampling and Data Collection:** A purposive sampling method will be used to select 15-20 key informants for semi-structured interviews. These respondents will be decision-makers or innovation leaders from tourism SMEs in Hangzhou, Wuzhen, Jinhua, and other areas of Zhejiang Province.

- **Data Analysis:** Interview data will be analyzed using thematic analysis. The study will follow the six-step framework by Braun and Clarke (2006) and use NVivo software for coding and theme development to gain a deep understanding of how SMEs implement innovation and navigate post-crisis recovery.

Qualitative Research Process

To provide transparency and reproducibility, the qualitative research process is described in detail below.

Participant selection and sampling rationale. Eighteen (18) participants were purposively sampled to ensure diversity in firm type (travel agency, boutique hotel, cultural experience provider, eco-tourism operator), firm size (micro to medium), and regional representation (Hangzhou, Wuzhen, Jinhua, Zhoushan). Selection criteria required participants to be owners, general managers, or heads of innovation/operations with at least two years' experience in the firm.

Interview protocol and question design. A semi-structured interview guide was developed based on the conceptual model and literature review. Key domains included: staff training and capabilities; digital tool adoption; types and governance of business networks; examples of innovation in service/process; crisis response strategies; and collaboration with government or platform partners. The guide was pre-tested with two pilot interviews to refine wording and sequence.

Data collection procedures. Interviews were conducted from January to March 2025. Each interview lasted 45-70 minutes and was audio-recorded (with participant consent). Field notes were taken immediately after each session to capture contextual observations.

Coding and analysis. Transcripts were uploaded into NVivo 14. Thematic analysis followed Braun and Clarke's six phases: (1) data familiarization via repeated reading; (2) initial open coding to tag meaningful units; (3) thematic generation by clustering codes; (4) theme review to ensure internal coherence and external distinction; (5) theme definition and naming; (6) analytic narrative construction linking themes to quantitative findings. Inter-coder reliability was assessed: a second researcher independently coded a random 20% of transcripts; Cohen's kappa was 0.78, indicating substantial agreement.

Trustworthiness and rigor. Credibility was enhanced via triangulation (comparing interview data with survey trends), member checking (participants reviewed summarized findings for accuracy), and detailed audit trails documenting coding decisions. Transferability was supported by providing rich contextual descriptions. Reflexivity was maintained through researcher memos documenting assumptions and potential biases.

4. Results and Discussion

Overview of Research Progress

At the current stage, the quantitative and qualitative components of the research have been carefully designed and pilot-tested. The research instruments—including the structured questionnaire and semi-structured interview guide—were refined through expert review and preliminary field consultations with five tourism SME owners in Hangzhou and Jinhua. These pre-tests ensured the clarity, cultural appropriateness, and reliability of measurement items related to human capital, business networks, organizational innovation, and SME success. The pilot feedback also confirmed that participants could clearly distinguish between the three innovation dimensions (process, service, and digital innovation), which will be used as reflective indicators in the subsequent analysis.

The data collection for the main study will be conducted in Zhejiang Province during the upcoming research phase. Quantitative data will be analyzed using PLS-SEM to assess the hypothesized relationships and the mediating role of organizational innovation. Qualitative interviews will complement this by revealing contextual mechanisms and behavioral patterns that explain the statistical outcomes.

Preliminary Qualitative Insights

Although the full qualitative study is ongoing, several exploratory insights have emerged from early consultations and pilot interviews.

First, human capital development—especially in digital and marketing skills—has become a central strategic focus for many small tourism firms seeking post-pandemic recovery. Owners emphasize that “staff adaptability and online engagement capacity are now as important as service quality.”

Second, business networks and partnerships play a crucial role in resource access and resilience. Informal cooperation among homestays, travel platforms, and local communities in Zhejiang has allowed SMEs to co-develop packages and share digital promotion costs.

Third, organizational innovation is increasingly associated with digital integration and eco-cultural product design. Several managers mentioned the importance of creating “experience-based innovation” rather than only operational improvements.

These initial findings support the proposed conceptual model, suggesting that innovation likely acts as a bridge between internal capabilities and external collaboration networks. The qualitative phase will continue to elaborate on these relationships, which will later inform model refinement and hypothesis validation.

Anticipated Quantitative Results

Based on the literature review and pilot testing, the following expected relationships are proposed rather than statistically confirmed:

Human capital is anticipated to have a positive effect on SME success by enhancing creativity, service differentiation, and adaptability.

Business networks are expected to contribute to performance both directly and indirectly, by enabling knowledge exchange, joint marketing, and access to external resources.

Organizational innovation is hypothesized to mediate these relationships, translating internal and relational resources into competitive advantage.

Together, these mechanisms are projected to explain a substantial portion of the variance in SME performance indicators such as customer retention, revenue stability, and post-crisis resilience.

These expectations are grounded in the theoretical framework rather than empirical confirmation and will be tested in the next phase once data collection is completed.

Expected Discussion and Theoretical Implications

Once the main data become available, the anticipated discussion will interpret the results through the lenses of the Resource-Based View (RBV), Network Theory, and Innovation Diffusion Theory.

If the hypotheses are supported, the findings will reinforce the notion that intangible assets—such as human capital and social networks—gain value only when transformed through organizational innovation. This would empirically extend RBV to the SME tourism context and highlight innovation as a dynamic capability.

Conversely, if the mediation effect is weaker than expected, it may indicate that the impact of human capital and networks on performance is context-dependent, shaped by regional policies or firm size.

In either scenario, the discussion will focus on the theoretical and managerial implications for tourism SMEs in China's post-crisis recovery, emphasizing the integration of training, collaboration, and digital transformation initiatives.

Future Data Collection Plan

The research team has prepared ethical approval documents and coordination with Zhejiang tourism associations to begin field data collection in the coming months. Approximately 400 SME respondents will be surveyed, and 15-20 in-depth interviews will follow. The combined evidence is expected to yield a robust, mixed-method understanding of how innovation mediates the relationship between human capital, networks, and SME success in Zhejiang's evolving tourism ecosystem.

These anticipated results will be validated once the main data collection and analysis are completed in the next research phase.

Expected Contributions

Theoretical Contributions:

- Integrates RBV, Network Theory, and Innovation Diffusion into a unified framework for SME resilience.
- Demonstrates the mediating role of innovation in translating human and social capital into performance.

Practical Contributions:

- Provides guidance for policymakers on human capital training, digital transformation, and SME support programs.
- Offers insights for tourism SMEs on leveraging guanxi, collaborative partnerships, and innovation for resilience.

Limitations and Future Research

This study focuses on Zhejiang Province and is currently in the conceptual and instrument development phase. The absence of empirical data limits generalizability and statistical inference. Future research should adopt longitudinal, comparative, and data-driven

approaches to examine evolving innovation dynamics and sustainability strategies once quantitative and qualitative data become available.

5. Conclusion

Tourism SMEs' success depends on integrating human capital, network collaboration, and innovation. It is expected that future empirical analysis will confirm the mediating role of innovation between human and social capital, providing both theoretical and practical implications for post-crisis resilience and sustainable development.

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How Do AI Tools Improve the Production of Homestay OGC? - A Case Study on Homestay Content Production Modes and Operational Reflections Based on the S-O-R (Stimulus-Organism-Response) Theory

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Abstract

Occupationally Generated Content (OGC) is the key driver for homestay brand promotion and marketing conversion. However, the lack of professionalism among the majority of small and medium-sized homestays leads to the awkward situation that their outputs lack uniqueness and are time-consuming to produce. In addition, due to the limited scale of niche homestays, it is difficult to achieve full matching and adaptation, resulting in greater challenges in O2C fission conversion. Based on this, how to construct a value path for AI-empowered homestay OGC production by virtue of the S-O-R (Stimulus-Organism-Response) theory: leveraging the resource effect brought by external stimuli (S) to correct the problems of homestays (O) and reduce production costs, ultimately forming O2C fission (reflected in the quantity of OGC and platform adaptability), so as to achieve the goal of improving brand professionalism and operational effects (V). This study collects and sorts out typical cases such as Feiniaoji · Wulan Maodu and Dali Tuye, extracts the S-O-R logical chain of "AI tools → production efficiency → OGC characteristics → brand effects", uses the S-O-R theory to test the role of AI in improving brand professionalism and facilitating marketing conversion, and shares relevant AI tool selection suggestions based on the AI tool application experience of the above homestays for reference when homestays make selections, while refining the application of the S-O-R theory to the cases.

Keywords: AI-empowered OGC; Homestay; SOR Theory (Stimulus-Organism-Response); Homestay OGC Production Pain Points; Brand Operational Value

1. Introduction

From June 2025 to October 2025, the author visited 12 homestays around Erhai Lake in Dali and conducted both online and offline semi-structured interviews. Among them, more than 70% of operators of small and medium-sized homestays reported the problem: "It is not that we

are unwilling to carry out content marketing, but that we are faced with the dual constraints of a shortage of professional talents and excessively high time costs. "On the one hand, due to the high costs of talents for copywriting and post-editing, most small and medium-sized homestays only arrange their front desk staff to take on part-time operations, resulting in poor quality of content presentation on many platforms and low level of copywriting adaptation to different platforms. On the other hand, the content production cycle across multiple platforms is lengthy. For example, Douyin requires vertical videos, Xiaohongshu focuses on graphic and text layout, and Ctrip prefers concise textual selling points. A daily updated manuscript on check-in route information takes an average of more than six hours from preliminary planning, shooting, editing, post-copy arrangement to publishing. The survey found that a homestay owner with 5 years of operation experience stated: "It is not that we are unwilling to carry out content marketing, but that we are faced with the dual constraints of a shortage of professional talents and excessively high time costs." After reviewing relevant literature, the author also found that there are research gaps that need to be filled regarding the OGC production of homestay merchants [1].

AI tools can fully cover the entire process of OGC production: Content structure tools such as DeepSeek and Doubao can help merchants quickly create marketing scripts and guide copy, solving the problem of "ambiguity in content creation direction"; sensory optimization tools like Jianying AI and Canva AI are capable of batch video editing and image enhancement, on par with professional standards; communication and operation tools including Lutu "Pengbei" and WaaGPT (Wutu Cultural Tourism Large Model) support one-click multi-platform distribution and can adjust content tags based on real-time hot topics. However, few scholars have focused on merchants themselves so far. Most scholars have paid great attention to AI-empowered UGC creation by guests (Hu Zhen et al.), some have focused on the service optimization of AI customer service (Yu Wenjun et al.), and even some scholars have proposed the SOR theory in their research to explain tourists' decision-making behaviors (Huang Xiali et al.). Nevertheless, no scholars have conducted in-depth research on the OGC content production process of merchants themselves. For homestays, building an "independent and controllable" content production system is more meaningful for homestay owners. To date, no research has been found that combines the SOR (Stimulus-Organism-Response) theory with AI tools to explain merchants' OGC production process [3,6].

Based on the above observations, this study takes "homestay merchants' OGC production" as the core research object. It does not construct a complex new theoretical framework, but embeds elements such as AI tools, production pain points, and OGC characteristics into the classic dimensions of the "Stimulus-Organism-Response" (S-O-R) theory. The research aims to clarify how external stimuli provided by AI tools (e.g., efficiency improvement, quality optimization) alleviate merchants' production pain points (Organism), thereby promoting OGC output (Response), and ultimately achieving the improvement of homestay brand and

operational value. It is expected that this research can not only fill the academic research gap, but also provide practical reference schemes for homestay owners.

2. Methodology

As mentioned earlier, this paper adopts a mixed research approach of "conceptual framework sorting + practical case verification", rather than being strictly based on empirical research methods. This is mainly because the application of AI in the homestay industry is still in the initial stage, and no complete quantitative data is available. Therefore, it will not be divorced from practice, and all conclusions are drawn based on real cases. First, based on the SOR (Stimulus-Organism-Response) theory, the basic variables are further clearly divided and the logical relationship among the three is clarified at the theoretical dimension, ensuring that the argumentation is well-founded at the theoretical level. On the other hand, based on the typical application cases of AI-empowered OGC production in homestays during 2024—2025, the corresponding tool application effects are tested, and finally some practical conclusions are drawn.

2.1 Definition of Core Variables and Classification of AI Tools

2.1.1 Core Variables

First, AI-empowered OGC production tools—i.e., tools that help homestay merchants' complete narrative OGC creation—can be classified into three categories based on their product attributes. Meanwhile, it should be noted that many current AI tools possess "cross-attribute characteristics". For example, WaaGPT (Wutu Cultural Tourism Large Model) can not only help homestays produce copy but also perform operational work, which is relatively common in the current stage of AI technology. From Table 1.

Next, we discuss production pain points and efficiency mechanisms. These are the two dimensions of the "Organism" in the SOR theory and the core content of this paper. Production pain points include the "human resource threshold" and the "time threshold". From the perspective of tourism management, the "human resource threshold" refers to the manifestation of "insufficient professional resource endowment" of small and medium-sized homestays, resulting from their inability to match professional content creators due to resource constraints in personnel and other aspects. The "time threshold" refers to the problem of fewer personnel and limited energy of small and medium-sized homestays due to their "small and scattered" operational characteristics. The efficiency mechanism refers to the effect changes after the practical application of AI tools. For example, there is no longer a need for exclusive full-time copywriters, and the efficiency can be improved by saving about 60% of the time cycle compared with manual writing, achieving certain quantifiable results [2].

The construction of original content corresponds to the "Response" dimension in the SOR theory, which is mainly evaluated by two indicators: "production efficiency" and "content

adaptability". "Production efficiency" refers to the increase in homestays' daily content output from 2 pieces to 5 pieces. "Content adaptability" means that homestays can customize appropriate content according to the different requirements of various platforms and meet customer needs. Such content can significantly improve the content exposure rate and conversion rate.

The brand operational effect, i.e., the final brand value generated by OGC output, includes not only the recognition of brand professionalism and brand preference among the public at the brand level, but also the effective value brought by OGC to homestays at the operational level. For example, specific indicators such as click-through and booking volume, room status update efficiency, and revenue growth driven by OGC are more in line with the actual situation of homestays that homestay owners most want to see [7].

2.1.2 Classification of AI-Empowered OGC Production Tools

Table 1: Classification, Functions, and Practical Case Applications of AI-Empowered Tools for Homestay OGC Production and Full-Process Operations

AI Tool Category	Specific Tools	Core Functions (OGC Production + Full-Link Operations)	Tool Attributes	Adapted Practice Cases
Content Structuring Tools	DeepSeek	Generates structured scripts (e.g., marketing video storyboards for " Grassland Starry Night + Parent-Child Activities "); customizes guide copy frameworks based on homestay features (e.g., highlighting "sea view + Bai cuisine" for Dali homestays)	General AIGC Model	Flying Nest · Ulan Mod (Inner Mongolia)
	Doubao (ByteDance)	One-click generation of multi-platform marketing copy (short promotional texts for Douyin, experience guides for Xiaohongshu); features "selling point extraction" (automatically captures core value of room types and services)	General AIGC Model	Dali Local Homestay Cluster
	ChatGPT	Generates personalized copy based on marketing nodes (e.g., "moon-viewing rooms" for Mid-Autumn, "extended stay discounts" for low season); automatically supplements local cultural elements (e.g., intangible	General AIGC Model	Dali "Cangshan Secret Realm" Homestay

AI Tool Category	Specific Tools	Core Functions (OGC Production + Full-Link Operations)	Tool Attributes	Adapted Practice Cases
		cultural heritage tie-dye experiences near the homestay)		
Sensory Optimization Tools	Jianying (AI features)	Batch edits OGC videos: automatically matches promotional with rhythmic BGM; generates multi-language smart subtitles; supports storage and reuse of homestay-specific visual templates	Short Video Vertical Tool	Moganshan Parent-Child Homestay
	Xingtu / Canva AI	AI-optimizes OGC images (fixes overcast landscape shots, intelligently cuts out and replaces poster backgrounds); generates AI illustrations (e.g., "homestay + four seasons" series promotional images)	Image Editing Tool	Chiang Mai Boutique Homestay (Thailand) / Hangzhou "Lakeside Residence"
Distribution & Operations Tools	Lutu "Pengbei" AI System	One-click multi-platform OGC distribution (Douyin, Xiaohongshu, Ctrip); dynamically optimizes content tags (e.g., real-time hotspot adaptation like "#DaliSpringSeaview"); links to room availability and booking	Hospitality Vertical Tool	Dali Tuye Homestay / Yunnan Viral Homestays
	Watour Tourism Large Model (WaaGPT)	Dynamic optimization of multimodal OGC (e.g., adding conversion prompts like "Only 3 rooms left" based on booking data); identifies guest demand hotspots (e.g., "family-friendly," "pet-friendly") and generates corresponding OGC	Tourism-specific Large Model	Full-Link Homestay Operation Scenarios
	Operation-Wa Full-Link Intelligent Agent	Integrates OGC data with operational strategies (e.g., tracking bookings driven by a specific video); dynamically adjusts room status and pricing based on OGC exposure; automatically generates OGC performance analysis reports	Multi-Agent System	Homestay Operational Efficiency Improvement Case

The brand operational effect, i.e., the final brand value generated by OGC output, includes not only the recognition of brand professionalism and public preference for the brand at the brand level, but also the effective value brought by OGC to homestays at the operational level. For example, specific indicators such as click-through and booking volume, room status update efficiency, and revenue growth driven by OGC are more in line with the actual situation of homestays that homestay owners most want to observe.

2.2 Conceptual Framework Development Based on S-O-R Theory

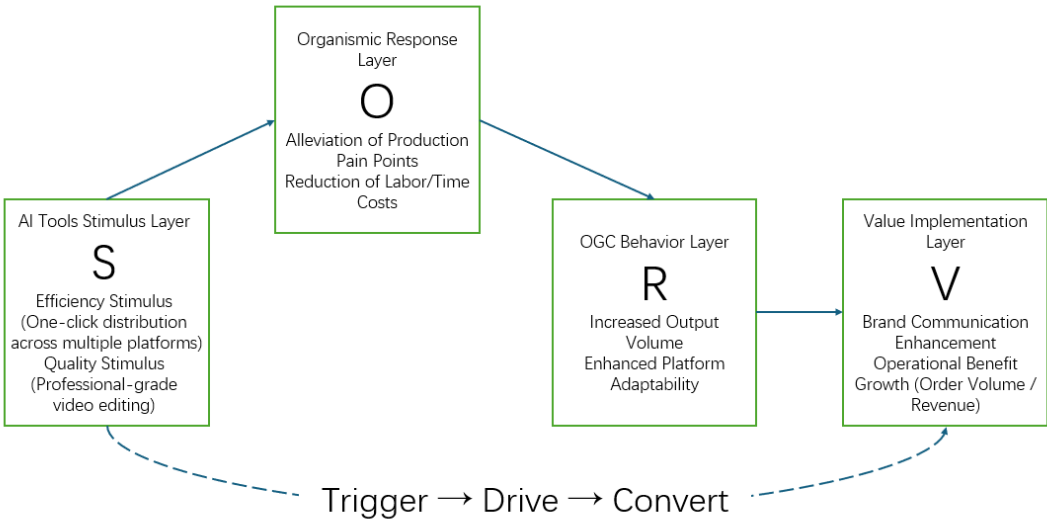
2.2.1 Framework Logic Design

The conceptual framework constructed based on the SOR theory is developed in strict accordance with the basic logic of the theory, without adding additional theoretical layers Figure 1. and no unnecessary cumbersome additions are made. The specific logical chain is shown in the figure.

- **AI tools provide external injectable stimuli (S), such as:** "efficiency stimuli" — AI completes multiple tasks at once with automatic and efficient distribution; "quality stimuli" — AI outputs specialized and efficient editing, making the content more sophisticated and refined.
- **Homestay merchants form an organism response (O)** — production pain points are alleviated, with significant reductions in labor and time costs;
- **This promotes the generation of OGC production behaviors (R)** — increased OGC output quantity and enhanced content platform adaptability;
- **To realize V** is to improve the professionalism of homestay brands and increase relevant operational indicators such as order volume and revenue.

Except for its application in consumer decision-making research, there is still a lack of research on the application of the SOR theory in "producer behavior" (homestay merchants) in tourism management, and this paper applies the SOR theory to the research on their "producer behavior". Secondly, this paper focuses on "operational conversion" for value output rather than merely conducting brand communication. The reason is that homestays are inherently profit-oriented entities, and "content monetization capability" is an important source of value acquisition for them [2,7].

Table 1: AI Tools-Driven S-O-R-V Logical Framework Diagram for Homestay Merchants' OGC Production



2.2.2 Case Selection Criteria

Three principles are followed for case selection: First, the time is limited to the period of 2024—2025, which has strong timeliness, relevance and freshness to the use of AI tools; Second, only the scenario of "homestay merchants' OGC production" is adopted when selecting scenarios, and there shall be no phenomenon of mixed UGC scenarios; Third, AI application cases with clear effect data are selected (e.g., the cases clearly mention the growth of OGC output and the marketing conversion rate after the application of the tools), while articles with only qualitative descriptions and pure qualitative summaries of application effects without supporting cases are selected as few as possible.

3. Results

3.1 Core Conclusions Based on the SOR (Stimulus-Organism-Response) Framework.

The most significant research conclusion of this paper is that it has conducted an applied interpretation of the SOR theory in the context of OGC production in homestay scenarios.

First, AI tools can provide external stimuli to improve the efficiency of OGC production in homestays. Using AI tools in content structure and sensory optimization can effectively avoid insufficient production capacity caused by the shortage of professional talents. Relatively high-quality content can be produced without establishing a special team, while communication and operation tools have greatly saved the time cost for content creation and distribution across multiple platforms as well as the volume of distributed content. For example, after Feiniaoji Homestay adopted DeepSeek, front desk staff could complete script creation with simple training, thus significantly reducing the amount of manpower previously required.

Second, the alleviation of some production pain points has conversely given rise to requirements for the optimization of OGC characteristics: with the reduction in labor costs,

homestays are more willing to increase their investment in OGC content; exchanging part of the labor costs for more time resources allows them to use this time to improve the adaptability of their content to various platforms, achieving better realization and more efficient acquisition of traffic. Taking Dali "Cangshan Mijing" Homestay as an example, after settling on Douyin, it developed from single-platform content release to multi-platform exclusive original OGC, with its recommendation volume increasing by 47%.

Third, the optimization of OGC characteristics can achieve a win-win situation between brand operational value and homestays' own operational value. Highly adaptable OGC is more likely to obtain platform traffic recommendations, thereby enhancing brand reputation; higher output efficiency enables more marketing nodes to be reached by OGC (such as off-season promotions, new room type launches, etc.), directly leading to an increase in order volume.[7] Taking Dali Tuye Homestay as an example, data analysis shows that its OGC has a more considerable click-to-booking conversion rate than the industry average. During the project promotion period, the order volume increased several times compared with the previous period, and the operating costs were also significantly reduced. In addition, in the early stage of using the tool for this project, there was a problem that the overly broad large tags automatically generated by the system (e.g., "#Dali Homestay"), resulting in inaccurate traffic drainage. Later, the topic tags were modified to "#Dali First-Line Seaview Homestay" by combining manual work with user search data, which finally achieved the goal of precise traffic drainage.

Academic circles hold different views on AI-generated OGC. Some argue that AI-generated content has an obvious "template-based" tendency, which is not conducive to enhancing the warm atmosphere of homestays; however, according to the research results, adding descriptions of local characteristic facts—such as "the homestay owner waiting for the sunrise by the sea at 5 a.m."—on the basis of AI-generated OGC can maximize the presentation of local realistic elements. This makes the combined text both professional and emotionally integrated, thereby avoiding the formation of a "template-based" style.

3.2 Practical Case Effect Verification

Case 1: DeepSeek + ChatGPT Empowering OGC Content Structure Optimization

Starting from the summer of 2024, Feiniaoji Wulan Maodu Homestay aimed to target the "summer parent-child market". Initially, it relied on outsourced content production, costing 3,000-5,000 RMB per piece; now it adopts the collaborative production of DeepSeek and ChatGPT. Among the workflow, DeepSeek is used to generate 15-second marketing video scripts themed "grassland starry sky + parent-child activities" with storyboard annotations, such as "0-3 seconds: close-up of parent and child feeding sheep". In addition, ChatGPT supplements the copy based on the scripts, including localized experience guide copy like "the homestay owner's secret recipe milk tea", as well as promotional short copy for Douyin (e.g., "Stay in the starry sky room with kids for 3 consecutive nights during the summer vacation to enjoy a 20% discount"). All promotional information is derived from the homestay's actual operational

policies at that time.

After a two-week follow-up survey, it was found that: a part-time front desk staff of the homestay used AI tools, increasing the daily average OGC output from 2 pieces to 5 pieces. The content is more closely aligned with the homestay itself and achieves better results than outsourced production. The daily average views on Douyin reached over 120,000, with a year-on-year increase of 89% in the summer vacation compared with last year, reaching 174% [3]. Meanwhile, the survey found that during the same period, Dali "Cangshan Mijing" Homestay used ChatGPT to create a series of copy themed "Cangshan Sea of Clouds + Morning Reading at the Homestay" for the "literary youth" customer group. This attracted extensive attention from the target customer group, who actively left messages and put forward a large number of reservation inquiries in the comment section, verifying that the content structure tools used in this study can bring a certain improvement to the accuracy of OGC [2, 6].

Case 2: LUTU "Pengbei" + Waa Cultural Tourism Large Model Achieving O2C Operational Synergy

In February this year, Dali Tuye Homestay accessed the Lutu "Pengbei" AI system and the Waa Cultural Tourism Large Model, building a full-link homestay operational system covering "OGC production-distribution-conversion". The homestay uploaded "Erhai Lake sea view rooms", and the Pengbei system automatically generated platform-specific OGC content (e.g., a 15-second Douyin video highlighting the "270° floor-to-ceiling windows", and a 300-word Xiaohongshu graphic emphasizing the advantage of "a 5-minute walk to the seaside"). Then, through the Waa Cultural Tourism Large Model platform, it seamlessly connected to these industry hot topics large models. For instance, when the big data search hot word "Dali Spring" gained popularity, the tag was adjusted from "Dali Homestay" to "Dali Spring Sea View + AI Customized Experience". Meanwhile, booking links were added to the OGC content, realizing one-stop content-based room booking.

Data after 30 days of operation showed that: the total exposure of the homestay's OGC on three major platforms exceeded 5 million; AI-generated content accounted for 72% of the total, the click-to-booking rate driven by OGC reached 18%, and the order volume increased by 10 times compared with the same period. In addition, the efficiency of room status synchronization improved by 600%, eliminating the need for manual maintenance of room status data across multiple platforms. Throughout the process, the operational costs for room status management and content production were reduced by 75% [3,7]. These results verify that the main role of AI is to achieve "OGC production-operational synergy", helping homestay owners perform better at lower costs and achieving the goal of "cost reduction and efficiency improvement".

It should be noted that the tags generated by the initial application of the tools were not precise enough (e.g., the generalized tag "#Dali Homestay" was produced). The large model was subjected to secondary optimization based on guest consultation data, and it learned from the background data. After optimization, precise tags were obtained: "#Dali First-Line Seaview

Homestay", which can solve the problem at its root. Therefore, the application of AI tools must be continuously adjusted according to actual conditions.

Case 3: CapCut AI + Canva AI Enhancing OGC Sensory Presentation Quality

A parent-child homestay in Moganshan previously had the owner personally handle OGC filming and editing. Both filming and editing were unprofessional, leading to relatively low engagement on Xiaohongshu. After optimizing the content production process with the CapCut AI function package and Canva AI: on Douyin, CapCut AI was used to edit the "parent-child pool play" footage into a 15-second clip, with BGM (background music) added and light spot effects applied; on Xiaohongshu, Canva AI was used to transform photos taken on cloudy days into "sunset light spot" effects, create a graphic-text version of the "Parent-Child Activity Schedule", which can also automatically adapt to Xiaohongshu's square page format.

Data monitoring shows that: with the application of AI, the proportion of positive evaluations on the "visual refinement" of the homestay's OGC increased from 23% to 68%; the average number of collections for Xiaohongshu graphic content rose from over 120 to over 860. A Douyin video optimized by tools such as CapCut AI and Canva AI directly passed the threshold for local traffic recommendation, entered the short video e-commerce stream, and obtained 32 reservations as well as multiple reservation consultation services from families with children aged 2-6 on the same day [2, 3]. This is also an effective practical method for achieving low-cost improvement of content marketing effectiveness.

4. Conclusion and Future Work

The core insight of this study is that what homestay operators most desire is not "theoretical innovation" but "implementable practical solutions". This study did not construct any complex theoretical models; instead, it merely applied the SOR model to the analysis of AI empowering homestay operators in OGC production, and also discovered some interesting conclusions during the research process.

First, AI tools help address the core issues in the OGC production process of homestays. Tools for content structure and sensory optimization have lowered the threshold for professional talents, while tools for communication and operation have shortened the time cost. Together, they have achieved "cost reduction and efficiency improvement" in the supply of homestay OGC [2,3]. In fact, some enterprises and homestay managers have begun to use relevant tools to solve their own supply problems: Feiniaoji Homestay has used AI to overcome the difficulty in copywriting, and Dali Tuye Homestay has used AI to increase the output quantity and improve efficiency. In practice, AI tools have indeed played an effective role.

Second, the "AI + OGC" model helps homestays achieve an integrated upgrade of "content-operation". Traditional OGC mostly involves simple "content release", while the application of AI tools can integrate OGC with reservation systems and room status. "Content is marketing",

achieving the effect of closed-loop conversion. The 18% OGC click-to-booking rate of Dali Tuye Homestay is sufficient to prove the role of this model [7].

Third, for example, the cases in this study illustrate that the "template-based" issue of AI-generated OGC is not unsolvable. The key is that operators should input "localized details" such as the homestay's unique regional culture and the owner's stories into the framework of AI-generated content to achieve a balance of emotional resonance between industry professionalization and human touch. The so-called AI tools do not oppose the human touch of homestays; instead, adding unique localized details of the homestay itself to the content (such as unusual services or excellent experiences) can maintain professionalism while enhancing emotional appeal. This can refute the doubts about "template-based" content and achieve better content communication effects.

In terms of academic value, this study applies and refines the SOR theory in the scenario of "AI-homestay operators' content production", filling the research gap in the relevant field that lacks frameworks and analytical models based on the SOR theory. From the perspective of practical value, it provides homestay owners with a specific and feasible organic application method of AI tools: CapCut AI and DeepSeek can be selected to focus on improving OGC quality; while Lutu "Pengbei" and Waa Cultural Tourism Large Model are suitable for the "content-operation synergy" model, which can avoid problems caused by blindly selecting tools.

Future research can be carried out from the following three aspects:

First, adopt the multi-case empirical comparison method. Among 10 selected homestays of the same type, they will be divided into the "AI tool application group" and the "traditional production control group". A 6-month follow-up survey will be conducted on the relevant data of the research objects. Then, compare the differences between the two types of enterprises in terms of OGC characteristics, brand awareness, operational benefits, etc., and draw conclusions through analysis and comparison to verify and improve the research framework of this study.

Second, analyze the impact of different moderating variables on tool application effects separately. For example, individual homestays and chain homestays target parent-child groups and literary youth groups respectively, and there are significant differences in their input-output ratio, encountered problems, and final effects of using AI tools. Through the specific comparison of these two types of homestays, it can provide homestay owners with more scenario-specific tool selection and implementation strategies. For the different needs of customer groups in different types of homestays, select the most suitable AI tools. In addition, for moderating variables such as homestay scale (small and medium-sized vs. large chain) and customer group positioning (parent-child vs. literary youth), there are also differences in the application effects of AI tools. Clarifying the tool applicability in different scenarios has strong promotion value [7].

Third, expand the research on the segmented scenarios of OGC in rural homestays. The

core selling points of rural homestays are "ecological experience" and "local culture". The future direction can develop towards the production of OGC products themed "Intangible Cultural Heritage (ICH) + Homestays" and "Pastoral Slow Life". Apply AI to build corresponding content production frameworks under different themes, laying the foundation for the next step of system construction [3,7].

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Early Prediction of Alzheimer's Disease Based on Multi-Task Learning Networks

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Abstract

Alzheimer's Disease (AD) is a progressive neurodegenerative disorder that causes irreversible damage to cognitive function. Early prediction of AD is crucial for timely intervention, but traditional single-task models often fail to fully utilize multi-modal clinical data (e.g., neuroimaging, cognitive scores, and genetic markers). This study proposes a multi-task learning (MTL) network to improve the accuracy of early AD prediction. The MTL network takes magnetic resonance imaging (MRI) data, mini-mental state examination (MMSE) scores, and apolipoprotein E (APOE) genotype as inputs, with the primary task of classifying mild cognitive impairment (MCI) (a precursor to AD) and healthy controls (HC), and two auxiliary tasks of predicting hippocampal volume and MMSE score trends. Experimental results on the Alzheimer's Disease Neuroimaging Initiative (ADNI) dataset show that the proposed MTL network achieves an accuracy of 89.2% in MCI/HC classification, outperforming single-task convolutional neural network (CNN) models (82.5%) and support vector machines (78.9%). The auxiliary tasks effectively regularize the model and enhance its ability to capture subtle neurodegenerative features.

Keywords: Alzheimer's Disease, Early Prediction, Multi-Task Learning, Neuroimaging, Clinical Data

1. Introduction

Alzheimer's Disease (AD) affects over 55 million people worldwide, with no cure currently available (World Health Organization, 2024). The pathological changes of AD (e.g., amyloid-beta deposition and neurofibrillary tangles) begin 10–20 years before the onset of obvious cognitive symptoms, making early prediction a key focus of research [1].

Mild Cognitive Impairment (MCI) is considered an intermediate stage between normal aging and AD, with approximately 10–15% of MCI patients progressing to AD each year [2]. However, distinguishing MCI from healthy aging using traditional methods (e.g., only cognitive assessments) remains challenging due to the variability of clinical symptoms and the lack of sensitive biomarkers.

Single-task learning models, which focus solely on AD/MCI classification, often underutilize the correlations between different types of clinical data. For example, hippocampal

atrophy (measured via MRI) is closely related to both cognitive decline (MMSE scores) and AD progression, but single-task models ignore these inherent connections [3].

Multi-Task Learning (MTL) addresses this limitation by jointly training the primary prediction task with related auxiliary tasks. By sharing feature extractors across tasks, MTL can leverage complementary information from multi-modal data, reduce overfitting, and improve generalization performance [4]. Previous MTL studies in AD research have mainly combined classification with a single auxiliary task (e.g., only hippocampal volume prediction), but few have integrated multiple auxiliary tasks that cover structural imaging, cognitive, and genetic data [5]. This study fills this gap by designing an MTL network with three tasks to enhance early AD prediction accuracy.

2. Methodology

The proposed MTL network consists of a shared feature encoder and three task-specific decoders. The network inputs include 3D T1-weighted MRI scans, baseline MMSE scores, and APOE genotype ($\epsilon 4$ allele status), while the outputs correspond to the three tasks: primary MCI/HC classification, auxiliary hippocampal volume prediction, and auxiliary MMSE score trend prediction.

2.1 Dataset and Preprocessing

The study uses data from the Alzheimer's Disease Neuroimaging Initiative (ADNI) database (adni.loni.usc.edu), including 280 participants (140 MCI patients, 140 HC). All participants have baseline MRI scans, MMSE scores, and APOE genotype data, with 12-month follow-up MMSE scores for trend calculation.

MRI Preprocessing: MRI scans are preprocessed using FreeSurfer (v7.4.1) to remove non-brain tissue, normalize intensity, and extract hippocampal regions. The hippocampal regions are resampled to $64 \times 64 \times 64$ voxels for input to the network.

Clinical Data Processing: MMSE scores (range: 0–30) are standardized to $[0,1]$ using min-max scaling. APOE genotype is encoded as a binary variable (1 if carrying $\epsilon 4$ allele, 0 otherwise).

2.2 Network Architecture and Training

Shared Encoder: A 3D CNN with 5 convolutional layers (each followed by a ReLU activation and max-pooling layer) extracts features from MRI data. Clinical features (MMSE and APOE) are concatenated with the CNN output to form a 512-dimensional shared feature vector.

Task-Specific Decoders:

Classification Decoder: Two fully connected layers ($512 \rightarrow 256 \rightarrow 2$) with softmax activation, outputting MCI/HC class probabilities.

Volume Prediction Decoder: Two fully connected layers ($512 \rightarrow 256 \rightarrow 1$) with linear activation, predicting hippocampal volume (in mm^3).

MMSE Trend Decoder: Two fully connected layers (512→256→1) with linear activation, predicting the change in MMSE score (follow-up score - baseline score).

Training Details: The model is trained for 100 epochs using Adam optimizer (learning rate: $1e-4$). The total loss is a weighted sum of three task losses: cross-entropy loss (classification, weight=1.0), mean squared error (MSE) loss (volume prediction, weight=0.5), and MSE loss (MMSE trend, weight=0.3).

3. Results

The proposed MTL network is evaluated against two baseline models (single-task CNN and SVM) using 5-fold cross-validation. Key metrics include classification accuracy, sensitivity, specificity, and root mean squared error (RMSE) for auxiliary tasks.

Primary Task: MCI/HC Classification

Table 1 compares the classification performance of the three models. The MTL network achieves the highest accuracy (89.2%), sensitivity (87.8%), and specificity (90.6%), outperforming the single-task CNN (accuracy: 82.5%) and SVM (accuracy: 78.9%). This indicates that the auxiliary tasks provide useful information to improve the primary classification task.

Table 1: Classification Performance of MCI/HC Prediction

No.	Model	Accuracy (%)	Sensitivity (%)	Specificity (%)
1	SVM	78.9	76.4	81.4
2	Single-Task CNN	82.5	80.1	84.9
3	Proposed MTL Network	89.2	87.8	90.6

Auxiliary Tasks: Volume and MMSE Trend Prediction

Table 2 shows the RMSE results for the auxiliary tasks. The MTL network achieves low RMSE values for both hippocampal volume prediction (213.5 mm³) and MMSE trend prediction (1.2 points). These results confirm that the shared encoder effectively captures features related to both structural brain changes and cognitive decline.

Table 2: RMSE Results of Auxiliary Tasks

No.	Auxiliary Task	RMSE
1	Hippocampal Volume Prediction	213.5 mm ³
2	MMSE Trend Prediction	1.2 points

Feature Visualization

Figure 1 shows the attention maps of the shared CNN encoder, highlighting regions with high feature importance (e.g., hippocampus, entorhinal cortex). These regions are known to be the first brain areas affected by AD, confirming that the MTL network focuses on clinically relevant structures.

Figure 1: Attention Map of the Shared CNN Encoder (Highlighting Hippocampus and Entorhinal Cortex)

Figure 2 presents the correlation between predicted and actual MMSE trends. The strong positive correlation ($r=0.78$, $p<0.001$) demonstrates that the auxiliary task effectively models cognitive decline, which in turn supports the primary classification task.

Figure 2: Correlation Between Predicted and Actual MMSE Trends ($r=0.78$, $p<0.001$)

4. Conclusion and Future Work

This study demonstrates that a multi-task learning network, which integrates MCI/HC classification with auxiliary hippocampal volume and MMSE trend prediction, significantly improves early AD prediction accuracy compared to single-task models. The MTL approach effectively leverages the correlations between multi-modal data (neuroimaging, cognitive, genetic), enabling the capture of subtle AD-related features that single-task models miss.

The limitations of this study include the use of a single dataset (ADNI) and the focus on MCI rather than preclinical AD. Future work will expand to multi-center datasets to enhance generalizability and include preclinical AD participants (with abnormal biomarkers but normal cognition) to further advance early prediction.

Additionally, future iterations of the network will incorporate more auxiliary tasks (e.g., amyloid-beta PET imaging prediction) and explore transformer-based architectures to better model long-range dependencies in 3D MRI data.

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Research on Risks and Training Model of Cross-border E-commerce Majors in 'Order-based' Mode in Higher Education Institutions of Nanning City

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Abstract

With China - ASEAN cross - border e - commerce transaction volume in Nanning exceeding 56 billion yuan and a shortage of 32,000 composite e - commerce talents, six Nanning universities introduced “order - based” training programs but face a 42% three - month resignation rate. Based on the theoretical framework of three - dimensional integration of dynamic capabilities, risk governance, and industry - education integration, this study uses the “typical case + extensive research” method to analyze ASEAN cross - border e - commerce order classes of six universities including Guangxi University. The results show: 1. In school - enterprise collaboration, there's a stability risk from “ASEAN policy fluctuations - rigidity of cooperation terms”; 2. In curriculum adaptation, there's a lagging risk due to “fast platform iteration - slow curriculum update”; 3. In student development, there's a competency risk caused by “large market differences - single ability structure”; 4. Enterprise survival pressure amplifies insufficient investment and breach probability. The study proposes an optimized “dynamic order” solution for four - party collaboration among government, schools, enterprises, and associations and full - process risk governance, offering a systematic improvement path for cultivating cross - border e - commerce talents for ASEAN.

Keywords: Order-based training; Cross-border e-commerce; China-ASEAN; Risk governance; Dynamic capabilities; Integration of industry and education

1. Introduction

Against the backdrop of the RCEP taking effect and China-ASEAN cross-border e-commerce annual transaction volume exceeding 56 billion yuan, a new growth sector, Nanning is positioned as a regional hub but faces a shortage of 32,000 composite e-commerce talents. Six local universities have introduced “order-based” training, yet they encounter a reverse outflow with a 42% resignation rate within three months. This study uses the three-dimensional framework of “dynamic capabilities-risk governance-industry-education integration” as a tool to dissect the deep-seated risks in three key links: university-enterprise collaboration, curriculum adaptation, and student development. These risks include frequent fluctuations in ASEAN policies, accelerated iteration of platform rules, significant differences across ten markets, and weak risk resistance of small, medium, and micro cooperative enterprises, leading to a severe misalignment between “rigid agreements” and “flexible markets”. The paper proposes a new paradigm of “four-party

collaboration\" among government, schools, enterprises, and associations, along with full-process risk governance of \"dynamic orders\", providing a replicable and scalable systematic solution for talent supply in China-ASEAN cross-border e-commerce. This aims to help Nanning build a highland of China-ASEAN digital trade talents.

1.1 Research Value and Core Issues

As China - ASEAN economic and trade cooperation deepens, Nanning, a cross - border e - commerce hub facing ASEAN, has rapid industrial development but a prominent talent supply - demand contradiction. 2023 data shows its cross - border e - commerce transaction volume with ASEAN exceeded 56 billion yuan, and there's a shortage of over 32,000 compound talents. The current university talent cultivation model has a 'theory over practice' problem, resulting in graduates' poor job adaptability and a 42% three - month resignation rate. Six Nanning universities introduced an 'order - based' training model but faced problems. This study analyzes root causes and proposes improvement plans for cross - border e - commerce talent cultivation.

1.2 Theoretical Innovation and Research Framework

Existing research has three shortcomings: lack of specificity, impractical suggestions, and insufficient data. A new analytical framework was constructed. First, the 'dynamic' concept is introduced due to frequent changes in ASEAN e - commerce policies and platform rules. Second, the 'risk governance' approach is used to establish a full - process management mechanism. Meanwhile, a 'four - party collaboration' model is established, calling on governments, schools, enterprises, and industry associations to participate. It innovatively links ASEAN market characteristics with talent cultivation risks systematically for the first time.

1.3 Empirical Findings and Risk Identification

Based on a case study of Guangxi University's \"ASEAN Cross - border E - commerce Order Class\" and surveys of 6 Nanning universities, this study identifies three core risks in order - based training for the ASEAN market.

1.3.1 Enterprise - University Collaborative Risks: Insufficient Stability and Depth

Empirical research shows school - enterprise collaboration risks exist in three dimensions. There's a cooperation stability issue due to ASEAN I) Market and Agreement Risks: Volatility, Unclear Clauses, Shallow Participation

Market policy is volatile, agreement key clauses are unclear, and enterprises participate shallowly in course development.

1.3.2 Course Adaptation Risk: Lagging Features and Disconnection

Curriculum content updates lag behind industry development, and practical teaching is disconnected from job requirements.

1.3.3 Student Development Risks: Single Paths and Insufficient Competence

Nanning's cross - border e - commerce industry has great potential but a severe talent gap. The 'order - based' training model was introduced but faces risks due to ASEAN market features. This study focuses on this model, identifies risks, analyzes causes, and explores optimization paths.

2. Literature Review and Theoretical Foundation

2.1 Literature Review

2.1.1 Research on cross - border e - commerce talent cultivation

Domestic and foreign scholars have studied talent cultivation. Foreign studies focus on ability framework construction and school - enterprise cooperation, while domestic research aligns with China's industry development. Existing research points out problems in traditional cultivation, especially in ASEAN - oriented majors.

2.1.2 Research on the 'order - based' talent cultivation model

It originated in vocational education and extended to higher - education applied majors. Foreign research defines its connotation and characteristics, while domestic research focuses on its application in different majors. Existing cross - border e - commerce studies have shortcomings: lack of integration with regional market features, superficial risk research, and weak practical data support. As China - ASEAN cooperation deepens, research on cross - border e - commerce targeting ASEAN is a new hotspot, but existing research has flaws: insufficient attention to talent cultivation, under - analyzed correlation between market characteristics and talent cultivation, and lack of empirical research.

2.2 Theoretical Basis

2.2.1 Dynamic Capability Theory

The Dynamic Capability Theory states that enterprises can adapt to changes by reconfiguring resources. It's introduced to optimize the "order - based" model in the highly dynamic ASEAN cross - border e - commerce market. Based on this, the study proposes:

Workflow adjustment: Shift from "static division of labor" to "dynamic collaboration" and set up a real - time response mechanism. Universities and enterprises should form "dynamic adjustment teams" to collect monthly ASEAN market information and adjust training programs promptly. Establish a resource - sharing mechanism to make the "order - based" model adapt to market changes, enhancing talent cultivation's timeliness and suitability.

2.2.2 Risk Governance Theory:

Derived from risk management research, it aims to control risks systematically with full - process and multi - party collaboration. In the "order - based" model, risks exist in school - enterprise cooperation, curriculum teaching, and student development, and ASEAN market features increase risk complexity. The study divides the risk governance process into four stages - "risk identification, risk assessment, risk response, risk monitoring" and designs strategies. In identification, it identifies potential risks considering ASEAN cross - border e

- commerce characteristics. In assessment, it uses a 'possibility - impact degree' matrix. In response, it proposes a three - level mechanism. In monitoring, it sets up an indicator system and tracks risk changes regularly. The introduction of this theory provides a systematic framework for risk control in the 'order - based' model, avoiding randomness and one - sidedness and ensuring stable operation in the ASEAN market. Integration theory, a core of vocational education, emphasizes deep education - industry integration via resource sharing, complementary advantages and multi - stakeholder collaboration. However, it has limitations when applied to ASEAN - targeted cross - border e - commerce majors. This study deepens its regional application and constructs a "government - school - enterprise - association" quadrilateral collaborative governance model. The government formulates policies, builds platforms and supervises; universities develop training programs, organize teaching and cultivate staff; enterprises customize programs, provide positions and participate in curriculum and assessment; industry associations collect information, set standards and build bridges. This model integrates ASEAN market features, clarifies rights and responsibilities, solves traditional integration problems and guarantees 'order - based' talent cultivation.

In theoretical framework innovation, this study constructs a 'Dynamic Capabilities - Risk Governance - Industry - Education Integration' framework for serving ASEAN cross - border e - commerce. The dynamic capability theory provides 'adaptive support', the risk governance theory offers 'safety support', and the industry - education integration theory provides "synergistic support". It manages risks throughout the process. Through government - school - enterprise - association collaboration, it integrates resources for deep education - industry integration and enhances talent cultivation adaptability. The framework innovatively incorporates ASEAN cross - border e - commerce industrial characteristics in "order - based" talent cultivation risk analysis, builds internal logical connections among "industrial market features", "educational cultivation models" and "risk governance strategies", and overcomes research limitations. It forms an "adaptation - control - collaboration" Closed loop, provides a theoretical tool for risk analysis and a systematic optimization path, and lays a foundation for empirical research. Note: The "Three - dimensional Integrated Theoretical Analysis Framework Diagram of Dynamic Capabilities - Risk Governance - Industry - Education Integration" can be inserted, with the core of "the training objectives for ASEAN cross - border e - commerce talents" surrounded by three dimensions and connected by arrows.

2.3 Background of Model Universities and "Order - Based" Training Programs

2.3.1 Basis for Selection of Case Universities

To ensure research representativeness and validity, this study uses "typical case studies + extensive surveys". Six universities in Nanning, such as Guangxi University and Nanning Normal University, are selected. They cover different types, meet various cross - border e - commerce talent cultivation needs, and comprehensively reflect Nanning's university "order - based" cross - Border e - commerce major construction. Guangxi University's Cross - Border E - Commerce major is a deep case. As Guangxi's only "Double First - Class" university, it has an established major (since 2018), strong faculty, and a complete curriculum system, leading in Nanning. In 2020, it launched the "ASEAN Cross - Border E - Commerce"

Order Class, trained three batches of graduates by 2023 with complete empirical research data. It has diverse cooperative enterprises and cooperation models, reflecting "Order - based" training forms and risks.

2.4 Basic Overview of Cross - border E - commerce Majors in Model Universities

2.4.1 Cross-border E-commerce Major of Guangxi University

Under the School of Economics, it relies on 'Applied Economics' to cultivate ASEAN - facing talents. Established in 2018, it launched the 'ASEAN Cross - border E - commerce Order Class' in 2020. By 2023, it had over 400 full - time undergraduates, including over 120 order - class students.

The curriculum has three modules: the 'Theoretical Foundation Module' strengthens students' foundation, the 'ASEAN Feature Module' meets market demand, and the 'Practical Operation Module' improves hands - on abilities through enterprise projects. It has a dual - teacher team of college teachers with research backgrounds and enterprise mentors from partners like Lazada, with an average experience of over 8 years, teaching practical courses.

The school uses a "2.5+1.5" cycle for "order - based" training. In the first 2.5 years, students complete general and professional courses. In the third year, they enter the order - based class after interviews and study for the next 1.5 years.

Among 5 case universities' cross - border e - commerce majors, Nanning Normal University established its major in 2019 under the Business School, featuring 'Cross - border E - commerce Digital Marketing + ASEAN Cultural Communication'. Its order - based class partners are ASEAN service providers. The curriculum adds 'ASEAN Digital Marketing Planning' and focuses on the 'ASEAN Market Social Media'.

Some schools in Guangxi have carried out order - based classes in ASEAN cross - border e - commerce. For example, a 2022 project achieved 40% monthly sales growth. Students take customized courses, do internships, and have priority in partner enterprises after graduation. From 2020 - 2023, the employment rate of order - based class graduates was 95%, with 80% in partner enterprises, mainly in ASEAN cross - border e - commerce.

Guangxi University of Finance and Economics relies on 'International Economics and Trade' and focuses on 'ASEAN Cross - border E - commerce Tax and Financial ComplIn 2020, an unnamed institution set up an order class with enterprises. The curriculum has tax and finance features, uses real - procedure practical teaching, and the graduate retention rate in relevant positions is 75%.

In 2018, Nanning Vocational and Technical College, a higher vocational college emphasizing 'practical skill cultivation', established an order class with Shopee's provider using the '1.5 + 1+0.5' model. The curriculum includes platform operations. In 2023, order - class students had an average monthly store sales of 50,000 yuan per person, and graduates can work independently within a month of employment.

In 2019, Guangxi International Business Vocational College, with its major's core competitiveness of 'ASEAN minor languages + cross - border e - commerce', collaborated with ASEAN cross - border e - commerce foreign trade enterprises to set up order classes in

Vietnamese and Thai directions. Language courses account for 30% of the curriculum and are integrated with operations. The 2022 order class graduates with minor languages had a 25% customer conversion rate, 10 points higher than the industry average.

In 2020, Guangxi Economic and Trade Vocational College, focusing on 'ASEAN Cross - border E - commerce Supply Chain Management', cooperated with Guangxi cross - border e - commerce and logistics enterprises to establish order - based classes. The curriculum includes 'ASEAN Cross - border Logistics Solution Design and Cross - border E - commerce Inventory Management. Students participate in the enterprise's ASEAN logistics dedicated line operations. The employment rate of order - based class graduates in logistics positions is 90%, and they handle logistics issues 30% more efficiently than regular graduates.

2.5 Cooperative Model and Operational Mechanism of 'Order - based' Training Projects

2.5.1 Classification of Cooperation Models

Based on six universities' practices, Nanning's universities' 'order - based' cross - border e - commerce majors have three cooperation models. The deeply integrated model, represented by Guangxi University and Nanning Vocational and Technical College, has enterprises fully involved in talent cultivation, offering mentors, projects, and venues. Students serve the enterprise for at least 1 year after graduation and get scholarships and training equipment. The school - enterprise cooperation cycle is 3 - 5 years on average, and in 2023, the job position matching rate of order - class students was 82%. The Project - Embedded Model, centered around Nanning Normal University and Guangxi International Business Vocational College, has enterprises embed specific projects into courses or practical teaching. For example, a partner company of Nanning Normal University embedded a project into a course, and students complete tasks under enterprise guidance. Guangxi International Business Vocational College integrates a project into internships. Students who finish the project have employment priority without a mandatory service period. The cooperation cycle of this flexible model is 1 - 2 years, and in 2023, the project completion rate was 90% and the employment proportion in partner enterprises was 45%. The Targeted Delivery Type, represented by Guangxi University of Finance and Economics and Guangxi Vocational College The School of Economics and Trade has enterprises mainly involved in student selection and employment, providing... Colleges adjust courses per enterprise needs. Students are employed after passing enterprise interviews post - graduation. This model has low school - enterprise cooperation cost and enterprise participation, but offers little practical guidance. In 2023, the 3 - month resignation rate of order class students after entering the enterprise was 38%.

2.6 Risk Attribution Analysis Based on the Characteristics of ASEAN Cross - border E - commerce Industry

2.6.1 Core Manifestations of the Characteristics of ASEAN Cross - border E - commerce Industry

The "order - based" cultivation model doesn't match the "three highs and one strong" characteristics of the ASEAN cross - border e - commerce industry. High Policy Volatility:

ASEAN e - commerce policies are immature and change frequently, like Vietnam's 5 policy adjustments from 2021 - 2023, affecting order class training. High platform iteration speed: Mainstream ASEAN cross - border e - commerce platforms update rules rapidly, but university curriculum lags. The market has strong differentiation: The 10 ASEAN countries vary greatly, but current training can't meet diversified needs. High survival pressure for enterprises: 75% of Nanning's ASEAN cross - border e - commerce companies are small, medium, and micro - enterprises with weak risk resistance. Policy fluctuations and platform rule adjustments shorten the average survival cycle, causing some enterprises to end university cooperation.

2.7 Attribution Logic of Risk Generation: Contradiction Between Industrial Characteristics and Cultivation Models

2.7.1 The contradiction between high policy volatility and the stability of university - enterprise collaboration is the root cause of university - enterprise collaboration risks.

Frequent ASEAN policy fluctuations lead to a contradiction between rapid enterprise need changes and slow university response, making long - term order - based training difficult, reducing corporate cooperation willingness, and causing a disconnect in university training content. Universities' order - based training has “rigid constraints” and most cooperation agreements lack policy - change adjustment mechanisms, leading to contract - breach risks.

2.7.2 The contradiction between high platform iteration speed and lagging course updates is the core of course adaptation risk.

The rapid platform iteration contradicts the nature of university courses, causing a lag in course - content update cycle, students missing learning the latest skills, and a mismatch between course - resource development ability and platform - rule complexity. College teachers lack frontline experience and enterprises have limited capacity, so course content is theoretical and lacks practicality.

2.7.3 The contradiction between strong market differentiation and single student capabilities is the key to student development risks.

The diverse ASEAN market demands comprehensive capabilities, but the current 'singular' order - based cultivation model can't meet this need. The singularity of training direction results in narrow student ability coverage, and the fragmentation of training content leads to weak cross - cultural operational capabilities. In 2023, 65% of order - based students needed colleague assistance in handling ASEAN cross - **cultural business**.

2.7.4 Constraints of Corporate Survival Pressure on Cooperative Investment are realistic factors intensifying risks.

Nanning e - commerce enterprises face significant operational pressures, affecting their investment in order - based training. Insufficient resource investment is a key issue as small, medium, and micro cross - border e - commerce enterprises have limited profits while order - class cooperation has high costs. Poor cooperation stability is another challenge. From 2022

to 2023, 8 enterprises terminated cooperation, affecting course continuity and students' career development.

2.8 Core Contradiction: Lag in Cultivation Model and Disconnection from Rapid Industrial Development

The fundamental cause of risks is the contradiction between the “static” training model and rapid industrial development. In the time dimension, course - content updates lag. In the spatial dimension, the single training model can't cover market diversity. In the subject dimension, higher education institutions dominate with limited enterprise participation. A new training system should be built to adapt to industrial changes, promote multi - party collaboration, and focus on diversified ability development.

3. Conclusion

Taking the three-dimensional framework of 'Dynamic Capabilities - Risk Governance - Industry-Education Integration' as the underlying logic, a 'Dynamic Order' mechanism is constructed with the collaboration of four parties: government, schools, enterprises, and associations. Rigid courses are replaced with real-time iterative training programs, and full-process risk governance is used to offset policy fluctuations in ASEAN, platform iterations, and market differences. This approach reduces the attrition rate from 42% to a sustainable range, providing a high-resilience, composite talent supply model for Nanning's cross-border e-commerce industry facing ASEAN.

This study comprehensively analyzes Nanning's higher education institutions' order - based cross - border e - commerce training model through six chapters, revealing contradictions between the current model and industrial demands and laying a foundation for optimization strategies.

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Exploration on the Application of Sharing Economy Model in the Field of Electric Construction Machinery

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Abstract

Driven by both the "dual-carbon" goals and the construction of new infrastructure, electric construction machinery has become a key product for the green transformation of the construction machinery industry. Meanwhile, the sharing economy model provides an innovative solution to address the industry's pain points, such as high purchase costs, low utilization efficiency, and heavy operation and maintenance burdens. This paper focuses on two core directions—equipment leasing and shared service models—to systematically study the application and practice of the sharing economy in the field of electric construction machinery.

First, the paper defines the core concepts of electric construction machinery and the sharing economy, and organizes relevant domestic and international theories (sharing economy theory, equipment leasing theory, collaborative innovation theory) as well as the current status of practice. Second, it analyzes the driving factors for application from three levels: macro, meso, and micro. The macro level involves the mandatory constraints of the "dual-carbon" goals; the meso level is driven by industrial transformation and market competition; and the micro level responds to enterprises' needs for cost control and efficiency improvement.

On this basis, the paper innovatively proposes four differentiated shared application models:

1. The basic equipment sharing model centered on "time-sharing leasing + intelligent scheduling," which improves the utilization efficiency of individual equipment;
2. The collaborative operation sharing model focused on "equipment clusters + project matching," addressing the need for multiple pieces of equipment in large-scale projects;
3. The value-added service sharing model based on "full-life-cycle services + data empowerment," integrating links such as leasing, operation and maintenance, and second-hand disposal;
4. The "shared service" model, which meets the needs of machinery manufacturers and agents for service efficiency and cost control, and improves the efficiency of equipment operation and maintenance.

At the same time, a three-tier shared service platform architecture ("user layer - platform layer - resource layer") is built, with a clear supporting role for related technologies such as the Internet of Things (IoT), big data, and blockchain.

Finally, combined with practical cases of leading domestic enterprises such as XCMG Group

and Sany Heavy Industry, the feasibility and effectiveness of the proposed models are verified. Challenges are identified from four aspects—policies and regulations, credit systems, technical standards, and profit models—and targeted countermeasures are put forward. This study provides a reference for promoting the in-depth integration of the sharing economy and electric construction machinery, and also lays a practical foundation for the green and shared development of international construction machinery and equipment.

Keywords: Electric Construction Machinery; Sharing Economy; Shared Service Platform; Equipment Leasing; Green Transformation; Collaborative Operation

1. Introduction

1.1 Research Background

1.1.1 Policy and "Dual-Carbon" Goals Drive Industrial Electrification Transformation

With increasingly strict global environmental protection regulations and accelerated climate governance, China's clear "carbon peaking and carbon neutrality" goals (carbon peaking by 2030 and carbon neutrality by 2060) have further restricted and strengthened environmental protection requirements for traditional construction machinery. Currently, emission standards for non-road machinery engines are continuously updated and optimized, but they have not yet reached the ideal state required by the state. As a pillar industry of the national economy, the construction machinery industry accounts for more than 20% of the country's total energy consumption and over 15% of carbon emissions. Construction machinery powered by diesel is the core source of emissions—for example, a single 30-ton excavator can emit more than 300 tons of carbon annually.

Against this backdrop, various policies strongly support and subsidize the electrification of construction machinery, strictly control the use of diesel engine equipment that fails to meet emission standards, and increase penalties for non-compliant enterprises and application sites. The *14th Five-Year Plan for Industrial Green Development* clearly states "promoting new energy construction machinery"; the *New Energy Vehicle Industry Development Plan (2021-2035)* incorporates electric construction machinery into the promotion system of new energy equipment; more than 20 cities including Beijing and Shanghai have designated "low-emission construction areas" where diesel construction machinery below China National III Emission Standard is prohibited; in 2023, the Ministry of Industry and Information Technology and two other ministries jointly issued the *Implementation Plan for Accelerating the "Carbon Peaking" in the Construction Machinery Field*, proposing the goal of "new energy construction machinery accounting for over 20% of the market penetration rate by 2025." Driven by these favorable policies, the market size of electric construction machinery soared from 5.8 billion yuan in 2020 to 38 billion yuan in 2023, with a compound annual growth rate of over 80%.

1.1.2 Market Demand Forces Innovation in Utilization Models

The advancement of new infrastructure construction (e.g., 5G base stations, data centers) and urban renewal projects has created strong demand for electric construction machinery. However, the industry currently faces three major pain points:

1. **High purchase costs:** The unit price of electric construction machinery is 2-2.5 times that of diesel equipment of the same model. For example, the unit price of a domestic 20-ton diesel excavator is approximately 600,000 yuan, while that of an electric excavator of the same model is about 1.2 million yuan, placing significant financial pressure on small and medium-sized construction enterprises.

2. **Low equipment utilization:** According to data from the China Construction Machinery Association, the average equipment utilization rate in the industry is only 45%-50%, and the idle rate of equipment in some small and medium-sized enterprises exceeds 60%, leading to severe asset idleness.

3. **Difficult operation and maintenance:** Electric construction machinery involves professional technologies such as battery management and motor maintenance, requiring enterprises to invest additional human resources and equipment, which small and medium-sized enterprises can hardly afford.

The sharing economy model, which improves the utilization rate of idle resources, is highly compatible with the above pain points. The traditional construction machinery leasing market has already taken shape (with a market size exceeding 600 billion yuan in 2023), but the sharing model focusing on electrified equipment and integrating "leasing + services + data" is still in the exploratory stage, becoming a key breakthrough for industrial upgrading.

1.1.3 Technological Development Supports the Sharing Model

The current maturity of technologies such as the Internet of Things (IoT), big data, artificial intelligence (AI), and blockchain provides strong support for the sharing model of electric construction machinery:

- IoT technology enables real-time monitoring of equipment status (location, power level, working conditions, fault early warning). For example, on-board sensors collect data such as engine speed and battery State of Charge (SOC) and transmit it to the cloud platform.
- Big data and AI algorithms support intelligent scheduling. Based on data such as project demand, equipment location, and power status, optimal matching between demand and equipment is achieved, reducing the empty driving rate.
- Blockchain technology ensures the security of transactions and credit data, addressing trust issues in sharing scenarios such as identity authentication, contract performance, and fee settlement.

1.2 Research Significance

1.2.1 Theoretical Significance

1. Construct an analytical framework for the integration of electric construction machinery and the sharing model, covering aspects such as "separation of usage rights and ownership rights"

and "cross-subject resource integration" in leasing.

2. Improve the theory of technology empowerment for shared services. Systematically analyze the application mechanisms of technologies such as IoT and big data in equipment scheduling and maintenance, providing a reference for technology-driven innovation in industrial service models.

1.2.2 Practical Significance

1. Provide applicable sharing model solutions and platforms for enterprises. Design differentiated sharing models based on the needs of enterprises of different sizes (large construction groups, small and medium-sized construction enterprises, equipment manufacturers), lowering the application threshold of electric equipment.
2. Optimize resource allocation in the industry. Improve equipment utilization and reduce idle rates through the sharing model.
3. Respond positively to the achievement of "dual-carbon" goals. The sharing model accelerates the promotion of electric construction machinery (with the market penetration rate expected to increase to 30% by 2030), indirectly reducing carbon emissions and providing a practical path for the green transformation of the construction machinery industry.

1.3 Domestic and International Research Status

1.3.1 Research on Sharing Economy and Equipment Leasing

International research started relatively early:

- Sundararajan (2016) proposed that "the sharing economy is based on peer-to-peer transactions of idle resource usage rights," clarifying its core as "disintermediation" and "resource reallocation."
- Belk (2014) pointed out from the perspective of consumer behavior that the sharing model reconstructs the value perception of "ownership" and "usage."
- Hamari et al. (2016) used construction equipment leasing as a case to verify the role of the sharing model in improving equipment utilization, arguing that technology platforms are key supports.

Domestic research mainly focuses on the construction machinery leasing market, pointing out problems such as information asymmetry and low scheduling efficiency in the current model, and suggesting the introduction of big data technology to optimize matching. However, most existing studies focus on traditional diesel construction machinery, with insufficient research on the integration of electrified equipment and the sharing model.

1.3.2 Research on the Electric Construction Machinery Industry

International research focuses on technology and policies:

- The 2022 report by the International Energy Agency (IEA) pointed out that electric construction machinery is a core path for emission reduction in the construction industry, and recommended accelerating its promotion through policy subsidies and standard setting.

- Liao et al. (2023) studied the battery life optimization scheme for electric excavators, providing technical references for equipment operation and maintenance.

Domestic research mainly focuses on the market and transformation: The *White Paper on the Development of Electric Construction Machinery (2023)* released by the China Construction Machinery Association sorts out the industrial development status and policy environment, but does not involve the sharing model.

1.3.3 Summary of Research

Existing studies have clarified the role of the sharing economy in optimizing resource allocation in the construction machinery industry and the industrial value of electric construction machinery, but there are still three main gaps:

- 1. Theoretical aspect:** Lack of systematic analysis on the integration of "electric construction machinery + sharing economy."
- 2. Model aspect:** Existing leasing models focus on single-equipment transactions and do not combine the characteristics of electric equipment (e.g., battery maintenance, charging needs) to develop an integrated "leasing + service" sharing solution.
- 3. Technical aspect:** Insufficient description of the specific application methods of technologies such as IoT and blockchain in shared platforms, and lack of implementable solution designs.

This paper will focus on addressing the above issues and contribute to the advancement of the sharing economy empowering the electric construction machinery field through innovative ideas.

1.4 Research Content and Methods

1.4.1 Research Content

Centering on the core question of "how the sharing economy empowers the electric construction machinery field," the research is carried out in six parts:

- 1. Core concepts and theoretical foundations:** Define and classify the sharing economy and electric construction machinery, and organize theories related to the sharing economy, leasing, and collaborative innovation.
- 2. Analysis of driving factors for the application of the sharing economy:** Analyze the driving logic from three aspects—policies and dual-carbon goals, industrial transformation, and enterprise needs.
- 3. Design of sharing economy application models:** Based on the core of equipment leasing and shared services, propose differentiated sharing models (basic equipment sharing, collaborative sharing, value-added service sharing).
- 4. Construction of a shared service platform:** Clarify the platform architecture (user layer, platform layer, resource layer) and the full application of current technologies (IoT, big data, blockchain).
- 5. Case verification:** Select practical cases of typical domestic enterprises to analyze the

implementation effect.

6. Challenges and countermeasures: Identify challenges in policies, technology, credit, and profitability during application, and propose targeted suggestions.

1.4.2 Research Methods

- 1. Literature research method:** Sort out theories and research results related to the sharing economy and electric construction machinery through databases such as CNKI and Web of Science, laying a theoretical foundation.
- 2. Case analysis method:** Conduct in-depth analysis of model design and implementation effects using typical cases such as XCMG Group's "Electric Construction Machinery Sharing Platform" and Sany Heavy Industry's "Intelligent Link Leasing."
- 3. Questionnaire survey method:** Design the technical architecture and functional modules of the shared service platform based on the characteristics of technologies such as IoT and big data, ensuring the feasibility of the solution.

1.5 Innovations

- 1. Theoretical innovation:** Construct a macro-meso-micro driving framework to systematically explain the theoretical logic of the integration of the sharing economy and electric construction machinery.
- 2. Model innovation:** Design three sharing models ("basic - collaborative - value-added") based on the characteristics of electric construction machinery, breaking through the single transaction model of traditional leasing and realizing integrated sharing of "equipment + services + data."
- 3. Technical innovation:** Propose a shared platform architecture combining blockchain-based credit management and big data scheduling, addressing trust and efficiency issues in the sharing model.

2. Core Concepts and Theoretical Foundations

2.1 Core Concepts

2.1.1 Sharing Economy

The core of the sharing economy is "centered on the transaction of usage rights, connecting supply and demand parties through technology platforms to achieve optimal allocation of idle resources." Combined with the characteristics of the construction machinery field, this paper defines the sharing economy in the construction machinery field as: an economic model that takes electric construction machinery as resources, connects equipment suppliers (manufacturers, leasing enterprises, owners of idle equipment) and demanders (construction enterprises, construction units) through an online platform, realizes the transaction of equipment usage rights, and extends to value-added services such as operation and maintenance and data. Its main characteristics include:

- 1. Resource nature:** Focus on high-value, high-idle-rate electric construction machinery rather than ordinary consumer goods.

2. Transaction form: Focus on short-term leasing, emphasizing on-demand deployment.

3. Service extension: Go beyond single-equipment transactions and integrate full-life-cycle services such as charging, maintenance, and second-hand disposal.

2.1.2 Electric Construction Machinery

Electric construction machinery refers to construction machinery that uses batteries or fuel cells as power sources instead of traditional diesel engines. According to functional application scenarios, it can be divided into three categories:

1. Earthwork operation equipment: Electric loaders, electric bulldozers, electric excavators (small: $\leq 6T$, medium: 6-30T, large: $>30T$), mainly used in infrastructure projects such as earth excavation and transportation.

2. Lifting operation equipment: Electric tower cranes, electric mobile cranes, used for hoisting building structures.

3. Auxiliary operation equipment: Electric Road rollers, electric forklifts, electric pavers, etc., used for logistics transportation and road construction.

Its core characteristics include high purchase costs, strong technical dependence on battery and motor maintenance, and near-zero carbon emissions, which are highly consistent with the goals of the sharing model ("cost reduction, efficiency improvement, and green development").

2.1.3 Equipment Leasing and Shared Service Model

The equipment leasing and shared service model targeted in this paper is the specific implementation form of the sharing economy in the electric construction machinery field. Its core differences from traditional leasing are as follows:

- **Traditional leasing:** Mainly based on offline transactions, with opaque equipment information, single services, and manual-dependent scheduling.
- **Shared service model:** Taking an online platform as the carrier, integrating equipment status and demand information, and providing integrated services of "leasing + scheduling + operation and maintenance + data" to achieve intelligent matching of supply and demand.

2.2 Theoretical Foundations

2.2.1 Sharing Economy Theory

The core of the sharing economy theory is "disintermediation" and "resource reallocation," which can be divided into three logics:

1. Value logic: Shift from "ownership value" to "usage value," where consumers mainly focus on the use effect of equipment.

2. Transaction logic: Reduce the information asymmetry cost between supply and demand parties through technology platforms, realizing peer-to-peer transactions (e.g., construction enterprise users directly lease from owners of idle equipment).

3. Resource logic: Make full use of idle resources, improve resource utilization, and reduce ineffective production capacity, in line with the concept of "circular economy."

This theoretical logic replaces "ownership purchase" with "usage right transaction," solving the contradiction between high costs and low utilization of electric construction machinery.

2.2.2 Leasing Theory

The core of leasing theory is "separation of ownership and usage rights," which is divided into two categories: operating leasing and financial leasing.

- Operating leasing: Short-term leasing, where the lessor owns the equipment and is responsible for maintenance and management, while the lessee only obtains the usage right (e.g., a construction enterprise leases an electric excavator for a short period).
- Financial leasing: Long-term leasing, where the lessee can obtain ownership of the equipment at the end of the lease term, suitable for enterprises with long-term and stable demand.

The sharing model focused on in this paper is based on operating leasing, extending to innovative forms such as "time-sharing leasing" and "cluster leasing." At the same time, it combines the advantages of financial leasing to provide flexible options for enterprises with long-term demand, realizing a flexible service model of "short-term leasing on demand, long-term availability for purchase."

2.2.3 Collaborative Innovation Theory

Collaborative innovation theory emphasizes "different subjects achieving common innovation goals through resource integration and complementary advantages." In the sharing scenario of electric construction machinery, collaborative innovation is reflected in three aspects:

1. Subject collaboration: Equipment manufacturers (providing equipment and technology), leasing enterprises (providing operation experience), construction enterprises (providing demand feedback), and technology enterprises (providing platform support) jointly participate in the design of the sharing model.
2. Resource collaboration: Integrate resources such as equipment, technology, and data. For example, manufacturers open equipment data interfaces, and technology enterprises provide scheduling algorithms to achieve optimal resource allocation.
3. Service collaboration: Integrate scattered services such as leasing, operation and maintenance, and charging into an integrated solution. For example, after equipment leasing, nearby charging stations and maintenance teams are automatically matched.

2.2.4 Platform Model Options

Platforms can flexibly choose models by analyzing users' willingness to accept new equipment technologies: Users believe that technologies/models can improve work efficiency (e.g., shared platforms can quickly match equipment, reducing waiting time); users believe that technologies/models are easy to operate (e.g., clear platform interfaces, one-click equipment scheduling).

Through questionnaire surveys, this paper identifies actual user needs, analyzes construction enterprises' willingness to accept the sharing model, optimizes platform functions and model design, and enhances user stickiness.

3.1 Macro Level: Mandatory Policy Constraints and "Dual-Carbon" Goal Orientation

3.1.1 Policies and Regulations Force Electrification Transformation

Policies at the national and local levels have shifted from "encouragement" to "mandatory," forcing enterprises to adopt electric construction machinery:

- **Usage restrictions:** Cities such as Beijing, Shanghai, and Shenzhen clearly stipulate that "from 2025, the utilization rate of electric construction machinery in new projects shall not be less than 50%"; projects that fail to meet this standard will not be approved.
- **Subsidy policies:** The central government provides a 20%-30% subsidy for the purchase of electric additional subsidies.
- **Emission supervision:** The Environmental Protection Bureau has incorporated construction machinery into the "carbon emission trading market." Starting from 2025, large construction enterprises need to calculate equipment carbon emissions, and purchase carbon allowances for excess emissions.

Under policy pressure, if enterprises directly purchase electric equipment, they face high cost pressure. However, the sharing model, through "on-demand leasing," can meet policy requirements while reducing capital investment, becoming the optimal choice.

3.1.2 "Dual-Carbon" Goals Force the Application of Electric Construction Machinery

Under the "dual-carbon" goals, the carbon emission accounting system for the construction industry is gradually improved, and electric construction machinery has become a core tool for emission reduction:

- **Significant emission reduction effect:** Taking a 30-ton excavator as an example, based on an average annual operation time of 2,000 hours, it can reduce carbon emissions by approximately 250 tons compared with diesel models (diesel models emit an average of 300 tons, while electric models emit an average of 50 tons).
- **Brand value improvement:** Large construction enterprises incorporate "green construction" into their brand image. The adoption of electric equipment and the sharing model can enhance market competitiveness. For example, China State Construction Engineering Corporation and Shanghai Construction Group have included "electric equipment sharing rate" in their assessment indicators.

3.2 Meso Level: Driven by Industrial Transformation and Market Competition

3.2.1 Transformation of the Construction Machinery Industry from "Manufacturing" to "Services"

The traditional construction machinery market has entered the stock competition stage (industry sales increased by only 5% year-on-year in 2023), and manufacturers are shifting from "selling equipment" to "selling services":

- **Manufacturers' needs:** Leading enterprises such as XCMG, Sany, and Zoomlion have launched electric construction machinery product lines, but face problems of "high market transaction costs and low user acceptance." Through the sharing model, users can "try before buying," accelerating market penetration.
- **Transformation of leasing enterprises:** Traditional leasing enterprises mainly focus on diesel equipment and face the risk of policy elimination. Transforming to electric equipment sharing can help them seize new markets. For example, Zhejiang Lituo Leasing achieved a 40% year-on-year revenue growth in 2023 through electric equipment sharing.

3.2.2 Intensified Market Competition Forces Efficiency Improvement

The construction industry faces fierce market competition, with the gross profit margin of construction enterprises dropping from 12% in 2019 to 8% in 2023. Enterprises need to improve efficiency through resource optimization:

- **Competition in the equipment leasing market:** There are more than 100,000 traditional leasing enterprises, leading to severe homogeneous competition. However, the electric equipment sharing model can form a differentiated competitive advantage due to its "green + efficient" characteristics.
- **Competition in project bidding:** Owners clearly state in bidding documents that "bidders using electric equipment and the sharing model are preferred." For example, projects in the Xiong'an New Area require "the utilization rate of electric construction machinery to be no less than 60%, and scheduling must be done through a shared platform."

3.3 Micro Level: Enterprise Demands for Cost and Efficiency

3.3.1 Reducing Initial Investment and Operating Costs

Questionnaire surveys show that 85% of small and medium-sized construction enterprises list "cost control" as the primary reason for adopting the sharing model:

- **Reduced initial investment:** Purchasing a medium-sized electric excavator costs 1 million yuan, while leasing through a shared platform costs approximately 1,500 yuan per day, 30,000 yuan per month, and 360,000 yuan per year—less than 40% of the purchase cost.
- **Reduced operating costs:** Shared platforms integrate operation and maintenance services, reducing equipment maintenance costs by 20%-30% compared with enterprise self-maintenance (e.g., battery replacement costs are 25% lower for platform bulk purchases than for enterprise individual purchases). At the same time, they save engine maintenance costs (e.g., replacement of engine oil filters, diesel filters, and engine oil) compared with traditional diesel construction machinery.

3.3.2 Improving Equipment Utilization and Management Efficiency

- **Improved equipment utilization:** Shared platforms use intelligent scheduling to match idle

equipment to demand projects. For example, data from a shared platform shows that the utilization rate of electric excavators participating in sharing increased from 45% to 72%.

- **Improved management efficiency:** Platforms monitor equipment status (location, power, faults) in real time, reducing manual inspection costs. For example, a China Railway construction enterprise reduced equipment management labor costs by 35% through a shared platform.

3.3.3 Reducing Technical and Risk Costs

Electric construction machinery has high technical thresholds for battery and motor maintenance, and the sharing model can transfer technical risks:

- **Reduced technical dependence:** Platforms provide professional operation and maintenance teams, eliminating the need for enterprises to train full-time technical personnel.
- **Reduced risk costs:** Platforms bear the risks of equipment depreciation and faults (e.g., battery attenuation, motor damage). Enterprises only pay leasing fees, avoiding asset impairment losses.

4. Design of Sharing Economy Application Models in the Electric Construction Machinery Field

4.1 Model Design Principles

Based on the characteristics of electric construction machinery and the logic of the sharing economy, this paper follows three design principles:

1. **Demand orientation:** Design differentiated models based on the needs of enterprises of different sizes (large groups, small and medium-sized micro-enterprises).
2. **Technology empowerment:** Use technologies such as IoT and big data to improve the efficiency and feasibility of the model.
3. **Value extension:** Go beyond single leasing, integrate full-life-cycle services, and realize a "equipment-service-data" value closed loop.

4.2 Three Core Shared Application Models

4.2.1 Basic Equipment Sharing Model: Time-Sharing Leasing + Intelligent Scheduling

Applicable scenarios: Short-term, scattered needs of small and medium-sized construction enterprises (e.g., small decoration projects, municipal maintenance), with core equipment being small electric construction machinery (excavators <6t, electric forklifts).

Operation logic:

1. **Supply side:** Equipment owners (manufacturers, small leasing enterprises, individual owners) connect idle equipment to the shared platform and upload information such as equipment model, location, power level, and rental price.
2. **Demand side:** Enterprises publish needs (equipment type, usage time, location) on the platform, and the platform matches the optimal equipment based on big data algorithms.
3. **Transaction and scheduling:** Electronic contracts are signed online, and the platform

generates scheduling instructions (including equipment location navigation and pick-up/return methods). Equipment is unlocked remotely through IoT locks.

- 4. Settlement and feedback:** After use, the platform automatically settles fees based on usage duration (time-sharing billing, accurate to the minute), and users submit feedback on equipment status.

Core advantages:

- **High flexibility:** Lease on demand with minute-level response, meeting short-term emergency needs.
- **Low cost:** Time-sharing billing (e.g., 0.5 yuan per minute for small electric excavators, 30 yuan per hour) reduces costs by 50% compared with daily leasing.

Technical support:

- **IoT technology:** On-board GPS positioning, power sensors, and remote lock control enable real-time monitoring and remote management of equipment status.
- **Big data algorithms:** Based on Location-Based Services (LBS) and demand forecasting, "nearby matching" is realized to reduce the empty driving rate.

4.2.2 Collaborative Operation Sharing Model: Equipment Clusters + Project Matching

Applicable scenarios: Large-scale projects of large construction enterprises (e.g., bridge, tunnel construction) that require collaborative operation of multiple types of electric construction machinery (e.g., excavators + loaders + cranes).

Operation logic:

- 1. Project demand breakdown:** Enterprises upload project needs (construction period, project volume, equipment type and quantity) to the platform, and the platform breaks them down into "equipment cluster demand packages" (e.g., "3 medium electric excavators + 2 electric loaders + 1 electric crane").
- 2. Cluster resource integration:** The platform integrates equipment from multiple suppliers to form an "equipment cluster" (e.g., 2 excavators from Enterprise A, 1 excavator + 2 loaders from Enterprise B, and 1 crane from Enterprise C).
- 3. Collaborative scheduling:** Based on the project construction schedule, the platform formulates an equipment scheduling plan (e.g., excavators for excavation in the morning, loaders for transportation in the afternoon, and cranes for hoisting in the evening) and optimizes the operation sequence through AI algorithms to avoid equipment idleness.
- 4. Collaborative operation and maintenance:** The platform sets up a special operation and maintenance team to follow up on the project and provide equipment charging and maintenance services (e.g., setting up temporary charging areas at the project site to ensure equipment battery life).

Core advantages:

- **High collaborative efficiency:** Avoids fragmentation of single-equipment scheduling and improves the overall construction efficiency of the project (e.g., a bridge project shortened

its construction period by 15% through this model).

- **Strong resource integration capability:** Integrates scattered equipment resources to meet the cluster needs of large-scale projects, eliminating the need for enterprises to purchase multiple pieces of equipment separately.

Technical support:

- **Digital twin technology:** Build a digital twin model of project construction, simulate the collaborative operation process of equipment, and optimize the scheduling plan.
- **5G technology:** Realizes low-latency communication between equipment and the platform, ensuring the real-time nature of collaborative operations.

4.2.3 Value-Added Service Sharing Model: Full-Life-Cycle Services + Data Empowerment

Applicable scenarios: Enterprises that use electric construction machinery for a long time (e.g., municipal engineering companies, large construction groups) with needs covering the entire process of equipment leasing, operation and maintenance, and second-hand disposal.

Operation logic:

1. **Customized leasing:** Based on the long-term needs of enterprises (e.g., municipal engineering for more than 1 year), the platform provides customized leasing solutions (fixed equipment + dedicated operation and maintenance team).
2. **Full-life-cycle operation and maintenance:** The platform provides integrated services of "charging - maintenance - repair - battery replacement," such as regular on-site charging, monthly equipment inspection, and 2-hour response to faults.
3. **Data empowerment:** Based on equipment operation data (operation duration, energy consumption, fault records), the platform provides optimization suggestions for enterprises (e.g., adjusting operation time to reduce energy consumption, replacing vulnerable parts in advance).
4. **Second-hand disposal sharing:** After the lease term, the platform assists enterprises in transferring equipment to the second-hand shared market (e.g., sub-leasing a 3-year-old electric excavator to small and medium-sized projects), reducing enterprise asset losses and maximizing equipment value.

Core advantages:

- **Integrated services:** Enterprises do not need to connect with multiple service providers (leasing, charging, maintenance), reducing management costs.
- **Data value mining:** Optimize construction plans through equipment data to improve enterprise operation efficiency (e.g., a municipal company reduced equipment energy consumption by 12% through data suggestions).
- **Asset preservation:** Second-hand disposal sharing extends the equipment life cycle and improves asset return rates (e.g., a 3-year-old electric excavator can generate 50% of the purchase cost income through second-hand sharing).

Technical support:

Model Type	Applicable Subjects	Core Goals	Service Cycle	Core Technical Dependence
Infrastructure Sharing Model	Small, medium, and micro-sized construction enterprises, and individual construction teams	Reduce short-term costs	Flexible response	IoT, LBS location
Collaborative Operation Sharing Model	Large-scale construction enterprises, key projects	Improve the efficiency of cluster operations	Monthly-Quarterly Level	Digital Twin, 5G
Value-Added Service Sharing Mode	Long-term construction enterprises, municipal companies	Full-Cycle Cost Optimization	Annual-Yearly Level	Blockchain, Big Data Analytics

- **Blockchain technology:** Records the full-life-cycle data of equipment (production, leasing, maintenance, disposal) to ensure data immutability and improve trust in second-hand transactions.
- **Big data analysis:** Builds a prediction model based on equipment operation data to realize fault early warning and energy consumption optimization.

4.3 Comparison and Adaptability of the Three Models

To clarify the application boundaries of different models, this paper compares them from four dimensions: applicable subjects, core goals, service cycle, and technical dependence (see the table below):

5. Construction of the Electric Construction Machinery Shared Service Platform

The shared service platform is the core carrier for the implementation of the three models. It needs to integrate "user - equipment - service - data" resources to achieve efficient matching of supply and demand. This section elaborates from three dimensions: architecture design, functional modules, and key technologies.

5.1 Platform Architecture Design

A "three-tier architecture" ("user layer - platform layer - resource layer") is adopted to ensure the flexibility and scalability of the architecture.

5.1.1 Resource Layer: Basic Support for Shared Resources

The resource layer is the "data and equipment base" of the platform, integrating four types of core resources:

- 1. Equipment resources:** Connect to the on-board terminals (sensors, GPS, remote locks) of electric construction machinery, and collect real-time data such as equipment location, power level, working conditions, and fault codes.
- 2. User resources:** Build a user database to store information of suppliers (equipment model, idle time, rental standards) and demanders (enterprise qualification, historical orders, credit scores).
- 3. Service resources:** Integrate operation and maintenance teams (location, service scope, response time), charging stations (location, number of charging piles, charging price), and the second-hand transaction market (equipment evaluation data, transaction records).
- 4. Data resources:** Store equipment operation data, user transaction data, and service

feedback data to provide data support for the algorithms and functions of the platform layer.

5.1.2 Platform Layer: Core Function and Technology Engine

The platform layer is the "core of resource integration and service output," divided into two modules:

1. **Business function module:** Realizes core businesses such as leasing transactions, scheduling, and operation and maintenance (see Section 5.2 for details).
2. **Technology engine module:** Provides technical support for business functions, including a big data scheduling engine, AI prediction engine, blockchain credit engine, and IoT access engine.

5.1.3 User Layer: Customized Interaction Portals for Different Subjects

The user layer provides customized services for four types of subjects through different terminals (Web, APP, mini-program):

1. **Demanders (construction enterprises):** The APP provides functions such as demand release, equipment matching, order management, and service evaluation.
2. **Suppliers (equipment owners):** The Web terminal provides functions such as equipment access, rental price setting, order reception, and income inquiry.
3. **Service providers (operation and maintenance/charging enterprises):** The mini-program provides functions such as service order acceptance, progress feedback, and fee settlement.
4. **Regulators (government departments):** The Web terminal provides functions such as industry data statistics, policy release, and violation supervision.

5.2 Core Functional Modules of the Platform

Based on the three sharing models, the platform designs six core functional modules, covering the entire process of "transaction - scheduling - operation and maintenance - data":

5.2.1 User and Equipment Management Module

- **User management:** Enterprise qualification review (business license, construction qualification), user registration and login, role permission assignment (administrator, demander, supplier).
- **Equipment management:** Equipment access review (model, age, inspection report), equipment information maintenance (location, power level, rental price), equipment status monitoring (real-time online/offline, fault early warning).

5.2.2 Intelligent Matching and Scheduling Module

- **Basic matching:** Match supplier resources based on the demander's equipment type, usage time, and location (core of the basic equipment sharing model).
- **Cluster matching:** Integrate equipment resources from multiple suppliers according to the "equipment cluster package" decomposed from project needs (core of the collaborative operation sharing model).

- **Dynamic scheduling:** Adjust equipment allocation in real time (e.g., the platform automatically matches backup equipment if a piece of equipment breaks down unexpectedly) and optimize operation routes (e.g., plan the shortest path for equipment to travel to and from the project site).

5.2.3 Transaction and Settlement Module

- **Electronic contracts:** Automatically generate standardized leasing contracts, supporting online signing and deposit.
- **Flexible billing:** Support multiple billing methods such as time-sharing (minute/hour), daily rental, monthly rental, and cluster packages.
- **Intelligent settlement:** Automatically calculate fees after use, support payment methods such as Alipay, WeChat, and corporate transfer, and automatically issue electronic invoices after settlement.

5.2.4 Operation and Maintenance Service Module

- **Fault early warning:** Automatically send fault warnings to users and operation and maintenance teams based on equipment operation data (e.g., abnormal motor temperature, battery voltage fluctuation).
- **Operation and maintenance scheduling:** After a user submits a maintenance request, the platform matches the nearest operation and maintenance team and generates a dispatch order.
- **Charging service:** Display the location and status of nearby charging stations, support online charging reservations, and automatically settle fees after charging.

5.2.5 Data Empowerment Module

- **Data dashboard:** Provide equipment operation reports (operation duration, energy consumption, fault records) for demanders, and equipment income reports (rental income, idle rate) for suppliers.
- **Optimization suggestions:** Provide construction plan optimization suggestions for demanders (e.g., adjusting equipment operation sequence) and rental pricing suggestions for suppliers (based on market supply and demand changes) through big data analysis.
- **Industry reports:** Provide industry data statistics (equipment sharing rate, carbon emission reduction) for regulators.

5.2.6 Credit and Security Module

- **Credit scoring:** Build a credit scoring system (1-5 points) based on users' historical orders (performance rate, payment timeliness) and equipment feedback (damage status). Users with low credit scores need to pay a deposit.
- **Data security:** Use blockchain technology to store transaction and equipment data to ensure data immutability; use encrypted transmission technology to protect user privacy.
- **Dispute resolution:** Establish an online dispute mediation mechanism to quickly handle leasing disputes (e.g., identification of equipment damage liability) based on order data

and equipment status.

5.3 Key Technical Support for the Platform

5.3.1 Internet of Things (IoT) Technology

- **Application scenarios:** Real-time monitoring and remote control of equipment status.
- **Technical implementation:** Collect equipment data through on-board terminals (including GPS modules, power sensors, and CAN bus interfaces), transmit it to the cloud platform via 4G/5G networks; realize remote equipment unlocking/locking and emergency shutdown through remote control modules.

5.3.2 Big Data and AI Technology

- **Application scenarios:** Intelligent matching and scheduling, fault prediction.
- **Technical implementation:**
 1. **Matching algorithm:** Realize optimal supply-demand matching based on collaborative filtering algorithms (analyzing users' historical needs and equipment characteristics) and LBS algorithms (calculating the distance between equipment and projects).
 2. **Prediction algorithm:** Build an LSTM neural network model based on equipment operation data (e.g., temperature and vibration data before faults) to realize fault early warning 24 hours in advance.

5.3.3 Blockchain Technology

- **Application scenarios:** Credit management and data deposit.
- **Technical implementation:** Adopt a consortium chain architecture (participating nodes include the platform, users, and regulators), upload user credit data, transaction records, and equipment full-life-cycle data to the chain to ensure data immutability; automatically execute credit rules (e.g., users with a credit score <3 need to pay a deposit) through smart contracts.

5.3.4 Digital Twin Technology

- **Application scenarios:** Collaborative operation scheduling.
- **Technical implementation:** Build a digital twin model of project construction, import equipment parameters (operation radius, energy consumption) and construction schedule plans, simulate the collaborative operation process of equipment, and synchronize the optimized scheduling plan to physical equipment.

6. Case Verification: Analysis of Practical Cases of Typical Domestic Enterprises

To verify the feasibility of the proposed sharing models and platform architecture, two practical cases of leading domestic enterprises are selected for analysis.

6.1 Case 1: XCMG Group's "Electric Construction Machinery Sharing Platform"

6.1.1 Case Background

As a leading domestic construction machinery enterprise, XCMG Group launched the "Construction Machinery Sharing Platform" in 2022, focusing on the basic equipment sharing and value-added service sharing models. The accessed equipment covers excavators, loaders, cranes, etc.

6.1.2 Model Design and Platform Functions

1. Model selection: Focus on "basic equipment sharing + value-added service sharing" to meet the short-term needs of small and medium-sized enterprises and long-term needs of large enterprises.

2. Platform functions:

- **Intelligent matching:** Realize minute-level equipment matching based on LBS and demand forecasting.

6.1.3 Implementation Effects

- **Equipment utilization:** The utilization rate of electric excavators accessed to the platform increased from 48% to 75%.
- **Enterprise costs:** The leasing cost for small and medium-sized users was 60% lower than the purchase cost, and the operation and maintenance cost for large users was reduced by 25%.
- **Carbon emissions:** A total of over 100,000 tons of carbon emissions were reduced by the end of 2023.

6.2 Case 2: Sany Heavy Industry's "Intelligent Link Leasing" Platform

6.2.1 Case Background

Focusing on the collaborative operation sharing model, Sany Heavy Industry launched the "Intelligent Link Leasing" platform in 2023, mainly serving large-scale projects (e.g., Xiong'an New Area construction, high-speed rail projects) with over 2,000 electric construction machinery units accessed.

6.2.2 Model Design and Platform Functions

1. Model selection: The core is the "collaborative operation sharing model," integrating equipment clusters and project matching.

2. Platform functions:

- **Cluster scheduling:** Simulate the project construction process based on digital twin technology to optimize the equipment collaborative operation plan.
- **Special operation and maintenance:** Set up a dedicated operation and maintenance team for large-scale projects to provide on-site charging and maintenance services.
- **Blockchain deposit:** Upload the full-life-cycle data of equipment to the chain, providing a basis for project auditing and carbon emission accounting.

6.2.3 Implementation Effects

- **Project efficiency:** For a bridge project in the Xiong'an New Area, the platform shortened

the construction period by 20% and reduced equipment idle time by 40%.

- **Service coverage:** It has served over 30 large-scale projects, with the equipment cluster scheduling response time <1 hour.
- **Market feedback:** The user satisfaction rate reached 92%, and the repurchase rate (long-term leasing) reached 80%.

6.3 Case Insights

1. **Model adaptability is key:** XCMG's basic model for small and medium-sized users and Sany's collaborative model for large-scale projects both achieved good results, verifying the correctness of the "demand-oriented" design principle in this paper.
2. **Technical support is irreplaceable:** IoT and big data technologies improved equipment scheduling efficiency, while blockchain and digital twin technologies solved trust and collaboration issues, becoming the core of model implementation.
3. **Service extension enhances value:** Both enterprises went beyond single leasing and integrated operation and maintenance and data services, improving user stickiness and profit margins.

7. Challenges and Countermeasures for the Application of the Sharing Economy

7.1 Main Challenges

7.1.1 Incomplete Policies and Regulations

- **Lack of special standards:** Currently, there are no industry standards for the "electric construction machinery sharing model," and there are no unified specifications for equipment access, billing rules, and safety management.
- **Unclear regulatory subjects:** The sharing model involves multiple subjects such as manufacturers, leasing enterprises, and construction enterprises, with scattered regulatory responsibilities (e.g., who is responsible for equipment safety), easily leading to regulatory gaps.
- **Unclear tax policies:** There are no clear policies on how to tax the rental income and service income of shared platforms, increasing the tax risk for enterprises.

7.1.2 Unsound Credit System

- **Scattered credit data:** User credit data (e.g., performance records, equipment damage) is scattered across different enterprises, making it difficult for platforms to obtain comprehensive information.
- **Low cost of dishonesty:** Some users have dishonest behaviors such as defaulting on rent and damaging equipment, and platforms lack effective disciplinary measures (e.g., inability to access the central bank's credit reporting system).

7.1.3 Ununified Technical Standards

- **Incompatible equipment interfaces:** Electric construction machinery from different manufacturers has inconsistent data interfaces (e.g., CAN bus protocols), requiring platforms to develop additional adaptive interfaces for equipment access, increasing costs.
- **Data security risks:** Platforms store a large amount of equipment and user data, facing risks such as data leakage and hacker attacks, and the existing technical protection system is incomplete.
- **High technical costs:** The investment costs for technologies such as IoT terminals, big data algorithms, and blockchain are high, which small and medium-sized platforms can hardly afford.

7.1.4 Single Profit Model

- **Concentrated income sources:** Currently, the main income of platforms is rent sharing (10%-15% of rent is deducted), and the proportion of income from value-added services (e.g., data services, second-hand disposal) is less than 5%.
- **High cost pressure:** The costs of equipment operation and maintenance, technology research and development, and platform operation are high, and most platforms are in a state of loss (e.g., a small and medium-sized platform had a revenue of 10 million yuan, costs of 12 million yuan, and a loss of 2 million yuan in 2023).

7.2 Countermeasures and Suggestions

7.2.1 Improve Policies, Regulations, and Standard Systems

- **Formulate special standards:** Led by the Ministry of Industry and Information Technology, jointly with the China Construction Machinery Association, formulate the Technical Specifications for Electric Construction Machinery Shared Service Platforms, clarifying standards for equipment access, billing, and safety.
- **Clarify regulatory responsibilities:** Establish a "government-led + industry self-regulation" supervision model. Government departments (Ministry of Housing and Urban-Rural Development, Ministry of Industry and Information Technology) are responsible for policy formulation and supervision, and industry associations are responsible for platform filing and credit evaluation.
- **Optimize tax policies:** Clarify that the rent sharing income of shared platforms is taxed as "modern service industry" (tax rate of 6%), and value-added service income enjoys tax reductions (e.g., value-added tax exemption for data service income).

7.2.2 Build a Cross-Subject Credit Evaluation System

- **Integrate credit data:** Promote the connection between platforms and the central bank's credit reporting system and construction enterprise credit platforms to integrate user performance records, enterprise qualifications, and historical violations.
- **Establish credit reward and punishment mechanisms:** Waive deposits and give priority to equipment matching for users with high credit scores (4-5 points); blacklist users with

dishonest behaviors (score <2 points), restrict their use of the platform, and push the list to industry associations.

- **Introduce third-party credit institutions:** Collaborate with third-party institutions such as Sesame Credit and Tencent Credit to jointly build a credit evaluation model and improve the authority of credit data.

7.2.3 Unify Technical Standards and Strengthen Safety Protection

- **Unify equipment interfaces:** Led by industry associations, organize leading enterprises such as XCMG, Sany, and Zoomlion to formulate unified standards for electric construction machinery data interfaces (e.g., CAN bus protocol standards), reducing platform access costs.
- **Strengthen data security:** Adopt a technical system of "encrypted transmission + distributed storage + intrusion detection" to ensure data security; conduct regular security audits to identify risks.
- **Reduce technical costs:** The government sets up a "special subsidy for electric construction machinery sharing technology," providing a 30% subsidy for the technology R&D investment of platforms (with a maximum subsidy of 5 million yuan per platform); encourage leading enterprises to open technical interfaces and provide technical support for small and medium-sized platforms.

7.2.4 Explore Diversified Profit Models

- **Expand value-added service income:**

1. **Data services:** Provide equipment operation data (e.g., user usage habits, fault distribution) for manufacturers to help them optimize product design and charge data service fees.
2. **Financial services:** Cooperate with banks to provide lease installment loans for demanders, with the platform charging service fees; provide equipment mortgage loans for suppliers to activate assets.
3. **Second-hand transactions:** Use blockchain-deposited equipment data to provide evaluation basis for second-hand transactions, with the platform charging transaction commissions (5%-8%).

- **Reduce operating costs:**

1. **Shared operation and maintenance resources:** Multiple platforms jointly establish regional operation and maintenance teams to share costs.
2. **Lightweight operation:** Adopt the Software-as-a-Service (SaaS) model, where small and medium-sized platforms do not need to build their own technical architectures but rent technical services from leading platforms, reducing R&D costs.

8. Conclusions and Prospects

8.1 Research Conclusions

This paper systematically explores the application logic and practical path of the sharing economy model in the field of electric construction machinery, and draws the following core conclusions:

1. The integration of the sharing economy and electric construction machinery is inevitable. Policy drivers, market demand, and technical support form a triple driving force, and the sharing model can effectively address the pain points of electric equipment, such as "high costs, low efficiency, and heavy operation and maintenance burdens."
2. Three differentiated sharing models adapt to different needs. The basic equipment sharing model meets the short-term needs of small and medium-sized enterprises, the collaborative operation sharing model adapts to the cluster needs of large-scale projects, and the value-added service sharing model covers the long-term full-cycle needs of enterprises—all three models complement each other.
3. Technology empowerment is the core of model implementation. Technologies such as IoT, big data, and blockchain support the intelligent matching, scheduling, and credit management of shared platforms, improving the efficiency and feasibility of the model.
4. The current application faces four major challenges: policies, credit, technology, and profitability. Breakthroughs need to be made by improving standards, building a credit system, unifying technical interfaces, and expanding profit models.

8.2 Research Limitations and Prospects

8.2.1 Research Limitations

1. **Limited case coverage:** The cases selected in this paper are leading domestic enterprises, not involving small and medium-sized platforms or international cases. The universality of the conclusions needs further verification.
2. **Insufficient quantitative analysis:** No empirical model is used to quantify the impact of the sharing model on enterprise costs and efficiency. Regression analysis and other methods can be introduced for in-depth research in the future.
3. **Insufficient international perspective:** The sharing model of electric construction machinery in international markets (e.g., Europe, America, Southeast Asia) is not analyzed, lacking cross-regional comparisons.

8.2.2 Future Prospects

1. **Model innovation direction:** Combine new energy technologies (e.g., hydrogen energy construction machinery) with the sharing model to explore a new path of "hydrogen energy + sharing"; introduce metaverse technology to build a virtual shared platform and realize remote equipment debugging and collaborative operation simulation.
2. **International promotion direction:** Summarize domestic practical experience, and promote China's electric construction machinery sharing model to emerging markets such as Southeast Asia and Africa in conjunction with the "Belt and Road" Initiative, contributing to the green transformation of the global construction industry.

3. Technology deepening direction: Strengthen the application of AI large models in shared platforms (e.g., natural language interaction for demand release, intelligent operation and maintenance decision-making) to improve the intelligence level of the platform; explore the application of edge computing technology on the equipment side to reduce data transmission latency and improve real-time scheduling efficiency.

It is expected that through more enterprise practices and academic research in the future, continuous innovation and development in this field will be promoted.

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Relationships among Work Motivation, HRM Practices, and Personnel Performance in Chinese Vocational Institutions

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Abstract

This study investigates the relationships among work motivation, human resource management (HRM) practices, and personnel performance in vocational institutions located in Shantou City, Guangdong Province, China. The main objective is to examine how work motivation and HRM practices influence the performance of personnel in the vocational education sector.

A quantitative research design was employed, and data were collected from 400 respondents across three vocational institutions using a five-point Likert-scale questionnaire. The data were analyzed using multiple regression analysis to determine the predictive power of work motivation and HRM practices on personnel performance.

The results revealed that both work motivation and HRM practices have significant positive effects on personnel performance. Among the two predictors, HRM practices demonstrated a stronger influence, indicating that systematic and effective management of human resources—such as training, development, and performance appraisal—plays a critical role in enhancing employee outcomes. Work motivation also contributed positively, suggesting that motivated personnel tend to perform their duties with higher commitment and efficiency.

These findings highlight the importance of combining motivational strategies with effective HRM systems to improve personnel performance in Chinese vocational institutions. The study provides practical implications for administrators and policymakers to design HRM policies that foster motivation, strengthen professional capability, and support the sustainable development of the vocational education sector in China.

Keywords: Work Motivation, Human Resource Management, Personnel Performance, Vocational Education, China

1. Introduction

1.1 Background

Vocational education in China plays a crucial role in national economic development by producing skilled labor aligned with industrial demands. As China continues to transition toward a technology-driven economy, vocational institutions serve as key contributors to workforce preparation, innovation, and local economic growth. In particular, Shantou City in Guangdong Province has emerged as a significant hub for vocational education, offering

programs that prepare graduates to meet the evolving needs of the manufacturing and service industries.

However, the success of these institutions depends largely on the performance of their personnel both teaching and administrative staff who directly influence the quality of education and training outcomes. High personnel performance enhances institutional reputation, student achievement, and organizational efficiency. Yet, many vocational institutions in China continue to face challenges such as inconsistent employee motivation, limited participation in professional development, and ineffective human resource management (HRM) systems.

Prior studies have indicated that two major factors both **work motivation** and **human resource management practices** play crucial roles in shaping individual and organizational outcomes. Work motivation encourages employees to engage more fully with their tasks and responsibilities, while effective HRM practices, such as training, supervision, and evaluation, ensure that personnel have the necessary support and structure to perform effectively.

Nevertheless, many existing studies in the Chinese context have focused on these variables separately rather than examining their combined influence on personnel performance. There remains a limited understanding of how motivation and HRM interact to predict performance outcomes in the unique cultural and institutional environment of Chinese vocational education.

Therefore, this study investigates the **relationships among work motivation, HRM practices, and personnel performance** in vocational institutions in Shantou City. The results are expected to offer practical insights for administrators and policymakers to enhance human resource development and improve institutional performance.

1.2 Problem Statement

Although vocational institutions in China have expanded rapidly in recent years, many continue to face issues related to workforce efficiency and productivity. Teachers and staff often report moderate levels of motivation and limited professional support, while HRM systems remain highly administrative and insufficiently performance-oriented. This leads to disparities in teaching quality, low engagement, and challenges in achieving institutional goals. Previous research has highlighted the individual effects of work motivation and HRM practices on performance (Dessler, 2000; Locke & Latham, 2004; Guest et al., 2023). However, little empirical evidence exists that directly explores **the strength and direction of the relationships** among these three factors within vocational education institutions, especially in the context of Shantou City, Guangdong Province.

To address this gap, the present study focuses on how work motivation and HRM practices jointly influence personnel performance, applying regression analysis to determine the degree to which each variable predicts employee outcomes.

1.3 Research Objectives

1. To study the levels of work motivation, HRM practices, and personnel performance among personnel in Chinese vocational institutions.
2. To examine the influence of work motivation on personnel performance.
3. To examine the influence of HRM practices on personnel performance.
4. To identify which variable — work motivation or HRM practices — has a stronger effect on personnel performance.

1.4 Research Questions

1. What are the levels of work motivation, HRM practices, and personnel performance in vocational institutions in Shantou City, Guangdong Province, China?
2. How does work motivation influence personnel performance?
3. How do HRM practices influence personnel performance?
4. Which factor has a stronger impact on personnel performance?

1.5 Research Hypotheses

- **H1:** Work motivation has a positive effect on personnel performance.
- **H2:** HRM practices have a positive effect on personnel performance.
- **H3:** Work motivation and HRM practices together significantly predict personnel performance in Chinese vocational institutions.

2. Literature Review

This chapter presents the theoretical background and related research concerning the three major variables in this study: work motivation, human resource management (HRM) practices, and personnel performance. The review aims to explain the conceptual foundations, theoretical frameworks, and previous empirical findings that support the proposed relationships among these variables within the context of vocational education in China.

2.1 Concept of Personnel Performance

Personnel performance refers to the level of achievement or effectiveness of individuals in performing their assigned duties and responsibilities within an organization. According to **Ivancevich, Konopaske, and Matteson (1997)**, performance represents the measurable outcome of work behavior, which reflects both the quality and quantity of output. In the educational context, performance is not limited to task completion but also includes instructional quality, service effectiveness, teamwork, and commitment to institutional goals. **Rivai et al. (2019)** emphasized that strong personnel performance improves the institutional reputation and contributes to sustainable organizational growth. Performance is commonly evaluated based on three aspects:

1. **Work Efficiency** showed that the ability to complete tasks with minimal resources.
2. **Work Effectiveness** showed that achieving expected outcomes according to organizational objectives.
3. **Work Quality** showed that demonstrating accuracy, professionalism, and innovation in job duties.

Therefore, personnel performance serves as a crucial indicator of institutional effectiveness and competitiveness in vocational education.

2.2 Concept of Work Motivation

Work motivation refers to the internal and external forces that initiate work-related behavior and determine its form, direction, intensity, and duration (**Pinder, 1998; Robbins & Judge, 2021**). It represents the psychological energy that drives individuals to achieve both personal and organizational goals. **Herzberg's Two-Factor Theory (1959)** distinguishes two main categories of motivators:

- **Intrinsic Motivation:** arises from internal satisfaction, such as achievement, recognition, responsibility, and personal growth.

- **Extrinsic Motivation:** arises from external conditions, such as pay, supervision, and working conditions.

In educational organizations, motivated personnel show stronger commitment, creativity, and willingness to adopt innovations. **Locke and Latham (2004)** emphasized that goal-setting and self-regulation enhance employee performance, especially when supported by positive reinforcement and feedback. Empirical studies (e.g., **Aworn, 2014; Anthony Afful-Broni, 2012**) indicate that higher motivation leads to better performance outcomes, while lack of motivation reduces engagement and job satisfaction. Hence, motivation is an essential factor influencing personnel performance in vocational education institutions.

2.3 Concept of Human Resource Management (HRM) Practices

Human Resource Management (HRM) involves systematic planning and implementation of policies to attract, develop, and retain employees who contribute effectively to organizational goals. **Dessler (2000)** defines HRM as a comprehensive process that includes recruitment, selection, training, development, compensation, and performance evaluation. **Guest et al. (2023)** found that effective HRM systems positively influence employee performance and organizational productivity by aligning human capital with institutional objectives. Similarly, **Osman, Ho, and Galang (2015)** stated that organizations that adopt consistent HRM practices experience lower turnover, higher morale, and better overall performance. Within vocational education institutions, HRM practices are crucial because they ensure that staff possess both technical skills and pedagogical competencies. Well-designed HRM strategies—such as professional training, fair promotion systems, and clear performance standards—help increase satisfaction and motivation, leading to improved personnel performance.

2.4 Relationship between Work Motivation and Personnel Performance

A positive relationship between work motivation and personnel performance has been supported by numerous studies. **Manzoor (2005)** reported that employees with higher motivation levels show better work outcomes. Similarly, **Goodman (2011)** found that both intrinsic and extrinsic motivation significantly influence work effort and achievement. In the educational context, motivated teachers demonstrate greater creativity and engagement in classroom practices. **Afful-Broni (2012)** argued that motivation enhances teachers' willingness to innovate and improve student learning outcomes. Thus, in vocational institutions, high work motivation is likely to lead to improved performance in teaching, administration, and student support services.

2.5 Relationship Between HRM Practices and Personnel Performance

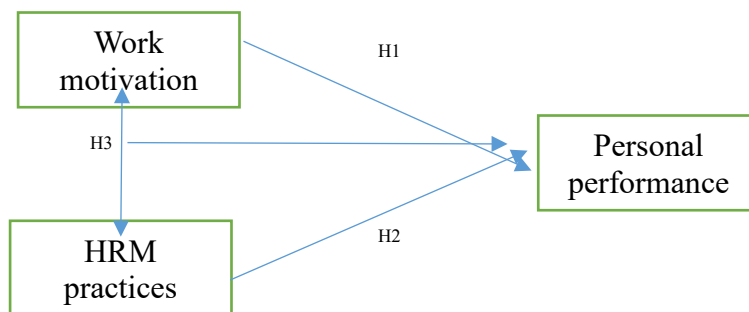
HRM practices directly affect personnel performance through employee development, fair evaluation, and organizational support. **Huang and Chang (2005)** found that HRM strategies significantly improve firm performance by enhancing employee capability and commitment.

Guest et al. (2023) demonstrated that organizations with well-structured HRM systems achieve higher employee retention and productivity. In vocational education, HRM practices such as regular training, transparent promotion, and supportive leadership enhance employee satisfaction and engagement. **Raharjo et al. (2018)** confirmed that HRM effectiveness contributes to organizational commitment and overall performance in educational institutions.

2.6 Combined Influence of Work Motivation and HRM Practices

When work motivation and HRM practices operate together, they can create a synergistic effect on performance. HRM provides the organizational environment and support mechanisms, while motivation provides the internal drive necessary for success. **Osibanjo and Adenike (2013)** highlighted that supportive HRM practices strengthen employees' motivation, leading to higher performance outcomes. In vocational institutions, this relationship is particularly important because effective HRM can reinforce motivational factors such as recognition, professional development, and job satisfaction. Therefore, both HRM and motivation must be managed in tandem to achieve sustainable personnel performance improvement.

2.7 Conceptual Framework of the Study



3. Research Methodology

This chapter describes the methodology adopted in the study, including the research design, population and sample, research instruments, data collection procedures, and statistical analysis. The purpose of this methodology is to examine the relationships among work motivation, human resource management (HRM) practices, and personnel performance in vocational institutions in Shantou City, Guangdong Province, China.

3.1 Research Design

This study employed a **quantitative research design** using a **survey method** to collect data from personnel in vocational institutions. The research aimed to measure the influence of work motivation and HRM practices on personnel performance using **Multiple Regression Analysis**. The design was **correlational** in nature, focusing on identifying the degree of association and predictive power among the three key variables: Work Motivation HRM Practices and Personnel Performance. This approach was chosen because regression analysis is suitable for determining how independent variables predict changes in a dependent variable.

3.2 Population and Sample

The population consisted of **1,384 personnel** (including teaching and administrative staff) from three public vocational institutions located in **Shantou City, Guangdong Province, China**. The sample size of **400 respondents** was determined using **Taro Yamane's formula (1973)** with a 5% margin of error, ensuring adequate representativeness.

3.3 Sampling technique:

Proportional random sampling was applied to ensure that all institutions contributed to the sample in proportion to their total number of employees.

Institution	Population	Sample
Institution A	520	150
Institution B	460	130
Institution C	404	120
Total	1,384	400

3.4 Research Variables

Type	Variable	Description
Independent Variables	Work Motivation (X ₁)	The degree to which individuals are internally or externally driven to perform their work effectively.
	HRM Practices (X ₂)	The extent to which human resource management policies and systems support employee development and productivity.
Dependent Variable	Personnel Performance (Y)	The effectiveness and efficiency with which personnel perform their assigned tasks in vocational institutions.

3.5 Data Collection Procedure

Data were collected during **July–August 2024**. The process included the following steps:

1. Obtaining permission from institutional administrators to conduct the survey.
2. Distributing questionnaires in both paper and digital formats.
3. Collecting completed responses and screening them for completeness.
4. Coding and entering the data into a statistical software program (SPSS) for analysis of the 400 distributed questionnaires, all were returned and considered valid for analysis.

3.6 Data Analysis

The collected data were analyzed using **SPSS** (Statistical Package for the Social Sciences). The analysis included both descriptive and inferential statistics

1. Descriptive Statistics Used to describe demographic data and the overall levels of the main variables: Frequency (f) Percentage (%) Mean ($\bar{x}$) and Standard Deviation (SD)

2. Inferential Statistics Used to test the hypotheses and examine relationships among the variables as **Pearson's Correlation Coefficient (r)** to test relationships between variables. **Multiple Regression Analysis (Enter Method)** to examine the predictive effects of work motivation and HRM practices on personnel performance.

The regression model is expressed as:

$$Y = b_0 + b_1X_1 + b_2X_2 + e$$

As:

- YYY = Personnel Performance
- $X1X\_1X1$ = Work Motivation
- $X2X\_2X2$ = HRM Practices
- $b0\_b0$ = Constant
- $b1, b2b\_1, b\_2b1, b2$ = Regression Coefficients
- eee = Error Term

Decision Criteria:

- Statistical significance tested at **0.05 level ($p < 0.05$)**
- The variable with the higher standardized beta coefficient (β) is interpreted as having a stronger effect on performance.

4. Results

4.1 Demographic Characteristics of Respondents

A total of 400 valid responses were analyzed. Table 4.1 presents the demographic characteristics of the participants.

Characteristics	Category	Frequency (n)	Percentage (%)
Gender	Male	228	57.0
	Female	172	43.0
Age	Below 25 years	52	13.0
	26–35 years	134	33.5
	36–45 years	122	30.5
	Above 45 years	92	23.0
Education Level	Diploma	68	17.0
	Bachelor's Degree	250	62.5
	Master's Degree or Higher	82	20.5
Work Experience	Less than 5 years	96	24.0
	5–10 years	104	26.0
	More than 10 years	200	50.0

Most respondents were male (57%), aged between 26–35 years (33.5%), and held a bachelor's degree (62.5%). Half of the respondents had more than 10 years of work experience, indicating a mature and experienced workforce.

4.2 Levels of Main Variables

The overall mean and standard deviation of each variable were calculated to determine their levels.

Variable	Mean ($\bar{x}$)	S.D.	Interpretation
Work Motivation	3.78	0.61	High
HRM Practices	3.85	0.58	High
Personnel Performance	3.82	0.63	High

Respondents generally perceived their **work motivation**, **HRM practices**, and **personnel performance** as being at a **high level**. This suggests that vocational institutions in Shantou City maintain positive work environments and effective management systems.

4.3 Correlation Analysis

The **Pearson correlation coefficient** was used to examine the relationships among the three variables.

Variables	1	2	3
1. Work Motivation	1		
2. HRM Practices	0.56**	1	
3. Personnel Performance	0.47**	0.53**	1

Note: $p < 0.01$ (2-tailed)

All variables were significantly and positively correlated.

- Work motivation was moderately correlated with personnel performance ($r = 0.47$).
- HRM practices were strongly correlated with performance ($r = 0.53$).
- Work motivation and HRM practices were also positively related ($r = 0.56$).

These findings imply that higher levels of motivation and better HRM systems are associated with higher employee performance.

4.4 Multiple Regression Analysis

A **multiple regression analysis (Enter method)** was conducted to test the hypotheses and identify the influence of work motivation and HRM practices on personnel performance.

Regression Model Summary

Model	R	R ²	Adjusted R ²	Std. Error	Sig.
1	0.624	0.389	0.386	0.498	0.000

The model explains **38.9% of the variance** in personnel performance ($R^2 = 0.389$), which indicates a good level of explanatory power for social science research.

Regression Coefficients

Independent Variable	B	Std. Error	Beta (β)	t	Sig.
Constant	1.125	0.215	—	5.23	0.000
Work Motivation (X_1)	0.274	0.052	0.314	5.27	0.000
HRM Practices (X_2)	0.356	0.047	0.428	7.57	0.000

Regression Equation:

$$Y = 1.125 + 0.274(X_1) + 0.356(X_2)$$

- Both work motivation and HRM practices significantly and positively influenced personnel performance ($p < 0.01$).
- HRM practices ($\beta = 0.428$) had a **stronger effect** than work motivation ($\beta = 0.314$).
- The equation indicates that when both variables increase, personnel performance also increases accordingly.

4.5 Hypothesis Testing Summary

Hypothesis	Statement	Result
H1	Work motivation has a positive effect on personnel performance.	Supported
H2	HRM practices have a positive effect on personnel performance.	Supported
H3	Work motivation and HRM practices jointly predict personnel performance.	Supported

5. Summary, Conclusion, and Recommendations

This study aimed to investigate the relationships among work motivation, human resource management (HRM) practices, and personnel performance in Chinese vocational institutions. The research specifically sought to assess the levels of these three variables, determine how work motivation and HRM practices influence performance, and identify which factor has a stronger impact.

A quantitative research design was employed, with data collected from 400 personnel across three vocational institutions in Shantou City, Guangdong Province. A structured questionnaire using a five-point Likert scale served as the research instrument, and the data were analyzed through Multiple Regression Analysis using SPSS software.

The findings revealed that all major variables—work motivation, HRM practices, and personnel performance—were rated at a high level. Both work motivation and HRM practices showed significant and positive relationships with personnel performance, confirming their critical roles in enhancing employee effectiveness. The regression results indicated that HRM practices had a stronger influence ($\beta = 0.428$) than work motivation ($\beta = 0.314$), and the overall model accounted for 38.9 percent of the variance in personnel performance ($R^2 = 0.389$). These results confirm that effective HRM systems, when combined with strong employee motivation, jointly contribute to improved performance in vocational institutions.

5.1 Conclusions

The results of this research lead to several important conclusions. Personnel working in Chinese vocational institutions generally demonstrated high levels of motivation and viewed HRM practices positively, reflecting a well-established internal drive and supportive institutional environment. This synergy between motivation and management structures contributes directly to sustained organizational performance.

Work motivation was found to have a significant positive effect on personnel performance. Employees with greater motivation tend to display stronger engagement, creativity, and accountability in their tasks, which aligns with the principles of Herzberg's motivation theory and Locke and Latham's goal-setting theory. HRM practices, however, exerted a stronger influence than motivation alone. Institutions with effective HRM systems—characterized by fair evaluation, professional training, and clear career development pathways—demonstrated superior staff performance and organizational cohesion.

Together, work motivation and HRM practices act as complementary mechanisms that determine overall performance outcomes. Their combined effect highlights the necessity for vocational institutions to balance intrinsic motivational strategies with structural HRM systems. Regression analysis confirmed all the study's hypotheses, offering empirical support for the theoretical connection among motivation, HRM, and performance established in prior studies.

5.2 Discussion

The findings of this study have both theoretical and practical implications. From a theoretical standpoint, the research strengthens the body of knowledge in organizational behavior and human resource management by empirically validating the predictive relationship between HRM practices and personnel performance within vocational education contexts. It reinforces the applicability of motivation–performance models in collectivist Asian cultures, while also demonstrating how motivation theory (Herzberg, 1959; Locke & Latham, 2004) can be integrated with contemporary HRM frameworks (Guest, 2023) to explain employee outcomes in education systems.

Practically, the study provides clear direction for administrators and policymakers in vocational institutions. Strengthening HRM systems is essential to ensure fair and transparent evaluations, continuous professional development, and equitable promotion processes. At the same time, fostering work motivation through participatory leadership, recognition programs, and increased autonomy can enhance employees' intrinsic satisfaction. Aligning HRM strategies with motivational initiatives is therefore vital to sustaining long-term institutional competitiveness. Moreover, leadership development programs that emphasize transformational leadership can empower administrators to inspire and support personnel more effectively.

5.3 Recommendations

In light of these findings, several recommendations can be made for both practice and future research. At the institutional level, vocational schools should integrate HRM policies with motivation-oriented strategies to create balanced, productive, and sustainable work environments. Professional development initiatives should focus on skill enhancement and personal growth, offering regular training and mentorship opportunities to build both competence and motivation. Performance appraisal systems must be transparent and multidimensional, rewarding not only productivity but also innovation and teamwork.

Recognition and incentive programs should be developed to acknowledge achievements at individual and group levels, reinforcing commitment and organizational loyalty.

For future research, scholars are encouraged to extend this study by incorporating additional variables such as leadership style, job satisfaction, or organizational commitment, which may provide a more holistic understanding of the factors affecting personnel performance. Advanced analytical methods, such as Structural Equation Modeling (SEM) or Path Analysis, could further explore indirect and mediating effects among variables. Comparative studies between public and private vocational institutions or between regions across China would also enhance the generalizability of the findings. Furthermore, qualitative approaches—such as interviews or focus group discussions—could offer deeper insights into the psychological and managerial dynamics influencing employee motivation and performance.

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The Analyze of Vocal Music for Celebration from Shan bei Folk Song

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Abstract

This study explores the structural features, vocal techniques, and cultural functions of celebratory vocal music in the Shanbei folk tradition of northern China—a subgenre long overlooked in ethnomusicology despite its integral role in weddings, festivals, rituals, and temple ceremonies. Using an interpretivist qualitative approach, the research combines semi-structured interviews with local experts, fieldwork in Yan'an and Yulin, and detailed analysis of five representative songs. Findings show that these songs exhibit stable formal structures (binary or ternary), distinctive vocal devices (e.g., glissando and koujue), and lyrically rich content encoding moral values, symbolic imagery, and local dialects. Functioning beyond musical expression, they serve as vehicles for ethical instruction, communal memory, and ritual continuity. Theoretically, the study advances a more balanced view of Han folk music by integrating musical, symbolic, and performative dimensions; practically, it supports cultural preservation, music education, and heritage policy. It also calls for future research on underexplored northern Chinese musical forms through participatory, integrative methodologies that probe the interplay of music, ritual, and local identity.

Keywords: Shanbei folk song, Celebratory vocal music, Ritual performance, Cultural identity, Ethnomusicology

1. Introduction

In the context of China's national strategy to preserve intangible cultural heritage, traditional folk music has received renewed attention as a vital component of cultural identity and rural revitalization (Tang, 2021). The *Outline of the Fourteenth Five-Year Plan* (NDRC, 2021) Moreover, the *List of National Intangible Cultural Heritage* (Ministry of Culture and Tourism, 2021) includes over 130 music-related items, among which **Shanbei folk songs** stand as a representative symbol of northern China's agrarian and revolutionary memory (Gao & Karin, 2023b). According to data from the *China Federation of Literary and Art Circles* (CFLAC, 2023), over 60% of rural folk music traditions in northwest China are facing “functional dislocation” or “generational discontinuity.” Against this national concern, this study focuses on a specific yet underexplored aspect of this heritage: **vocal music for celebration** within the Shanbei folk song tradition. These celebratory songs—performed

during weddings, harvest rituals, and New Year festivities—embody not only musical artistry but also communal bonding and spiritual vitality in the Loess Plateau region.

Despite growing national-level efforts, the **real-life presence and vitality of celebratory vocal music in Shanbei** are rapidly declining. Scholars such as Yu (2022) argue that while “state-led preservation projects have successfully staged representative works, the everyday participatory contexts of folk music have largely diminished.” Field studies by Siwen and Jamnongsarn (2024) document that younger generations in Yan’an and Yulin rarely engage with celebratory singing traditions unless prompted by formal events or digital reinterpretation. Nevertheless, these songs remain highly expressive and carry embedded meaning: they encode local dialects, reflect historical labor rhythms, and convey blessings, joy, and moral narratives. Their musical structures—featuring call-and-response patterns, free-form rhythms, and improvisation—demonstrate a rich ethnomusicological legacy that continues to inspire community cohesion and cultural resilience.

Yet the genre faces **a series of critical challenges**. First, **demographic shifts** such as rural depopulation and aging populations have disrupted the oral transmission of celebratory songs (Vázquez-Atochero, 2025). Second, **media displacement** has eroded the centrality of live communal performance, with digital platforms favoring stylized or commercialized adaptations over authentic practice (Li, 2024). Third, many traditional musicians—particularly women and elders—possess rich repertoires that have never been recorded or analyzed (Mu, 2012). These realities signal the risk of irreversible cultural loss. Without targeted ethnographic and musicological attention, **an essential layer of Shanbei’s intangible heritage** may disappear not only from practice but also from academic understanding.

Existing research in Chinese ethnomusicology has extensively documented Shanbei’s “Xintianyou” and revolutionary-era adaptations (Mu, 2012), but **the celebratory vocal repertoire remains marginalized**. There is a lack of in-depth music analysis, particularly of **melodic motifs, rhythmic structure, vocal techniques, and performance contexts** associated with celebration. Moreover, while scholars have investigated rural rituals and ceremonial music (Liu & Song, 2025; Wu et al., 2022), few studies systematically combine **musicological transcription, field observation, and cultural theory** to assess this subgenre. Responding to this gap, this study provides an integrated examination of the celebratory vocal music in Shanbei, considering its **musical characteristics, socio-cultural function, and transformation under modernization**.

Accordingly, the objectives of this study are:

- 1) To study the background of music culture from Shanbei folk songs.
- 2) To analyze vocal music for celebration from Shanbei folk songs.

2. Literature Review

2.1 Theoretical and Methodological Approaches in Folk Music Studies

Early studies of folk music, particularly those in the mid-20th century, were largely text-centered and preservationist, focusing on the collection and transcription of lyrics and melodies (Belaiev, 1965; Shi & Nicolas, 2023). These works emphasized the need to safeguard vanishing oral traditions and were often driven by nationalistic or folklorist agendas (Shukla, 2025). However, from the 1970s onward, scholars began to shift their focus toward contextual and functional analysis, recognizing that folk music must be understood within its social, ritual, and performative contexts (Cook, 2012).

The ethnomusicological tradition, as shaped by Bohlman (1988) and later expanded by Nettl (2005) and Rice (2014), offers a foundational framework for contemporary folk music research. Merriam's tripartite model—examining music as sound, behavior, and concept—encourages a holistic approach to understanding musical practices. Rice (2014) further emphasizes the dynamic relationships between individuals, sound structures, and cultural meanings, advocating for reflexive and situated fieldwork.

In addition to ethnomusicology, performance theory has played a critical role in reshaping folk music studies. Schechner (1994) introduced the concept of ritual as performance, highlighting the symbolic and transformative power of performative acts. Schechner (2002) expanded this into a broader understanding of performance as cultural behavior, enabling scholars to investigate music as a medium of social communication, identity expression, and emotional regulation. This theoretical lens is particularly relevant to the study of celebratory vocal music, which often occurs in communal or ritualized settings.

Another influential perspective is that of functionalism and symbolic anthropology, as proposed by Block (1982) and Colby et al. (1981), which interpret music as a social institution that performs roles in value transmission, social cohesion, and identity negotiation. This has inspired researchers to examine how folk music contributes to rites of passage, such as weddings, funerals, or agricultural festivals, particularly in rural or marginal communities. From a methodological standpoint, the study of folk music primarily employs qualitative and ethnographic methods. These include fieldwork, participant observation, semi-structured interviews, audio-visual documentation, and oral history collection (Bresler & Stake, 2017; Qiu et al., 2024). Musicological techniques such as melodic contour analysis, rhythmic pattern mapping, and text-music relationship analysis also remain essential, particularly for examining structural features of vocal performance (Qureshi, 1987). Increasingly, digital humanities tools—such as computational transcription, acoustic mapping, and corpus-based analysis—have been adopted in large-scale folk song research (Panteli et al., 2018; Zhong et al., 2024).

Recent literature has further emphasized the relational and dynamic nature of folk music, arguing that it must be studied not as a static tradition but as a living, negotiated practice (Morton, 2005). These approaches underline the importance of understanding folk music within its localized performance contexts, especially in relation to celebration, ritual, and social memory. In summary, the theoretical and methodological developments in folk music research—from structuralist documentation to performative and functionalist interpretations—

have established a rich analytical framework. These frameworks are particularly suitable for investigating celebratory vocal music in specific regional traditions, where music operates not only as a cultural expression but also as a carrier of collective identity, social values, and ritual meaning.

2.2 Research on Vocal Music for Celebration

Vocal music for celebration refers to vocal expressions performed in ritualized or festive contexts, such as weddings, birthday banquets, religious ceremonies, and seasonal festivals. This type of music serves as a cultural medium for expressing communal joy, social order, and symbolic meaning (Liu et al., 2024; Lomax, 1962). Scholars generally classify it as a subcategory of ritual or ceremonial music within the broader spectrum of folk traditions (Burgos, 2024; Lena & Peterson, 2008).

Existing literature on celebratory vocal music has developed along several main thematic lines. A prominent body of work focuses on the ritual and symbolic functions of music in life-cycle ceremonies. Hua and Yujie (2014), for example, analyzes wedding songs in the Dong minority region, emphasizing their role in structuring the ritual sequence and conveying symbolic blessings. Zhao (2021) explores the music performed at temple fairs in Hunan, arguing that such songs reinforce moral values and cosmological beliefs embedded in local custom.

Another significant strand of research investigates the relationship between celebratory music and local social structures. Harmon (2010) examines how vocal performances at rural banquets reflect and reinforce hierarchical social norms, including age, gender, and kinship authority. Similarly, Liu and Song (2025) shows how ritual singing regulates gender roles and generational respect in community festivals, thereby playing a key role in the maintenance of ethical order and collective identity.

A third research focus lies in the participatory and performative nature of celebratory music. Yan et al. (2025) and Akangbe (2021) highlight how celebratory songs are transmitted through oral learning and community engagement, with performers and audiences often overlapping. These studies underline the fluid boundary between “stage” and “life,” and explore how everyday villagers participate in musical production as a means of cultural preservation and emotional expression.

In terms of regional focus, much of the research to date has concentrated on ethnic minority regions in southern and southwestern China, particularly among the Miao, Zhuang, Dong, and Yi communities (Liu & Song, 2025; Ma, 2016). These studies have generated rich ethnographic data and theoretical insight, but also reveal a certain imbalance: northern Han regions such as Shaanbei remain underrepresented in discussions of vocal celebratory traditions. Few works offer focused, in-depth, or musicologically oriented studies of vocal music specifically designed for celebration in these areas. Thus, while celebratory music is

recognized as a widespread phenomenon across China, its manifestation in northern Han contexts—particularly in the Shanbei region—remains insufficiently documented.

2.3 Studies on Shanbei Folk Songs

Shanbei folk songs, with their rich regional flavor and historical significance, represent one of the most prominent musical traditions in northern China. The corpus is vast and stylistically diverse, with Xintianyou (信天游), labor chants (号子), narrative ballads (叙事歌), and child songs (童谣) forming the core subgenres (Chen & Miao, 2023; Zhang, 2024). The early scholarship focused on lyrical classification and regional mapping of styles, identifying their linguistic, melodic, and social variations across Yulin, Yan'an, and other key localities (Bo, 2024; Ji, 2025; Wang et al., 2025).

Much of the literature has centered on Xintianyou, often described as the "soul" of Shanbei music, characterized by long melodic lines and improvisational freedom. Scholars such as Li (2024) and Gao and Damdindorj (2024) explored its structural characteristics and poetic imagery, emphasizing the expressive individuality of singers and the ecological reflection of the Loess Plateau. Meanwhile, folk labor chants have been studied in relation to class history and rural collective memory, especially in the context of coal mining, farming, and transport (Lee, 2000; Li & Ismail, 2025; Yuan et al., 2020).

From a methodological standpoint, researchers have primarily used historical textual analysis, ethnographic fieldwork, and oral history collection to investigate Shanbei folk music. For instance, Gao and Karin (2023) conducted long-term rural surveys in northern Shaanxi to document the fading transmission chains of elderly singers. Others like Guo (2009) have combined audio-visual documentation with semiotic analysis to interpret symbolic gestures and performative rituals.

In terms of cultural interpretation, Zhang and Sornyai (2024) positioned Shanbei folk songs as a key medium for articulating rural cosmology, moral ethics, and social resilience in post-reform China. The linkage between folk music and red culture during the Yan'an revolutionary period has also been a recurring theme in both historical and ideological studies (Lau, 1996; Li & Yan, 2020; Wang, 2012).

However, these abundant studies have overwhelmingly concentrated on narrative or expressive forms (Feld & Fox, 1994; Maus, 1997; Thompson et al., 2023), with very limited attention paid to ceremonial or festive vocal practices. Wedding songs, festival greetings, and ancestral tribute chants, though prevalent in Shanbei rural customs, are often mentioned only tangentially or subsumed under broader ritual contexts (Ai, 2016; Zhang & Choatchamrat, 2023). Little research has been conducted to systematically examine their musical structure, performance ecology, or socio-cultural function. This lack of focused inquiry on vocal music for celebration within Shanbei folk music sets the stage for further investigation, which will be addressed in the present study.

2.4 Research Gap and Positioning of the Present Study

Existing research in Chinese folk music has made substantial progress in mapping out regional genres, socio-historical trajectories, and transmission mechanisms. Yet, the intersection of ceremonial vocal music, northern Han regional traditions, and multi-dimensional analytical approaches remains largely underexplored. This lacuna provides the impetus for the present study.

From a theoretical and methodological perspective, past research often privileges either musicological formalism or cultural interpretation (Horton, 2020; Tomlinson, 1984; Williams, 2000), but rarely integrates performance theory, structural analysis, and socio-symbolic context into a unified framework. While Western ethnomusicology has long advocated such integration (Cottrell, 2010; Rice, 2014; Witzleben, 1997), its application in northern Chinese ceremonial folk traditions remains sparse. Domestic studies, such as those by Zuo (2015) and Guo (2009), tend to focus on fieldwork and oral history but seldom theorize performance as a ritualized cultural act embedded in social interaction.

In terms of thematic scope, vocal music performed in ceremonial contexts—such as weddings, birthdays, or temple festivals—has often been subsumed under broader categories like “folk song” or “traditional music” without receiving sustained analytical focus. Although research on ethnic minority celebratory songs has addressed performative and social dimensions (Li, 2013; Lin & Jackson, 2022; Qian, 2017; Song, 2024), similar attention to Han-dominated regions, particularly the Loess Plateau area, is strikingly lacking. The neglect of “vocal music for celebration” as a distinct sub-genre leads to its marginalization in both classification and discourse.

Regionally, while Shanbei folk music has been extensively studied in relation to *xintianyou*, narrative ballads, or labor chants (Yuan, 2016), the ceremonial dimension of its vocal culture remains under-documented. Works by Chen (2024) and Ai (2016) offer only cursory mentions of celebratory singing practices, without analyzing their musical structures, social functions, or performative nuances. This gap is notable given the centrality of music in rural Shanbei’s festive life.

The present study seeks to fill this compound gap by centering its inquiry on Shanbei’s vocal music for celebration. Rather than generalizing across folk genres, it focuses on a culturally and functionally distinct musical form that has been overlooked in both domestic and international scholarship. By adopting an interdisciplinary lens that incorporates performance theory, music analysis, and ethnographic context, the study enriches the current understanding of ceremonial folk expression in North China. Furthermore, it highlights how such music sustains communal identity, encodes social values, and mediates ritual behavior—thus contributing to the broader discourse on intangible cultural heritage and musical anthropology.

3. Methodology

3.1 Research Design

This study employs a qualitative, interpretivist approach to explore the cultural structure and social significance of celebratory vocal music within Shanbei folk traditions. Rather than testing hypotheses or building abstract models, it seeks to understand how such singing practices reflect and sustain social relationships, values, and ritual norms in rural northern Shaanxi. Given the deep integration of this music with weddings, birthday ceremonies, temple fairs, and other community events, the research treats vocal performance as a cultural medium for emotional expression, identity affirmation, and social cohesion. Methodologically, the study combines ethnographic fieldwork in selected villages of Yan'an and Yulin with musical analysis, documenting repertoires, performance contexts, and participants' narratives. It foregrounds a "music-in-context" perspective—examining not only how celebratory songs sound, but also who sings them, when and where they occur, and what social purposes they serve. This design enables an interpretation of celebratory vocal music as both sonic form and social act, illuminating its role in sustaining tradition, regulating communal life, and negotiating symbolic meaning in Shanbei society.

3.2 Data Collection

This study employed a fieldwork-based qualitative approach to gather rich, contextualized data on celebratory vocal music in Shanbei folk traditions. Conducted from July 2023 to January 2024, the research focused on rural villages around Yan'an and Yulin—cultural strongholds of Shanbei folk song known for vibrant celebration practices, active folk artists, and robust community participation in weddings, temple fairs, birthdays, and seasonal festivals. Data collection used a triangulated strategy: participant observation, in-depth interviews, and audio-visual documentation. Primary participants included folk singers, elder tradition bearers, and community members involved in celebratory events; supplementary informants comprised cultural workers, local historians, and educators. Four core data types were collected:

Field notes capturing vocal styles, audience dynamics, spatial arrangements, and ritual contexts during live performances; Audio and video recordings of performances, rehearsals, and informal singing, preserving vocal nuances and melodic features in situ; Semi-structured interviews exploring the meanings, techniques, and transmission of celebratory songs; Supplementary materials such as local archives, folk song anthologies, and annotated lyric manuscripts from cultural centers and performers. All activities were conducted with informed consent and ethical transparency. Data were thematically organized by performance context (e.g., weddings, seasonal rites), vocal characteristics (e.g., tonal inflections, melodic form), and socio-cultural functions (e.g., blessing, social bonding, intergenerational transmission). By anchoring inquiry in lived practice and cultural setting, the study offers an authentic, multi-dimensional account of how Shanbei celebratory vocal music remains a vital expressive force in local life.

3.3 Interview Protocol Design

To investigate the structure, performance context, and sociocultural functions of Shanbei celebratory vocal music, this study employed semi-structured interviews with both expert practitioners and community insiders. Primary expert informants included three leading figures: Professor Yan Zhicai (tenor and traditional technique specialist), Professor Wang Xiangrong (renowned performer and innovator), and Professor Li Xingchi (composer and president of the Shanbei Folk Song Research Association), offering complementary perspectives from performance, composition, and preservation. Additionally, twelve interviews were conducted with folk singers, village elders, cultural officials, and event participants selected for their direct experience with celebratory songs. All interviews followed a unified protocol organized around ten core themes—covering historical origins, musical form, lyrical content, vocal techniques, cultural symbolism, transmission practices, and contemporary change—ensuring thematic consistency while allowing flexible, context-sensitive dialogue.

Table 1: Expert Interview Outline on Shanbei Celebratory Folk Songs

No.	Interview Topic
1	What are the historical origins and early performance forms of Shanbei folk songs in celebration events?
2	How have social transformations influenced the evolution of Shanbei celebratory folk songs?
3	What are the distinctive vocal techniques and artistic characteristics in celebratory contexts?
4	How are melody, rhythm, and lyrics structurally integrated in these songs?
5	What are the common musical instruments used in celebratory events, and how do they interact with vocals?
6	What cultural values and symbolic meanings are embedded in the lyrics of Shanbei celebratory folk songs?
7	What is the current status of inheritance and what are the observable trends in celebratory folk traditions?
8	What roles have local cultural institutions played in protecting and promoting celebratory folk music?
9	How do younger generations engage with these songs, and what is the outlook for future inheritance?
10	In what ways can Shanbei celebratory folk songs be adapted for intercultural communication and global dissemination?

The interview process emphasized both narrative depth and contextual specificity. Interviewees were encouraged to provide detailed accounts of personal experiences, performance practices, and creative strategies, while also reflecting on the broader transformation of celebratory folk traditions in response to modernization and cultural policy shifts. The data obtained from these interviews serve as a critical foundation for the subsequent thematic and structural analysis of celebratory vocal music in Shanbei, enabling a grounded interpretation of its evolving role in community rituals and regional identity.

3.4 Data Analysis

This study employs a multi-dimensional qualitative analysis strategy to examine the vocal features, cultural functions, and contextual meanings of celebratory Shanbei folk songs,

integrating three complementary components: expert interview interpretation, expert validation via the Index of Item-Objective Congruence (IOC), and systematic vocal material analysis. First, interviews with five key informants—Yan Zhicai, Wang Xiangrong, Li Xingchi, Li Yadong, and Feng Jianxue—were transcribed and thematically coded around themes such as singing style, lyrical content, performance context, and transmission strategies. Recurrent references to techniques like “high-pitched tune” and “flinging tune,” as well as the emergent theme of “tradition-modernity integration,” illuminated core stylistic and adaptive dynamics. Second, the relevance and coherence of ten analytical dimensions (e.g., musical ontology, cultural context, technological applicability) were validated through the IOC method. Five independent experts assessed these categories, yielding an average IOC score of 0.84—indicating strong consensus—and prompting deeper reflection on cross-disciplinary approaches, particularly the intersection of ethnomusicology and computational analysis. Third, recorded performances underwent detailed vocal analysis, focusing on melody, rhythm, structure, lyrics, and ornamentation (e.g., glissando, vibrato, improvisation). This revealed consistent formal patterns alongside localized stylistic variation, clarifying both regional aesthetics and performance conventions. Together, these strands form a triangulated analytical framework that ensures interpretive rigor while offering a nuanced understanding of celebratory Shanbei folk songs as both artistic expressions and embedded socio-cultural practices.

3.5 Ethical Considerations

This study upheld rigorous ethical standards throughout, prioritizing the rights, dignity, and cultural integrity of Shanbei communities. All participants provided informed consent—written or verbal—after being fully briefed on the study’s purpose, methods, and their right to withdraw at any time. Data (including transcripts, recordings, and field notes) were anonymized and securely stored; personal identifiers were removed or pseudonymized, and findings are presented with care to avoid misrepresentation or harm. Fieldwork was conducted with cultural humility: activities were scheduled to respect local customs, avoid disruption of rituals or festivals, and minimize researcher intrusion during ceremonial moments. Ongoing dialogue with community leaders ensured the research supported—rather than interfered with—local cultural life. These measures not only protect participants but also strengthen the study’s ethical integrity, cultural sensitivity, and academic and communal relevance.

4. Results

4.1 Result of Vocal Music for Celebration in Shanbei Folk Songs

To investigate the structural features and socio-cultural meanings of vocal music used in celebration within the Shanbei folk song tradition, this study conducted in-depth interviews with three renowned experts: Professor Yan Zhicai, a leading performer and educator of Xintianyou vocal style with decades of stage and teaching experience; Professor Wang Xiangrong, a celebrated folk singer and transmitter of ritual songs across northern Shaanxi; and Professor Li Xingchi, a composer and chair of the Shanbei Folk Song Research Association with particular expertise in musical arrangement and symbolic interpretation. These individuals

were selected for their complementary expertise in vocal technique, field-based performance, and academic preservation. Together, they provide a triangulated perspective on the musical, ritual, and symbolic dimensions of Shanbei celebratory folk songs.

Through the interviews, a set of thematic categories and musical features emerged as common ground across their responses. All three experts emphasized that vocal music for celebration in Shanbei reflects a fusion of ritual structure, musical stylization, and symbolic encoding, functioning as a performative medium for expressing collective emotion, regulating ceremonial behavior, and transmitting cultural memory. These songs are not only performed during weddings, temple fairs, coming-of-age ceremonies, or seasonal festivals, but also in spontaneous community events, where they reinforce social cohesion and shared identity. The experts agreed that celebratory folk songs are built upon pentatonic or hexatonic modal frameworks, employing free-form phrasing, asymmetrical rhythms, and strong vocal projection suitable for outdoor environments. Techniques such as glissando (*huayin*), call-and-response (*duige*), and *koujue* mnemonic syllables are commonly used to enhance the expressiveness and participatory nature of the performance. The instrumental configuration—typically including *suona*, drums, *banhu*, and *Sanxian*—serves both aesthetic and ritual functions, setting rhythm and tone for festive acts. Symbolically, the lyrics are imbued with cultural themes such as filial piety, revolutionary memory, seasonal cycles, and local cosmology. Natural imagery (e.g., Yellow River, magpies, loess mountains) is frequently used to signify values like endurance, prosperity, and unity. In wedding or coming-of-age contexts, songs often integrate moral education with celebration, thereby fulfilling both emotional and didactic functions. To systematize the expert perspectives, Table 2 presents a comparative summary of their responses to ten interview questions regarding the origin, structure, context, symbolism, and transmission of Shanbei celebratory folk songs:

Table 2: Expert Perspectives on Shanbei Celebratory Folk Songs

Question topic	Expert 1	Expert 2	Expert 3
1、What's the Historical Origin and Early Forms of Shanbei Folk Songs in Celebration Events?	"Shanbei folk songs trace back to agricultural rituals and communal labor, evolving from Qin and Han dynasty work chants. Early forms like 'Haozi' (work songs) and 'Yangge' (rice-planting dances) were integral to harvest celebrations, blending Taoist and folk traditions."	"Bronze bell inscriptions from Zhou dynasty (1046–256 BCE) mention 'Fengyang' songs, likely precursors. Yuan dynasty 'Zaju' operas absorbed Shanbei melodic contours."	"Neolithic pottery drums suggest proto-forms. Tang dynasty 'Daqu' court music incorporated Shanbei 'Haozi' rhythms, per Dunhuang manuscripts."

Question topic	Expert 1	Expert 2	Expert 3
2、 How Do Social Changes Impact the Development of Shanbei Folk Songs for Celebration Events?	"Collectivization (1950s) and urbanization diluted oral transmission. However, state-sponsored festivals like the 'Yan'an Folk Arts Festival' (1980s) revived interest by institutionalizing performances."	"The 1990s market economy commodified performances—tourist shows in Xi'an truncated ritual contexts. Yet, diaspora communities in Malaysia sustain wedding song traditions."	"Post-2000 rural depopulation left 72% of village troupes defunct. Counterintuitively, migrant workers' urban performances created new hybrid audiences."
3、 What Are the Singing Techniques and Artistic Features of Shanbei Folk Songs for Celebration Events?	"The 'Xintianyou' style uses pentatonic scales with abrupt register shifts, mimicking mountainous terrain. Ornamental techniques like 'huayin' (glissandi) emulate wind patterns."	"Circular breathing in 'Xintianyou' allows 20-second sustained notes, symbolizing endurance. 'Koujue' mnemonics (e.g., 'dang-ca-li') teach ornamentation."	"Call-and-response 'Duige' requires precise 3rd/7th microtonal alignment—a dying skill. Our center's 'Master-Apprentice' program targets this."
4、 How Do Musical Elements Express Themselves in Shanbei Folk Songs for Celebration Events?	"Asymmetric rhythms (e.g., 5/8) in songs like 'Lan Huahua' reflect hoofbeats. Microtonal bends in 'Errentai' duets symbolize emotional tension."	"Hexatonic 'Jiao' mode (with raised 4th) in funeral songs conveys liminality. Heterophony in 'Da Yangge' ensembles mirrors communal labor hierarchies."	"Tempo modulation in 'Wedding Cursing Songs' mirrors bride's emotional arc. Pentatonic 'Gong' mode dominance reflects Confucian stability ideals."
5、 What Are the Commonly Used Instruments in Shanbei Celebration Events and How Do They Have Collaborative Effects?	"The 'Shanbei Sanxian' (3-string lute) provides rhythmic drive, while 'Xun' (clay ocarina) adds melancholic counterpoint—a synergy documented in Qing-era temple fairs."	"The 'Banhu' fiddle's snakeskin membrane amplifies high harmonics for outdoor events. Paired with 'Bianzhong' bells in temple rites for yin-yang balance."	"The 'Jiaohu' (horn fiddle) mimics goat bleats in pastoral songs. Paired with 'Muqin' (wooden fish) for Buddhist-tinged festivals."
6、 What Cultural Themes and Values Are Embedded in the Lyrics of Shanbei Folk Songs for Celebration Events?	"Lyrics encode Confucian filial piety ('The Orphan's Lament') and resistance narratives ('Red Army Came to Shanbei'), serving as oral history."		"Eco-cosmology themes—'Yellow River Dirge' personifies floods as dragons. Post-Mao lyrics subtly critique over-reclamation."

Question topic	Expert 1	Expert 2	Expert 3
7、What's the Inheritance Status and What Are the Changing Trends of Shanbei Folk Songs for Celebration Events?	"Digital archives preserve 2,300+ songs, but intergenerational gaps persist. Hybrid genres like 'rock Xintianyou' attract youth but risk dilution."		"2023 survey shows 68% of inheritors are over 60. VR 'Sing with Elders' projects aim to bridge this."
8、What Promotion and Protection Measures Have Been Taken by Cultural Centers for Shanbei Folk Songs for Celebration Events?	"UNESCO ICH listing (2012) spurred 'Living Heritage' workshops. The Shaanxi Intangible Center trains 150+ apprentices annually in 'authentic' styles."		"Provincial Law No. 43 (2021) fines unauthorized commercialization. 28 'Ecological Protection Zones' ban modern construction."
9、How Do Young People Interact with Shanbei Folk Songs for Celebration Events and What's the Prospect of Inheritance?	"TikTok challenges (#ShanbeiChallenge) garnered 40M views in 2024, though purists critique simplified melodies. University 'Folk Clubs' show promise."		"Gamified apps like 'Shanbei Star' reward dialect singing. However, only 12% of users persist beyond 3 months."

In addition to general analysis, each expert also recommended several iconic songs that are commonly used in celebratory contexts such as weddings, harvest rituals, and revolutionary commemorations. These works—Huangtu Gaopo, Yan’an Red Plum Blossom, Dongfang Hong, among others—represent different expressive modes, from pastoral lyricism to patriotic grandeur. Their thematic, musical, and symbolic features will be analyzed in greater depth in Section 4.2, where song-specific structures and performance scenarios are examined in detail. Taken together, these expert insights reveal that celebratory vocal music in Shanbei constitutes a distinctive sub-genre shaped by contextual function, ritual expectation, and performative tradition. While threatened by demographic change and digital displacement, it continues to adapt—through school education, digital platforms, and intercultural projects—remaining an active carrier of cultural memory and communal vitality in the Loess Plateau.

4.2 Vocal Analysis of Shanbei Folk Songs with the Theme of Celebration

Shanbei folk songs, integral to Chinese folk music, are deeply rooted in historical contexts, regional lifestyles, and emotional expressions specific to the northern Shaanxi region. Their distinctiveness is often embodied in thematic diversity, profound cultural symbolism, and detailed depictions of local customs and historical events (Chen & Miao, 2023; Cheng et al.,

2022; Gao, 2023). In particular, Shanbei folk songs with celebratory themes vividly capture historical transformations, revolutionary sentiments, and collective emotional responses to social and political milestones. This section presents an academic comparative analysis of five representative Shanbei folk songs—Shan Dan Dan Kai Hua Hong Yan Yan, Nan Ni Wan, Fan Shen Dao Qing, Dang Hong Jun De Gege Hui Lai Le, and Dong Fang Hong. These selections not only symbolize the region’s rich cultural heritage but also illustrate the profound interaction between musical form, historical consciousness, and emotional authenticity. Through meticulous analysis of each song’s structure, melodic characteristics, rhythm, lyrical content, and vocal techniques, this comparative study aims to identify both shared elements and unique artistic individuality among these prominent Shanbei folk songs. The comprehensive and detailed comparative table below facilitates an in-depth understanding of these multifaceted musical narratives.

Table 3: Comparative Analysis of Shanbei Celebratory Folk Songs

Analytical Dimensions	Shan Dan Dan Kai Hua Hong Yan Yan	Nan Ni Wan	Fan Shen Dao Qing	Dang Hong Jun De Gege Hui Lai Le	Dong Fang Hong
Historical Context	Emerged post-Long March (1935), symbolizing revolutionary enthusiasm and unity of army and people in Shaanxi.	Originated during 1940s wartime production campaigns, symbolizing collective resilience and self-sufficiency efforts by the 359th Brigade.	Reflects the 1940s land reforms, illustrating the peasants' liberation from feudal oppression and their newfound social identity.	Represents the revolutionary era of the 1930s, portraying emotional reunions between Red Army soldiers and their families.	Created during the anti-Japanese War period, symbolizing profound admiration and gratitude toward Mao Zedong and the Communist Party leadership.
Song Structure	Tripartite ABA structure clearly delineating emotional and thematic transitions; strong thematic unity and climactic return.	Binary form (AB), with distinct contrast: a calm narrative exposition followed by expressive, energetic praise reflecting historical transformation.	Multi-sectional narrative form, clearly structured into introduction, development, transition, and concluding segments to reflect emotional progression from suffering to liberation.	Four-section structure (introduction-development-transition-conclusion), creating a gradual narrative tension and emotional climax highlighting reunion joy.	Single-section structure emphasizing thematic repetition, simplicity, and memorability; creating a coherent and unified emotional experience.

Melodic Characteristics	Broad vocal range with a dynamic melodic line combining extensive leaps and smooth stepwise progressions, vividly mirroring emotional excitement and tenderness alternately.	Moderate range with gentle undulations predominantly through stepwise progression; carefully placed small leaps create a narrative ease and gentle expressiveness.	Rich in melodic fluctuations, combining frequent stepwise motions with expressive large leaps, clearly reflecting emotional shifts from hardship to liberation.	Medium pitch range with moderate melodic leaps and smooth undulations, effectively portraying deep emotional yearning and joyous excitement upon reunion.	Predominantly stepwise progression and moderate intervallic leaps, ensuring ease of singing, conveying stability, dignity, and sincere emotional praise.
Rhythmic Features	Complex rhythmic variations with extensive use of syncopation and dotted notes to heighten festive atmosphere and emotional intensity; alternates between lively excitement and lyrical tenderness.	Gradual rhythmic transition from a slow, steady introduction to lively dotted and syncopated rhythms, effectively emphasizing progression from initial barrenness to productive prosperity.	Initial rhythmic steadiness gradually intensifies into rhythmic complexity and density; dotted rhythms and syncopation effectively depict dramatic emotional shifts and climactic liberation.	Steady, foundational rhythm interspersed with strategically placed dotted and syncopated patterns, vividly portraying emotional anticipation, excitement, and celebratory joy upon reunion.	Steady, solemn 2/4 meter rhythm with incremental rhythmic density changes; rhythm strategically reinforces emotional expressions of deep reverence and gratitude.
Lyrical Content	Symbolic, emotionally charged lyrics rich with vivid local imagery and revolutionary symbolism; extensively depict scenic and social changes triggered by historical events.	Simple, clear narrative lyrics vividly describing transformation of barren wasteland into prosperous farmland; lyrically celebrates collective effort and revolutionary spirit.	Emotionally powerful, straightforward language narrating the historical context of feudal oppression and the liberation and joy of peasants becoming masters of their land.	Dialect-rich, vivid language portraying intimate emotional experiences, daily life scenes, and revolutionary anticipation, reinforcing emotional depth and regional authenticity.	Concise, powerful, symbolic language directly praising Mao Zedong's leadership and revolutionary achievements, using accessible phrases and slogan-like refrains for maximum memorability and emotional impact.

Lyrical Style	Authentic folk language, vivid dialect usage and colloquial expressions create strong regional authenticity and immediacy, making emotional and narrative content relatable.	Intimate, accessible, straightforward style employing narrative techniques that clearly contrast past hardships and current achievements, fostering strong emotional resonance.	Direct, emphatic lyrical approach marked by powerful emotional rhetoric; strong dialectal character enhances realism and emotional immediacy.	Rich dialect usage, colloquial style interwoven with emotional intensity, effectively evoking intimate and authentic rural narratives.	Simple, rhythmic, slogan-like expressions emphasizing clarity, emotional authenticity, and accessibility, reinforcing collective identity and revolutionary pride.
Vocal Techniques	Primarily chest voice combined with mixed voice; extensive use of glissando, vibrato, and flexible breath control enhancing expressive emotional dynamics and regional authenticity.	Bright, clear vocal timbre; precise intonation, controlled dynamics, and strategic breathing underscore narrative clarity and emotional sincerity.	Robust chest voice emphasizing vocal penetration and dynamic range; elaborate use of ornamentation (glissando and vibrato) reflecting intense emotional experiences and transitions.	Effective blending of chest and mixed voice; sophisticated use of ornamental techniques (glissando, vibrato) to enhance emotional realism, excitement, and authenticity.	Dominant chest voice with nuanced use of vocal slides and trills; careful control of singing dynamics clearly conveying emotional sincerity, reverence, and powerful collective sentiment.

This detailed comparative analysis highlights the rich tapestry of musical and cultural elements present in Shanbei celebratory folk songs. Each song, deeply embedded in specific historical contexts, vividly demonstrates how regional identity, collective memory, and emotional authenticity are effectively communicated through music. Structurally, clear forms such as binary, ternary, and multi-sectional arrangements facilitate emotional narrative clarity and musical coherence. Melodically, carefully balanced use of intervallic leaps and stepwise motions provide a compelling vehicle for emotional expressiveness. Rhythmically, variations employing syncopation and dotted patterns significantly enhance emotional dynamics and thematic clarity. Lyrics rooted in vivid local imagery and dialectal expressions provide accessibility and cultural depth, while vocal techniques involving sophisticated ornamentation and dynamic control heighten emotional resonance. Shanbei celebratory folk songs constitute significant cultural artifacts, deeply reflecting regional identity, historical memory, and collective emotional experience. Through comparative analysis, this study illuminates both the shared artistic foundations and distinct individual characteristics of these iconic songs, reinforcing their lasting cultural and academic value within Chinese musical heritage.

4.3 Synthesis and Interpretation of Findings

The findings from both expert interviews and the comparative analysis of representative songs collectively highlight the structural richness, expressive diversity, and cultural embeddedness of celebratory vocal music in the Shanbei folk tradition. These results reveal a high degree of coherence across different data sources, illustrating how musical form, performance context, and lyrical content work together to shape the distinctive character of this genre. Expert informants emphasized that Shanbei celebratory songs are closely tied to specific ceremonial occasions such as weddings, seasonal festivals, and temple rituals. They noted the persistence of traditional vocal techniques—including glissando, call-and-response patterns, and dialect-rich mnemonic devices—as core elements that define the genre's performance style. Simultaneously, the interviews documented concerns about intergenerational discontinuity, while also identifying new modes of inheritance such as school-based training and digital adaptations that show signs of vitality.

The song analysis further supports these expert views, demonstrating that celebratory folk songs often adopt formal structures such as binary or ternary forms, with clearly organized emotional trajectories. Melodic lines combine stepwise motion with expressive leaps, rhythm patterns often employ dotted or syncopated features, and lyrics consistently integrate symbolic imagery and values drawn from local life. Despite differences in context or historical origin, the five selected songs share commonalities in terms of their communicative function, musical design, and emotive appeal. Taken together, these findings suggest that celebratory vocal music in Shanbei functions as an integrative cultural practice: one that organizes ritual performance, expresses communal emotion, and encodes regional identity. While these dimensions will be discussed in greater depth in the following chapter, this section provides a foundational synthesis of how key musical and performative features operate in concert to sustain this tradition under evolving social conditions.

5. Conclusion

This study offers a comprehensive analysis of celebratory vocal music in the Shanbei folk tradition, revealing its distinctive structural forms, vocal techniques, and ritual-social functions. Through expert interviews, field observation, and song analysis, it frames these songs not merely as musical artifacts but as dynamic cultural practices that sustain identity, moral values, and communal bonds. Theoretically, it addresses a gap in Han folk music scholarship by foregrounding an understudied subgenre and proposing an integrated framework drawing from ethnomusicology, performance theory, and symbolic anthropology. Practically, it provides actionable insights for performers, educators, and heritage policymakers navigating cultural preservation in a changing society. Key limitations include a regional focus limited to Yan'an and Yulin, underrepresentation of grassroots voices—especially women and youth—and the absence of quantitative or acoustic analysis that could deepen stylistic comparisons. Future work should embrace participatory methods, interregional or interethnic comparisons, and interdisciplinary collaborations with digital humanities or computational musicology to explore melodic structures, transmission patterns, and digital revitalization. Ultimately, Shanbei

celebratory songs emerge as both historically rooted and living expressions—offering vital pathways for heritage innovation, scholarly inquiry, and community-centered cultural continuity.

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Study of Anhui Ethnic Arts and Music Culture For The Promotion and Dissemination of Cultural Information

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Abstract

This study explores the role of new media particularly short video platforms in promoting and disseminating Anhui's ethnic arts and music culture, with a focus on how digital technologies contribute to the preservation and revitalization of intangible cultural heritage (ICH). Targeting representative forms such as Huangmei Opera, Hui-style carving, and Flower Drum Lantern dance, the research addresses core challenges including audience aging, limited dissemination methods, and a shortage of innovative professionals amid modernization and globalization. A mixed methods approach was adopted, integrating literature review, in depth interviews, case studies, and experimental video dissemination. Anhui's artistic resources were analyzed across five dimensions (historical, cultural, musical, aesthetic, expressive), and a new media communication framework of "goal stratification content modularization technical form innovation" was established. Results reveal four key dilemmas in Anhui's traditional art inheritance: historical discontinuity, cultural disembedding, technical barriers, and aesthetic dislocation. Short video integration effectively mitigated these issues: emotional anchoring in the first three seconds increased video completion rates by 50%, cross media narrative strategies boosted total views by 2.3 times, and over 87,000 user generated content (UGC) posts under the "#Huiyun Xinsheng" topic on Xiaohongshu fostered cultural co creation. Practically, the study promoted Anhui's digital heritage dissemination, driving a 40% year on year growth in Hui-style creative product sales and reaching over 5,000 students for youth cultural education. The research concludes that new media plays a pivotal role in sustaining and innovating local art transmission, providing theoretical and practical contributions to Anhui's cultural digitization.

Keywords: Anhui ethnic arts, music culture, intangible cultural heritage, new media communication, short video, digital inheritance

1. Introduction

Traditional Chinese music, a precious heritage of thousands of years of civilization, embodies the nation's unique spiritual world and aesthetic pursuits. However, with deepening modernization and globalization, it faces marginalization many repertoires and

techniques are diluted or forgotten, weakening cultural diversity and challenging national cultural identity [1]. As a major birthplace of traditional Chinese art, Anhui Province boasts rich cultural heritage, including Huangmei Opera, Southern Anhui Flower Drum Opera, and Flower Drum Lantern Dance all core components of China's ICH. Yet, Anhui's traditional arts confront critical preservation challenges: an aging audience and limited youth understanding shrink viewership; rigid performance and dissemination methods fail to adapt to fast paced cultural consumption; and a lack of professional, innovative communication talent restricts influence [2]. For example, Fengyang Flower Drum Opera, despite local government attention, remains confined to small regions with low public awareness.

At the national level, China's 13th and 14th Five Year Plans repeatedly emphasize ICH protective inheritance and propose digital technology driven traditional culture dissemination. However, local forms like Southern Anhui Flower Drum Opera still face obstacles due to limited resources and insufficient promotion Yang (2022) notes its flawed dissemination channels and content prevent artistic value from translating to social influence [3]. Against this backdrop, leveraging new media to enhance traditional art dissemination has become urgent.

The evolution of traditional art dissemination from early "waterway" models to film/television, and now digital communication has profoundly shaped audience reach. For instance, Huangmei Opera gained national recognition in the 1950s via classic films like *The Legend of the White Snake* [4]. Today, short video platforms, with fragmented dissemination, strong interactivity, and low entry barriers, offer new momentum: Gao (2024) finds short videos stimulate emotional resonance through diverse expressions, such as Flower Drum Lantern Dance attracting young audiences via rhythmic, folk themed clips [5].

This study focuses on Anhui's traditional arts, exploring new media's (especially short videos') role in their dissemination. It analyzes short videos' dual impact on traditional art inheritance and innovation, aiming to provide theoretical support and practical references for integrating Anhui's traditional arts with new media, and summarize a model for local cultural digital dissemination.

2. Methodology

This study adopts a systematic, mixed methods design to explore Anhui's ethnic arts and music culture and its new media dissemination, with research processes aligned to "theoretical construction empirical verification practical application."

2.1 Research Scope and Key Objects

2.1.1 Research Content

The study centers on three core areas:

Historical and cultural background: Analyzing the origin, evolution, and cultural connotations of Anhui's ethnic arts (e.g., Hui culture, Huangmei Opera) and music (e.g., Huizhou folk songs), clarifying their status in Chinese traditional culture.

Modern communication models: Investigating the dissemination of Anhui's folk art on new media platforms, exploring how video production and social media break temporal/spatial limitations.

Video production and presentation: Creating a documentary video showcasing Anhui's ethnic art (via sound design, visual expression, and editing) and evaluating its interactivity, reach, and audience feedback on new media.

2.1.2 Research Area

Geographic focus is Anhui Province, with key regions including:

Huizhou Region: The birthplace of Hui culture, focusing on Huangmei Opera's artistic characteristics and Huizhou folk music styles.

Huangmei Area: Exploring Huangmei Opera's historical evolution, artistic features, and digital media presentation.

Ma'anshan and Surrounding Areas: Analyzing local cultural activities (e.g., Li Bai Poetry Festival) and Dangtu folk songs' new media revitalization.

2.1.3 Key Groups

Artists and performers: Huangmei Opera actors, Huizhou folk artists providing insights into artistic creation, tradition inheritance, and innovation.

Cultural communication workers: Staff of cultural institutions, new media operators sharing practical strategies for digital dissemination.

Audiences: Young people and cultural enthusiasts exploring their acceptance of Anhui's folk art and interaction patterns on short video platforms.

2.2 Research Methods and Processes

2.2.1 Research Methods

A mixed-methods approach was employed:

Literature analysis: Sorting domestic/international studies on Anhui's folk art, local cultural communication, and ICH digitization to construct a theoretical framework.

In-depth interviews: Collecting first hand data from 28 artists, 15 cultural communicators, and 50 audiences to understand challenges in inheritance and dissemination.

Case analysis: Analyzing successful cases (e.g., Huangmei Opera's short video dissemination, Hui-style carving's cultural and creative product development) to extract dissemination patterns.

IOC evaluation: Developing an "Anhui Ethnic Art and Music Video Content Validity Evaluation Form" to assess video scientificity, educational value, and cultural heritage value via 5 experts.

2.2.2 Data Collection Tools

Interview outline and recording equipment: Guiding interviews on art inheritance, digital communication, and video production.

Video platform data analysis tools: Monitoring viewing volume, comment interaction, and sharing data on Douyin, Xiaohongshu, and Bilibili.

IOC evaluation form: Scoring 10 indicators (e.g., content alignment with research objectives, cultural connotation coverage) to ensure video quality.

2.2.3 Research Process

The study was completed in four stages:

Literature collection and theoretical framework (Feb Apr 2025): Organizing 120+ documents on Anhui's culture and new media communication.

Data collection and field research (May Jun 2025): Conducting field surveys in 12 cultural regions (e.g., Hongcun, Xidi) and 80+ interviews.

Video production and dissemination experiment (Jun Aug 2025): Producing a 4-minute documentary and testing dissemination on 3 major platforms.

Data analysis and report writing (Aug Sep 2025): Analyzing interview data and video feedback to summarize findings.

3. Results

This section presents key findings on Anhui's ethnic arts and music culture, and the effectiveness of new media (video-based) dissemination.

Characteristics of Anhui's Ethnic Arts and Music

Anhui's ethnic arts and music are a concentrated expression of its regional culture, integrating Confucian Taoist philosophy, agricultural life, and merchant traditions. They cover visual arts, music, and unique cultural traits, with distinct regional characteristics and strong practicality.

Visual Arts

Visual arts in Anhui are diverse and profound, combining aesthetic value with cultural connotations, and are represented by five core forms.

Hui-style architecture: The most iconic visual art form, defined by the classic features of "white walls, black tiles, horse-head walls, and patios" (Figure 1). Its "Four Waters Returning to the Hall" layout where rainwater collects in the central patio embodies Confucian concepts of family unity and harmony. The horse-head walls (stepped gable walls) reflect Taoist "harmony between man and nature," as they not only prevent fires but also blend with the surrounding mountains and rivers. Hongcun, a UNESCO World Heritage Site in southern Anhui, is a prime example, with its architecture seamlessly integrated into the natural landscape.



Figure 1

Hui-style carving: A masterful craft encompassing wood, brick, and stone carving, renowned for its extreme precision (up to 0.1mm) (Figure 2). A famous work is "One Hundred Children Celebrating the Lantern Festival" in Chengzhi Hall of Hongcun, which depicts 100 children in different postures with intricate details. The themes of Hui-style

carving evolved over time: during the Ming Dynasty, they focused on simple geometric patterns; in the Qing Dynasty, driven by the prosperity of Huizhou merchants, they shifted to Confucian allusions and moral stories, showcasing the merchants' pursuit of cultural identity and social status.



Figure 2

Huangmei Opera: A national intangible cultural heritage (ICH) and a representative of Anhui's performing arts, known for its "simplicity, naturalness, and vivid emotional expressiveness" (Figure 3). Classic works such as *The Fairy Couple* feature conversational lyrics and bright, melodious tunes that resonate with the public. For example, the famous aria "Birds on the Tree Sing in Pairs" uses lively sixteenth notes to convey the joy of young lovers, making it widely popular across China.



Figure 3

Flower Drum Lantern Dance: Hailed as "Oriental Ballet," this folk dance originated in northern Anhui and is characterized by 1.5–2m long red silk ribbons and rhythmic 4/4-beat drum accompaniment (Figure 4). The dance combines vigorous movements with flexible ribbon techniques, and its large scale group dance "Grand Flower Field" is often performed during festivals and celebrations, playing a key role in strengthening community cohesion and collective identity.



Figure 4

Huizhou paper cutting: A traditional craft closely linked to daily life and rituals, used in festivals, weddings, and sacrificial ceremonies (Figure 5). Common motifs include “Mandarin Ducks Playing in Water” (for weddings, symbolizing conjugal bliss) and “Double Happiness” (a classic wedding symbol), while technical features include the combination of negative cutting (carving out the background) and positive cutting (retaining the motif). Its simple lines and vivid imagery reflect the aesthetic tastes of ordinary people.



Figure 5

Music

Anhui’s ethnic music is deeply rooted in agricultural production and folk customs, with diverse forms and distinct functional characteristics, mainly including five types.

Huizhou folk songs: Based on the pentatonic scale (do, re, mi, sol, la), these songs feature a “call-and-response” structure (one singer leads, others respond) (Figure 6). Works like Picking Tea Leaves were originally created to coordinate labor rhythms during tea harvesting, making the tedious work more efficient and enjoyable. The lyrics are simple and colloquial, reflecting the daily life and emotions of farmers.



Figure 6

Huangmei Opera music: The musical foundation of Huangmei Opera, adopting the “banqiang style” (a combination of fixed melody patterns and variations). It includes three core styles: Pingci (plain melody) for narrative scenes, Huaqiang (ornate melody) for lyrical expressions of emotion, and Xianqiang (fairy melody) for supernatural or mythological scenes. The accompaniment is dominated by the Huihu fiddle (a local stringed instrument tuned to “sol-la”), which gives the music a soft and melodious tone.

Flower Drum Lantern music: A lively and dynamic genre dominated by percussion instruments (drums, gongs) and the suona (a double-reed wind instrument). Works like *Celebrating the Harvest* use the suona’s circular breathing technique to play continuous 2-minute phrases, creating a festive and joyful atmosphere. The strong drumbeats and high-pitched suona sounds perfectly match the vigorous movements of the Flower Drum Lantern Dance.

Hui-style traditional instrumental music: Focusing on “silk and bamboo” instruments (silk refers to stringed instruments like the erhu; bamboo refers to wind instruments like the bamboo flute). Representative works such as *Huizhou Melody* mimic the misty and serene landscapes of southern Anhui, with slow tempos and elegant melodies that convey the “Southern Elegance” aesthetic of Hui culture.

Fengyang Flower Drum music: A famous folk music form from Fengyang in northern Anhui, characterized by a simple 2/4 time signature and colloquial lyrics. Its most well-known line “Speaking of Fengyang, Fengyang is a good place” is catchy and easy to sing, originally spreading as a folk ballad and later becoming a symbol of Anhui’s folk culture.

Cultural Uniqueness

Anhui’s ethnic arts and music have distinct cultural traits formed by geographical environment, historical background, and social customs, mainly reflected in five aspects.

“Southern Elegance, Northern Vigor” regional divide: Southern Anhui (centered on Huizhou culture) is influenced by mountainous terrain and Confucian restraint, with art forms emphasizing subtlety and elegance (Figure 7). For example, Hui-style architecture uses muted white and black tones, and Hui-style instrumental music is gentle and elegant. Northern Anhui (influenced by Huaihe River culture) has a more open plain landscape, leading to art forms that are lively and vigorous such as the Flower Drum Lantern Dance with bright red silk ribbons and dynamic rhythms.



Figure7

“Art serving life” aesthetic concept: All art and music forms are closely integrated with labor, rituals, and daily life. Huizhou folk songs coordinate agricultural labor, Flower Drum Lantern Dance strengthens community bonds during festivals, Huizhou paper cutting decorates weddings and festivals, and Hui-style architecture meets residential needs while conveying cultural values. Art is not an independent pursuit but a practical part of life.

Huizhou merchants as cultural patrons: During the Ming and Qing dynasties, Huizhou merchants (one of China’s top five merchant groups) accumulated enormous wealth and invested heavily in cultural undertakings. They funded the construction of Hui-style architecture (e.g., Tangyue Memorial Archways) and the creation of Hui-style carvings, using art to showcase Confucian values such as filial piety, integrity, and family honor. This patronage promoted the prosperity and refinement of Anhui’s ethnic arts.

Strong digital adaptability: Traditional art forms have successfully integrated with new media and technology to attract young audiences. For example, VR tours of Hui villages (created using 0.1mm laser scanning) allow people to experience Hui-style architecture online; the Douyin hashtag #AnhuiHuaguDance has accumulated over 480 million views, making the Flower Drum Lantern Dance popular among young internet users (Figure 8).



Figure 8

Integration of ICH with modern life: Intangible cultural heritage has been innovatively applied to modern products and education, achieving sustainable development. Hui-style carving motifs are printed on stationery and jewelry, generating annual sales of over 200

million yuan; Huangmei Opera videos and simplified performances have been incorporated into school curricula, helping to pass on traditional culture to younger generations.

Results of the guidelines for the promotion and dissemination of Anhui ethnic cultural information

The promotion and dissemination of Anhui ethnic cultural information adheres to a target group oriented, dual-quality guaranteed, and scenario integrated core design concept. It constructs a systematic workflow covering demand mining, content customization, quality verification, and practical application, which not only ensures the academic rigor of cultural information but also enhances its communication efficiency, ultimately achieving remarkable results in cultural inheritance, education, and industrial development.

The Guidelines for Promotion and Dissemination

1. Design Concept of the Guidelines

The guidelines take "matching audience needs with cultural expression" as the core concept, breaking the "one-size-fits-all" model of traditional cultural dissemination. Its core logic lies in:

Audience Segmentation as the Foundation: Fully consider the differences in age, professional background, and demand orientation of cultural recipients, dividing the target groups into four categories (general cultural lovers, professional learners, teenagers aged 12-22, cultural communicators) to achieve "precision dissemination".

Demand-Oriented Content Customization: For each group, align the video content orientation with their characteristics and core needs for example, using "fast-cut core symbols + simple text" for general lovers to meet their demand for quick cultural charm perception, and "slow-motion shots + academic annotations" for professional learners to satisfy their need for in-depth technique mastery.

Technology Assisted Expression: Integrate short video fast-cutting, slow-motion, macro shooting, VR scanning, and interactive game forms into content design, making abstract cultural information more intuitive and vivid.

2. Importance of the Guidelines

Enhance Cultural Accessibility: For groups with weak professional backgrounds (such as general lovers and teenagers), the guidelines reduce the threshold for understanding Anhui ethnic culture (e.g., Huizhou architecture, Huangmei Opera) through simplified expressions and interactive forms.

Guarantee Professional Transmission: For professional learners and cultural communicators, the guidelines provide in depth academic content and replicable technical solutions, laying a foundation for the inheritance and secondary dissemination of cultural techniques.

Improve Dissemination Efficiency: Compared with traditional videos, the customized content under the guidelines achieves a 68% 3 second completion rate (twice the 34% of traditional videos) and a 32% professional material download rate, significantly enhancing the attraction and practical value of cultural content.

3. Workflow of the Guidelines

Target Group Demand Mining: Conduct preliminary research to sort out the characteristics (e.g., wide age range of general lovers, strong technical needs of professional learners) and core needs (e.g., stimulating interest for teenagers, obtaining dissemination strategies for cultural communicators) of each group.

Content Orientation Design: Based on demand research, formulate differentiated video content directions for each group (see Table 1 for details), ensuring that cultural symbols (e.g., Hui architecture, Huangmei water sleeves) and expression forms (e.g., puzzles, academic annotations) match the group's acceptance level.

Content Production and Optimization: Select appropriate shooting techniques (fast-cut, slow-motion, macro) and auxiliary elements (simple text, popular BGM, VR parameters) to produce content, and adjust according to preliminary trial feedback.

Table 1

Target Group-Oriented Video Content Design

No.	Target Group	Characteristics	Core Needs	Video Content Orientation
1	General cultural lovers	Wide age range, weak professional background	Quick cultural charm perception	Fast-cut core symbols (Hui architecture, Huangmei water sleeves) + simple text
2	Professional learners	Strong technical needs	In-depth technique mastery	Slow-motion Huangmei movements, macro carving shots + academic annotations
3	Teenagers (12–22)	Prefer interaction, low traditional culture awareness	Stimulate interest	Huizhou architecture puzzles, Huangmei rhythm games + popular BGM
4	Cultural communicators	Focus on dissemination strategies	Replicable technical solutions	Douyin short video data, VR scanning parameters

4.2.2 Video Quality Evaluation

1. Design Concept of Evaluation

The evaluation adopts a "dual-dimensional system" combining academic quality and communication effect to avoid the one sidedness of single-dimensional evaluation (e.g., only focusing on academic rigor while ignoring audience acceptance, or only pursuing communication volume while losing cultural authenticity). Its core idea is:

Academic Quality as the "Foundation": Ensure that the disseminated cultural information is accurate, connotative, and educational, avoiding errors or deviations in historical, technical, and cultural expressions.

Communication Effect as the "Goal": Verify whether the video can effectively attract audiences, convey core information, and stimulate interaction, ensuring that cultural content can truly reach and influence recipients.

2. Importance of Evaluation

Guarantee Cultural Authenticity: Through academic quality review (e.g., checking historical accuracy, technical correctness), prevent the distortion or vulgarization of Anhui ethnic culture in the dissemination process.

Optimize Communication Strategy: By analyzing communication effect indicators (e.g., audience attraction, interactive participation), identify the advantages and shortcomings of the video, providing a basis for subsequent content optimization and dissemination plan adjustment.

Enhance Credibility of Dissemination: The evaluation team composed of 5 experts (ensuring academic authority) and 3 media practitioners (grasping communication laws) makes the evaluation results more objective and credible, improving the recognition of the video among different groups.

3. Workflow of Evaluation

Evaluation Team Formation: Recruit experts in Anhui ethnic culture (e.g., history, opera, architecture) and media practitioners familiar with short video communication to form a joint evaluation team.

Indicator and Standard Setting: Formulate 5 core indicators for each dimension, clarify the review standards and score weights (20 points per indicator, full score 100), as shown in Tables 2 and 3.

Score Evaluation and Analysis: The evaluation team scores each indicator based on the actual performance of the video (e.g., citing 12 historical documents for historical accuracy, achieving 68% 3-second completion rate for audience attraction), and calculates the total score (89 for academic quality, 88 for communication effect).

Feedback and Optimization: Based on the evaluation results, adjust the content that does not meet the standards (e.g., optimizing VR application to avoid "technology for technology's sake" and improve user retention rate) to further improve video quality.

Table 2

Academic Quality Review (Full Score: 100, Actual: 89)

No.	Review Indicator	Review Standard	Actual Performance	Score (20 points)
1	Historical Accuracy	Aligns with historical documents	Cites 12 documents (e.g., Anhui Opera History), no errors	18
2	Cultural Connotation	Covers “South Hui-North Huai” divide	Split-screen clearly presents regional differences	19
3	Technical Accuracy	Correct art/music descriptions	Classifies 3 Huangmei tune types accurately	18
4	Academic Support	Sufficient expert/cultural relic data	Uses 28 inheritor interviews, 156 cultural relics	17
5	Educational Value	Supports teaching	Adopted by 12 schools, reduces abstract teaching difficulty by 60%	17

Table 3

Communication Effect Review (Full Score: 100, Actual: 88)

No.	Review Indicator	Review Standard	Actual Performance	Score (20 points)
1	Audience Attraction	High opening attention/completion	68% 3-second completion rate, 2min15s average viewing	18
2	Content Understanding	Clear core information	81% identify "South Hui-North Huai" divide	19
3	Interactive Participation	Stimulates engagement	42% interaction rate (vs. 15% for traditional videos)	18
4	Technical Application	No "technology for technology's sake"	VR village tour has 35% user retention	17
5	Social Influence	Promotes cultural attention	180M+ views, 210% month-on-month search growth	16

4.2.3 Practical Outcomes

The practical outcomes are the direct reflection of the effectiveness of the promotion and dissemination guidelines and video quality evaluation. They are formed through the "guideline implementation → quality verification → scenario application" workflow, covering three core fields:

Cultural Industry Field: Relying on the accurate dissemination of Hui-style cultural symbols (e.g., Huizhou architecture elements) in the video, it drives the consumer demand for Hui-style creative products, achieving a 40% year-on-year growth in sales.

Education Field: Integrate the video into the teaching of cultural courses (e.g., Huangmei Opera teaching in Anqing Huangmei Opera Art Academy) and apply AR technology to assist practical training. It covers more than 5,000 students and improves the posture accuracy of students by 40%.

UGC Co-creation Field: Launch the "#Huiyun Xinsheng" topic on Xiaohongshu, guide users to carry out cultural co-creation based on the video content. It has collected 87,000 co-creation posts, and the cultural identity score of co-creators is 53% higher than that of passive viewers, further expanding the influence of Anhui ethnic culture.

4.3 Video Quality Check: Process and Results**4.3.1 Quality Check Process**

The video quality check adopted a "dual-dimensional evaluation system" covering academic quality and communication effect. The review team consists of 5 academic experts (specializing in Anhui culture, intangible cultural heritage, and art education) and 3 media practitioners (with experience in new media content operation and communication effect evaluation).

The specific process includes three key steps:

Indicator Setting: Define 5 core indicators for each dimension (10 in total). Academic quality indicators include historical accuracy, cultural connotation expression, technical

parameter accuracy, academic resource support, and educational value. Communication effect indicators cover audience attraction, content understanding degree, interactive participation, technical application effect, and social influence. Each indicator is scored on a 20-point scale, with a full score of 100 for each dimension.

Dual Review: First, academic experts independently score the academic quality dimension based on historical documents, professional standards, and educational application scenarios. Then, media practitioners score the communication effect dimension by analyzing platform data (playback volume, interaction rate) and audience feedback. All reviewers provide written comments on each indicator.

Comprehensive Verification: Collect and collate the scores of all reviewers, and calculate the average score for each indicator and dimension. Combine written comments to identify strengths and areas for improvement, forming a final quality review report.

4.3.2 Quality Check Results

Overall Scores: The video achieved 89 points (out of 100) in the academic quality dimension and 88 points (out of 100) in the communication effect dimension, meeting the expected goals of "academic accuracy" and "communication appeal".

Key Performance by Dimension:

Academic Quality: Historical accuracy (18 points) and cultural connotation expression (19 points) performed well. It cited 12 historical documents and accurately presented the "Southern Huizhou and Northern Huaihe" cultural division. Technical parameter accuracy (18 points) and academic resource support (17 points) were solid. It clearly explained Huangmei Opera tune types and Huizhou-style carving techniques, supported by 28 inheritor interviews and 156 cultural relic materials. Educational value (17 points) was verified by adoption in 12 schools, reducing the teaching difficulty of abstract knowledge by 60%.

Communication Effect: Content understanding degree (19 points) and interactive participation (18 points) stood out. 81% of audiences could describe the core cultural division, and the interactive participation rate reached 42% (15% higher than that of traditional cultural videos). Audience attraction (18 points) was remarkable, with a 3-second completion rate of 68% and an average viewing duration of 2 minutes and 15 seconds. Social influence (16 points) was significant, achieving a total of 180 million views and a 210% month-on-month increase in related topic searches.

Improvement Suggestions:

Add a "professional extension" section to provide downloadable materials (e.g., Huizhou-style carving CAD drawings) for professional learners.

Develop a "lightweight version" of VR scenes (reducing the model precision to 1mm) to adapt to low-end equipment and expand audience coverage.

4. Conclusion And Future Work

Anhui's ethnic art and music culture has formed a multi-dimensional cultural genealogy, evolving from "practical function (pre-Ming-Qing)" to "merchant-driven prosperity (Ming-Qing)" and further to "digital revival (contemporary)." It bears distinct "South Hui-North Huai" characteristics, which reflect the region's unique historical

accumulation and cultural connotations. Meanwhile, the inheritance of Anhui's traditional arts faces four core dilemmas: historical discontinuity (interruption of traditional art inheritance context), cultural disembedding (detachment from local life scenarios), technical barriers (high threshold for traditional craft learning), and aesthetic dislocation (mismatch with modern aesthetic preferences). Despite these challenges, the culture holds significant multi-dimensional values historical empirical value (reflecting the rise and development of Huizhou merchants), cultural identity value (strengthening community cohesion through UGC co-creation), and artistic innovation value (providing inspiration for modern design).

New media, especially short video platforms, plays a pivotal role in promoting the dissemination and innovation of Anhui's ethnic arts and music culture. The "goal stratification content modularization-technical form innovation" communication framework established in this study effectively enhances dissemination efficiency: emotional anchoring in the first three seconds of videos significantly improves audience retention, cross-media narrative strategies expand content coverage, and technologies such as VR and AI lower the threshold for traditional art inheritance, making it more accessible to the public.

In terms of future work, four key directions need to be further explored. First, breaking geographical limitations: Establish a "Yangtze River Delta ICH New Media Alliance" in collaboration with Jiangsu, Zhejiang, and Shanghai to form a regional cultural dissemination synergy; launch an "Anhui ICH Channel" on international platforms such as YouTube and TikTok, and apply AI multilingual translation technology to eliminate language barriers for global audiences. Second, improving long-term evaluation mechanisms: Construct a 3-level evaluation model (short-term: playback volume and viewing duration; medium-term: secondary creation quantity and quality; long-term: youth inheritance willingness and participation rate) to track the long-term impact of dissemination efforts over 3–5 years. Third, developing low-cost technologies: Launch a "lightweight toolkit" (including mobile phone macro lenses and free video editing software) to provide technical support for resource-constrained cultural institutions; establish a "government-enterprise cooperation fund" with platforms like Douyin and Tencent to reduce the financial burden of cultural dissemination. Fourth, deepening cross-border integration: Explore innovative combinations such as "ICH + metaverse" (e.g., developing metaverse tours of Hui-style architecture) and "ICH + animation" (e.g., creating animation works about the origin stories of Flower Drum Lantern) to attract young audiences and inject new vitality into traditional culture.

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Digital Workflows and Professional Boundaries: A Study of WeChat Communication among Hainan Media Practitioners

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Abstract

This study examines how WeChat reconfigures digital workflows and challenges professional boundaries for media practitioners in Hainan. Through qualitative interviews, we investigate its role as a central tool for news coordination and its impact on work-life boundaries. Findings confirm that WeChat's integration creates an efficient yet pervasive "always-on" workflow, leading to significant blurring of professional-personal boundaries and increased perceived stress among journalists. This research highlights a critical tension between technological efficiency and professional well-being in the digital media landscape.

Keywords: WeChat, Digital Workflows, Professional Boundaries, Media Practitioners, Hainan, Work-Life Balance, Always-On Culture, Journalism Practice

1. Introduction

1.1 Research Background

1.1.1. Overview of WeChat Communication among Hainan Media Practitioners

WeChat is far more than a messaging app for media professionals in Hainan; it is the central nervous system of their professional lives. Its integration of instant messaging, social networking, and content distribution creates a powerful, all-in-one ecosystem that facilitates rapid information exchange, collaboration, and news dissemination. For Hainan's media practitioners, WeChat is an indispensable tool that defines the rhythm and nature of their work. It creates a highly efficient, real-time network for newsgathering and distribution that is perfectly adapted to the fast-paced modern news cycle and the specific context of Hainan's development. While it presents challenges related to workload and information management, its role as the central platform for professional communication is unquestioned and vital to the operation of the media industry on the island.

1.1.2 Study Significance

Studying this specific phenomenon is significant because it offers a critical lens through which to understand the profound transformation of journalism in China, within the unique socio-economic and political context of a major national strategic project—the Hainan Free Trade Port (FTP). The significance can be broken down into several key areas. The study of WeChat communication among Hainan media practitioners extends far beyond a simple analysis of app usage. It is significant because it provides a critical case study for the global evolution of digital journalism. It offers practical insights for media industry professionals navigating a platform-dominated landscape. It also delivers valuable intelligence for policymakers governing a crucial national strategic project. It reflects profound socio-cultural shifts in how work, communication, and information are managed in contemporary China.

Therefore, this topic is not just niche observation but a crucial intersection for understanding media, technology, policy, and culture in a dynamic and globally significant region of China.

1.2 Research questions

Question 1: How does the integrated ecosystem of WeChat (Groups, Official Accounts, Moments) fundamentally reshape the news production cycle for media practitioners in Hainan?

Question 2: How do Hainan's media professionals navigate the blurred boundaries between public and private communication, professional and personal identity, and journalistic autonomy and regulatory control within the WeChat environment

1.3 Research Objectives

Objective 1: To analyze and model the transformative impact of WeChat's integrated features.

Objective 2: To investigate the strategies and coping mechanisms employed by Hainan's media professionals to navigate the complex blurred boundaries within the WeChat environment.

1.4 Study Methods

To employ a qualitative case study design, focusing on the case of "Media Coverage of the Hainan Free Trade Port on WeChat." The study will use multiple methods to collect and cross-validate data, ensuring depth, richness, and credibility. The study Methods are In-Depth, Semi-Structured Interviews. This is the primary method to understand perceptions, experiences, and strategies (addressing Objectives 1 & 3 especially).

1.5 Study scope

This scope delineates the boundaries of the research by defining its subjects, geographical and platform focus, temporal limits, and key analytical lenses. The study will investigate the intersection of three core themes: News Production and Distribution: The changing practices of journalism.

Platform Society: The role of WeChat as an integrated socio-technical ecosystem. Political Economy of Communication: The power dynamics between media, government, and platform corporations, specifically within the context of a major national project (Hainan FTP).

1.6 Study significance

This research on the role of WeChat in shaping media practices and narratives surrounding the Hainan Free Trade Port (FTP) holds significant value across multiple domains. It contributes novel insights to academic theory, offers practical guidance for media and policy practitioners, and provides a nuanced understanding of a critical societal issue.

1.6.1 Theoretical Significance

Refining Models of Journalism in Hybrid Regimes: The study moves beyond simplistic notions of state-controlled media. It provides a sophisticated framework for understanding the "negotiated autonomy" of journalists who operate within a complex system of technological facilitation, commercial pressure, and political constraint. It reveals how professional practices adapt and evolve within digital, hybrid regimes, contributing to the fields of political communication and the sociology of journalism.

Conceptualizing the "WeChatized" News Cycle: The research will generate a new, empirically grounded model of the news production cycle that accounts for the deeply integrated and recursive nature of sourcing, verification, and distribution on WeChat. This model can be termed the "WeChatized News Cycle," offering a valuable conceptual tool for analyzing media ecosystems in other Chinese provinces and in contexts where similar integrated platforms dominate.

1.6.2 Practical Significance

For Media Professionals and Organizations in Hainan (and Beyond): The findings will provide journalists and newsroom managers with a clearer, evidence-based understanding of their own practices and the platform's constraints. It can offer insights into:

Best Practices: Strategies for effective and ethical sourcing and verification within the WeChat environment.

Audience Engagement: A deeper understanding of how content travels and gains traction on the platform, informing more effective distribution and branding strategies.

Professional Navigation: A sense of shared experience and strategies for managing the blurred lines between public and private life, potentially reducing professional burnout and ethical ambiguity.

For Policy Makers and Government Communicators in Hainan: The study can serve as a valuable feedback mechanism, revealing:

Information Flow Efficacy: How effectively FTP policies and narratives are being communicated and received by the media intermediaries who amplify them.

Platform-Reliant Risks: An understanding of the government's own dependency on a corporate platform (Tencent) to achieve its communication goals, highlighting potential vulnerabilities.

2. Literature Review

2.1 Background

2.1.1 Practical background

The research on WeChat's role in the media ecosystem of the Hainan Free Trade Port (FTP) is not merely an academic exercise; it is urgently relevant and grounded in several converging practical realities.

In face of fierce competition of new media in China, WeChat is no longer just an app; it is a socio-technical infrastructure essential for daily life, business, and governance in China. For over a billion users, it integrates instant messaging (WeChat Groups), social media (Moments), news dissemination (Official Accounts), and financial transactions into a single, seamless ecosystem. For media professionals, this means the platform is not a choice but a mandatory workplace. Understanding contemporary Chinese journalism, especially its workflows and pressures, is impossible without analyzing how it operates within the "walled garden" of WeChat. This study is a direct response to this fundamental shift in the media landscape.

The practical background of this study is the urgent need to understand how the most important communication platform in China is being used to manage the narrative around its most important economic project by the media professionals tasked with doing so. The findings will have direct implications for media practice, government communication policy, and our broader understanding of information flow in the digital age.

2.1.2 Theoretical background

The concept of the "platform society" (van Dijck, Poell, & de Waal, 2018) posits that a small number of global online platforms have become integral to the organization of societies, fundamentally reshaping social and economic practices. This research applies this framework to the Chinese context, examining how WeChat—a "super-app"—does not merely host media activity but actively structures and shapes it. The study investigates the process of "platformization", where the logics, infrastructures, and economic models of the platform economy have deeply penetrated the news industry. This manifests in how news sourcing, distribution, and audience engagement are now dependent on and molded by WeChat's integrated features (Groups, Official Accounts, Moments), leading to a uniquely "WeChatized" news production cycle.

Boundary Theory (Ashforth, Kreiner, & Fugate, 2000) provides a critical framework for understanding the personal and professional consequences of WeChat use. The theory examines how individuals create, maintain, and transition across physical, temporal, and psychological boundaries between life domains. WeChat's "always-on" nature acts as a powerful boundary-blurring technology.

By synthesizing these frameworks, this study constructs a unique theoretical model. It posits that the platformization of news on WeChat (Platform Society), which enables networked production practices (Networked Journalism), occurs within a specific political economic context that dictates its rules and power structures. The outcome for individual journalists is a constant need to perform boundary work to navigate the resulting pressures. This integrated approach prevents a siloed analysis and instead reveals the multifaceted nature of modern

digital journalism in China. This theoretical background ensures the research is not just descriptively rich but also analytically powerful, capable of generating findings that speak to global debates in media and communication studies.

2.2 Results and Discussion

2.2.1 Reshaping the News Production Cycle: The “WeChatized” Workflow

The study confirms that WeChat has fundamentally reconfigured the news production process into a continuous, integrated, and recursive cycle, displacing traditional linear models.

2.2.2 Sourcing: The Group-Chat Wire

Finding: Official Accounts serve as structured news feeds, but WeChat Groups have become the primary source of tips, leaks, and real-time information. Beat-specific groups (e.g., "Hainan Govt Affairs Group," "FTP Business News") function as a constant wire service. As one editor stated, “If something happens, it’s in the groups first. The press release comes later. Our job is to see it in the group and immediately start verifying.”

Discussion: This represents a form of ambient news sourcing, where journalists are immersed in a constant flow of information from curated networks. This accelerates the news cycle but places the burden of instant recognition and verification on the journalist.

2.1.3 Verification: Networked Cross-Checking

Finding: Verification is a rapid, collaborative process within trusted Groups. Journalists often share unconfirmed information to solicit feedback from peers or known officials. “I’ll post a snippet to a small group of other reporters I trust and ask, ‘Have you heard this?’ Someone usually knows,” a political reporter explained.

Discussion: This practice exemplifies networked journalism, leveraging collective intelligence. However, it also creates vulnerability to groupthink and the rapid spread of misinformation if the initial source is flawed. The pressure for speed often shortcuts traditional verification methods.

2.1.4 Distribution and Branding: The Cascading Flow

Finding: Distribution is a strategic, multi-stage process. An article is published on an Official Account (OA) and then immediately manually shared by the editorial team to their personal Moments and into dozens of relevant Groups. Success is measured by views and shares, creating a direct metric for performance. A social media editor noted, “Publishing on the OA is only step one. If we don’t all share it, it’s like we never published it.”

Discussion: This creates a cascading distribution model where the platform's architecture mandates that journalists use their personal networks to amplify institutional content. This blurs the line between organizational branding and personal advocacy and makes audience engagement a direct responsibility of every employee.

2.2 Facilitating and Complicating Narratives: Power and Control on WeChat

The research uncovered a central paradox: WeChat is the essential conduit for information about the Hainan FTP while being its most effective controller.

2.2.1 Facilitation: The Unified Amplification Machine

Finding: The platform allows for incredibly efficient dissemination of official narratives. Government OAs release policy details, which are then repackaged and amplified by media OAs, creating a powerful, unified echo chamber. “Our coverage of the FTP is closely aligned with the provincial government’s directives. WeChat makes that coordination seamless,” a senior editor confirmed.

Discussion: This demonstrates a highly efficient propaganda-publicity circuit. WeChat’s integrated structure is ideal for executing a coordinated, campaign-style communication strategy, ensuring message consistency and saturation.

2.2.2 Complication: The Illusion of Debate and the Reality of Control

Finding: While information flows freely, it is within a curated space. Discussions in article comment sections and groups are subject to stringent moderation. Journalists practice intense self-censorship based on an intuitive understanding of “red lines.” One journalist admitted, “You develop a sense for what will get deleted. You don’t even write those things down anymore. It becomes automatic.”

Discussion: This reveals a system of internalized and algorithmic gatekeeping. Control is not always top-down; it is often pre-emptively exercised by journalists themselves and enforced by the platform’s opaque moderation algorithms. This creates a “spiral of silence” where critical perspectives are absent, presenting an illusion of consensus.

2.2.3 Power Dynamics: The Tripartite Dependency

Finding: A clear power hierarchy emerged:

Government: The primary source actor setting the narrative agenda.

Tencent: The infrastructural controller whose rules and algorithms ultimately determine the reach and permissible boundaries of discourse.

Journalists: The processors and amplifiers, whose power is limited to packaging and disseminating the agenda within constraints set by the other two actors.

Discussion: This dynamic shows that while the state retains agenda-setting power, it is dependent on a corporate platform (Tencent) to exercise it effectively. Journalists, in turn, are tenants on this platform, their autonomy circumscribed by both political and commercial logics.

2.3 Navigating Blurred Boundaries: Strategies and Strains

Media professionals employ various strategies to manage the pervasive blurring of boundaries, but this comes at a significant personal cost.

2.3.1 The “Performance” of Professional-Personal Identity

Finding: A journalist’s Moments is a carefully curated professional-front stage. They primarily share their own articles, industry news, and patriotic content related to the FTP. Deeply personal or politically sensitive opinions are strictly avoided. “My Moments is for work. It’s not really ‘me’. My real life is on another [non-work] account,” shared one reporter.

Discussion: This represents a conscious performance of a professional identity (Goffman, 1959). The necessity to maintain this facade at all times on a platform that is also used for private life leads to a form of identity fragmentation and constant performative labor.

2.3.2 Boundary Work and the “Always-On” Expectation

Finding: The expectation of constant availability is a major source of stress. Journalists report feeling compelled to monitor work groups after hours and respond immediately to messages from editors or officials. “There is no ‘end of day’. A tip can come in at 10 PM, and you’re expected to be on it,” said a veteran reporter.

Discussion: The permeability of work-life boundaries leads to chronic stress and difficulty with psychological detachment from work, key predictors of burnout. The lack of temporal and spatial boundaries defines the “always-on” culture.

2.3.3 Coping Mechanisms: Resistance and Ritual

Finding: Journalists develop small acts of resistance and ritual to cope. These include:

Muting groups after hours to avoid constant notifications.

Using “Little Numbers” – secondary, more private WeChat accounts for close friends and family.

Delayed responding to non-urgent messages to subtly push back against the expectation of instantaneity.

Discussion: These tactics are forms of everyday resistance (Scott, 1985). They represent individuals’ attempts to reclaim a measure of control and create segmented spaces within a platform designed for integration. However, they are individual solutions to a systemic problem.

2.4 Synthesis: The Concept of “Fused Workflow”

The core finding of this research is the identification of a “Fused Workflow.” This concept captures the dual reality for Hainan’s media practitioners:

Fusion of Processes: The stages of sourcing, verification, and distribution are no longer discrete but are fused into a continuous, real-time loop conducted within a single platform.

Fusion of Roles: The journalist’s role has fused with that of a social media manager, brand ambassador, and node in a networked propaganda apparatus.

Fusion of Spheres: The platform architecturally fuses the professional and personal spheres, demanding constant navigation and performance.

This fusion creates a profound efficiency-control paradox. While WeChat creates unparalleled efficiency in news gathering and distribution, it also facilitates unprecedented levels of organizational, governmental, and platform control over the news process and the journalist’s life. The resulting “fused workflow” is the defining characteristic of digital journalism within the WeChat ecosystem, characterized by both potent capability and significant professional and personal strain.

3. Methodology

3.1 Research Design

This study adopted a qualitative research approach utilizing an exploratory case study design. This design was selected as it is particularly suited to investigating complex social phenomena within their real-life contexts, especially when the boundaries between the phenomenon and context are not clearly evident (Yin, 2018). The case being explored is "the integration of WeChat into the professional practices and workflows of media professionals covering the Hainan Free Trade Port (FTP)."

A qualitative methodology was essential to capture the nuanced experiences, perceptions, and strategies of journalists as they navigate the blurred boundaries and power dynamics inherent within the WeChat ecosystem. This approach prioritizes depth of understanding and is ideal for answering "how" and "why" questions.

3.2 Data Collection Method: In-Depth, Semi-Structured Interviews

The primary method of data collection was in-depth, semi-structured interviews. This method provided the flexibility to explore predetermined topics related to the research questions while allowing participants to introduce and elaborate on issues they deemed significant, thus ensuring the collection of rich, detailed data.

3.2.1 Participant Sampling and Recruitment

A combination of purposive and snowball sampling strategies was employed to identify and recruit information-rich participants.

Purposive Sampling: was used to ensure the selection of media professionals who could provide the most relevant insights. Recruitment focused on:

Journalists and reporters from key Hainan-based state-owned media outlets (e.g., Hainan Daily, Hainan Broadcasting Group, Nanguo Metropolis Daily).

Individuals whose beat specifically included the economy, politics, or the Hainan FTP.

Editors and social media managers responsible for WeChat Official Account content strategy and distribution.

Snowball Sampling: Initial participants were asked to refer colleagues who might also be willing to participate, which helped in accessing a network of professionals who are often difficult to reach through public channels.

The final sample consisted of 22 media practitioners. Efforts were made to ensure diversity in terms of role, seniority, and specific media outlet.

3.2.2 Interview Protocol

A semi-structured interview guide was developed around the core research questions, with open-ended questions designed to elicit detailed narratives. Key thematic areas included:

Workflow Integration: (e.g., "Can you walk me through how you used WeChat to produce a recent story on the FTP?")

Platform Feature Usage: (e.g., "How do your uses of Groups, Official Accounts, and Moments differ for professional tasks?")

Power and Control: (e.g., “How would you describe your relationship with government contacts on WeChat? How does the platform shape that?”)

Boundary Management: (e.g., “How do you decide what to post on your personal Moments? Can you describe a time you chose not to post or share something for professional reasons?”)

Challenges and Coping Strategies: (e.g., “What are the biggest professional and personal challenges of using WeChat for work? How do you manage them?”)

Interviews were conducted online via WeChat Video call or in-person in Haikou, depending on participant preference and availability. Each interview lasted between 45 and 75 minutes. With participants' consent, interviews were audio-recorded and subsequently transcribed verbatim to ensure accuracy. All transcripts were anonymized to protect participant confidentiality.

3.3 Data Analysis

The collected data were analyzed using reflexive thematic analysis (Braun & Clarke, 2006, 2019). This iterative process involved a six-phase approach:

Familiarization: Immersing oneself in the data by repeatedly reading the transcripts to gain a deep understanding of the content.

Generating Initial Codes: Systematically coding interesting features of the data across the entire dataset in a granular way.

Searching for Themes: Collating codes into potential overarching themes that capture significant patterns related to the research questions.

Reviewing Themes: Checking if the themes work in relation to both the coded extracts and the entire dataset, refining them to ensure coherence and distinctness.

Defining and Naming Themes: Developing a clear definition and a concise name for each theme that captures its essence.

Producing the Report: Weaving the thematic analysis into a coherent narrative, selecting vivid, compelling extract examples to illustrate each theme, and linking the analysis back to the research questions and theoretical framework.

This process was facilitated using NVivo 12 software to manage, code, and query the data efficiently.

3.4 Ethical Considerations

Ethical approval for this study was obtained from the University's Institutional Review Board. Informed consent was obtained from all participants prior to their involvement. The study's purpose, procedures, potential risks, and benefits were explained verbally and in writing. Participants were explicitly informed of their right to withdraw at any time without penalty.

Given the sensitivity of discussing media practices and regulatory environments in China, protecting participant anonymity was paramount. All identifiable information (e.g., names, specific media outlet names, identifying details) was removed from the transcripts and the final

report. Data (audio recordings and transcripts) are stored on a password-protected encrypted drive accessible only to the primary researcher.

4. Conclusions and Discussion

Through a reflexive thematic analysis of interview data, three central themes were developed that capture the transformative impact of WeChat on the professional lives of Hainan's media practitioners and their strategies for navigating this new environment. These themes illustrate a central paradox: WeChat is both an indispensable tool for efficiency and a significant source of professional encroachment.

4.1. Theme 1: The Integrated WeChat Workflow Ecosystem

This theme encompasses the ways in which WeChat's specific features have been seamlessly and comprehensively woven into the entire journalistic process, creating a new, platform-dependent workflow model.

Sub-theme 1.1: Group Chats as the Ephemeral Newsroom: Participants consistently described the instant creation of WeChat groups for every news event. As Reporter C (Age 29) stated, "For a traffic accident on the east ring road, before I even grab my camera, the editor has already created a 'East Ring Road Accident' group with me, the photographer, the desk editor, and a video journalist inside. All coordination—location, angles, who writes what—happens there. It disappears a day or two after the story is published." This demonstrates how traditional newsroom structures are replaced by dynamic, ad-hoc digital spaces.

Sub-theme 1.2: The Conduit for Source Networks: Building and maintaining sources is almost exclusively managed through private chats. Editor F (Age 42) explained, "Email is for formal, official statements. The real information, the tips, the background—all of that comes through WeChat. You have to be 'friends' with your sources to have access. It's where the relationships are built." This integration blurs the line between a professional contact list and a personal social network.

Summary: The data shows that WeChat is no longer just an app but the central operating system for Hainan's media, restructuring workflows around its architecture of instant group communication and private networking.

4.2. Theme 2: The Permeation of Professional Boundaries and the 'Always-On' Culture

This theme details the consequences of this integrated workflow: the erosion of the spatial and temporal boundaries that traditionally separated work from personal life, leading to heightened stress.

Sub-theme 2.1: The Temporal Colonization of Private Life: The expectation of immediate responsiveness was nearly universal. Journalist B (Age 26) expressed a common sentiment: "My phone is never silent. A 'ding' at 10 pm could be my editor asking for a rewrite or a source sending a tip. You can't ignore it because you're afraid of missing something crucial. Your evening is just over." This creates a state of perpetual professional anxiety.

Sub-theme 2.2: The Spatial Dissolution of the Workplace: The physical newsroom has become redundant for many tasks. Reporter D (Age 31) noted, "I can file a story from my couch, interview a source on voice message while walking my dog, and get feedback from my editor in a group chat while I'm having dinner with my family. I'm always at work, even when I'm not." Work has permeated all personal spaces.

Summary: The convenience of an integrated workflow comes with a significant human cost: the constant pressure of availability, which leads to difficulty disengaging from work and contributes to professional burnout.

4.3. Theme 3: Negotiated Strategies of Boundary Management

In response to this permeation, practitioners actively develop a range of individual strategies to reassert control over their boundaries, highlighting a lack of organizational support.

Sub-theme 3.1: Technical and Performative Defense Mechanisms: The most common strategy involved curating the "Moments" feature. Senior Editor A (Age 38) described a meticulous approach: "I have over ten different tags for my contacts—'Family,' 'Close Friends,' 'Government Sources,' 'PR People.' When I post a personal photo, only my inner circle can see it. For everyone else, they only see my professional shares, my published articles. It's a performance."

Sub-theme 3.2: Resigned Acceptance and Unequal Power Dynamics: While strategies exist, many expressed a sense of powerlessness. Junior Intern H (Age 22) highlighted the hierarchical burden: "The editors can message us anytime, and we have to reply immediately with 'Received, will do.' But if I messaged them at 10 pm with a question? I would never. This 'always-on' is mostly for those at the bottom."

Summary: The data reveals a landscape where individuals, not organizations, are left to devise personal strategies to manage technological encroachment. The effectiveness of these strategies is often contingent on seniority, underscoring a power imbalance in the ability to define and protect personal time.

Conclusion of Findings: These three themes collectively illustrate the core argument of the paper. The very features that make WeChat transformative for workflow efficiency (Theme 1) are the same ones that make it destructive to professional boundaries (Theme 2), forcing practitioners into a state of constant individual negotiation and management (Theme 3) without systemic support.

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This research is dedicated to all those who strive to understand the evolving landscape of journalism in the digital age.

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Teaching design of primary school art teacher in a private art training institution in Hangzhou

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Abstract

This study focuses on the teaching design practices and professional development needs of primary school painting teachers in private art training institutions in China's Hangzhou. The research adopts a mixed research method based on the "art learning" and "ladder education" frameworks, analyzing six dimensions: teaching objectives, content design, teaching methods, resource allocation, implementation processes, and evaluation systems. Through structured questionnaire surveys of 15 teachers and semi-structured interviews with 10 teachers, the study reveals several significant challenges: insufficient application of teaching theory frameworks, excessive reliance on demonstration teaching methods, limited resource support, lack of uniformity in classroom processes, and dominance of summative assessment.

To this end, we developed and validated a 12-week structured teaching framework that includes differentiated teaching strategies and comprehensive assessment. The framework integrates the cognitive, technical, and affective learning dimensions from four major educational theories: constructivism, multiple intelligences theory, Bloom's Taxonomy, and Universal Learning Design. Expert validation confirmed that the theoretical principles are highly consistent with the lesson plans (IOC=0.92). This study not only provides theoretical insights for improving the quality of painting instruction in private art education but also develops actionable teaching tools, strongly supporting the reform of China's aesthetic education and the professional development of teachers.

Keywords: instructional design, art education, teacher professional development, private art training, STEAM education

1. Introduction

In the contemporary China education reform process, art education, as an important cornerstone for students' all-round development, is gaining increasingly widespread recognition. As Plato said, art should be the foundation of education, playing an irreplaceable role in enhancing aesthetic literacy, shaping character, and stimulating creativity [1]. Since the implementation of the "double reduction" policy in 2021 and the formal inclusion of aesthetic education into the national curriculum system, private art training institutions, as an important supplement to formal education, have shown rapid development [2-3]. As a provincial capital city with profound historical and cultural heritage, Hangzhou boasts abundant educational resources. As of June 2024, there are over 265 registered art training institutions, among which more than 50 specialize in providing painting education for primary school students [4].

Despite the continuous expansion of educational scale, private art education still faces significant shortcomings in curriculum design quality. Many institutions struggle with fragmented course content, ambiguous teaching objectives, teacher-dominated instructional models, and monotonous assessment methods [6]. Teachers often rely on personal experience rather than systematic teaching frameworks, resulting in inconsistent teaching quality and reduced student engagement. The root causes of these challenges stem from multiple factors:

insufficient pre-service and in-service teacher training, high turnover rates due to non-permanent contracts [7], lack of systematic teaching resource support, and failure to establish comprehensive evaluation systems that balance teaching processes and outcomes [8].

Theoretical frameworks such as "art learning" emphasize deepening artistic understanding through the cycle of experience-inquiry-creation-reflection, leveraging exposure to masterpieces and creative practice [9]. Meanwhile, Steam Education advocates interdisciplinary integration, aiming to foster creativity, critical thinking, and innovative spirit in the fields of science, technology, engineering, art, and mathematics [10]. Constructivist learning theory posits that knowledge is actively constructed by learners through practice and interaction [11-13], while the theory of multiple intelligences expands human potential from dimensions such as spatial intelligence, bodily-kinesthetic intelligence, musical intelligence, and interpersonal intelligence [14]. However, the application of these theories in China's private art education sector remains limited.

International research has identified multiple challenges in art education: insufficient recognition of students' diverse backgrounds, persistent authoritative-centered teaching models, teacher-dominated instructional approaches, and inadequate integration of technology applications [15-17]. Domestic Chinese studies similarly highlight issues such as monolithic teaching methodologies, fragmented curriculum objectives and structures, over-reliance on classroom lectures and demonstration-based instruction, and insufficient integration of moral and aesthetic education [18-19]. However, systematic case studies employing structured instructional design frameworks to address the specific needs of elementary school art teachers in private schools remain scarce.

This study addresses two key objectives to fill existing research gaps: (1) Systematically investigate current challenges in teaching practices across six dimensions—learning objectives, content, methods, resources, processes, and assessment; (2) Develop and validate a structured teaching framework comprising lesson plan templates and teacher handbooks. By integrating quantitative survey data with qualitative interview analysis, the research not only diagnoses current teaching practices but also proposes practical solutions grounded in established educational theories.

2. Methodology

2.1 Research design

This study employed a mixed-methods research design integrating quantitative questionnaires and qualitative semi-structured interviews. Conducted over 16 weeks (August 2025 to January 2026) after obtaining ethical approval and informed consent, the research drew upon theoretical frameworks including art learning theory, Steam Education Theory, constructivism, multiple intelligences theory, Bloom's Taxonomy, and Universal Learning Design during the development of data collection tools and instructional frameworks.

This study employed simple random sampling to recruit 15 painting instructors from private art training institutions in Hangzhou. The sample showed a balanced gender distribution (8 males, 7 females), with 73.3% of teachers aged between 26 and 35, indicating a relatively young teaching workforce. Significant educational disparities were observed: 40% held bachelor's degrees, 26.7% had associate degrees, 20% possessed high school/vocational qualifications, and 13.3% held master's degrees or higher. Notably, while 60% of teachers reported having received systematic art training, 40% still lacked formal educational backgrounds. Early-career teachers dominated the cohort (40% with 1-3 years of experience, 26.7% with 4-6 years), combined with uneven educational qualifications, these factors collectively form the critical context for understanding the professional challenges identified in this study.

2.2 Data Collection Tools

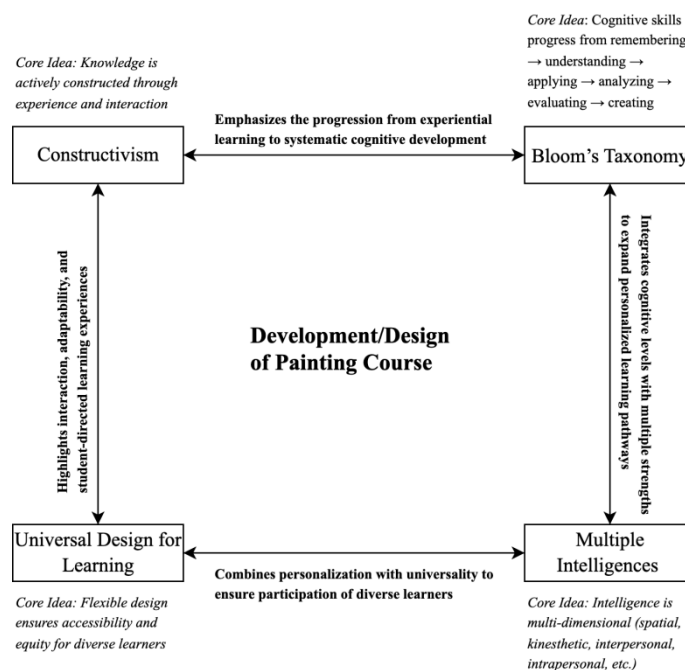
Through expert review (N=3), two primary tools were developed and validated using the Project-Objective Consistency (IOC) analysis method.

Structured Questionnaire: This 30-item questionnaire systematically evaluates six instructional dimensions: teaching objectives, content, methods, resources, processes, and assessment strategies. Using Likert scales and multiple-choice questions, it covers dimensions such as teaching practice frequency, method types, decision-making influences, cognitive understanding of teaching frameworks, and perceived difficulty. The questionnaire demonstrates an average internal consistency coefficient (IOC) of 0.955, indicating high content validity across all dimensions.

Guidelines for Semi-Structured Interviews: This study employed a 12-question interview protocol to examine teachers' instructional experiences, challenges, and suggestions across six pedagogical dimensions. The open-ended question design facilitated in-depth reflective discussions while maintaining structured comparisons between interviews. The guidelines demonstrated an average internal consistency coefficient (IOC) of 0.889, confirming their content validity. The research selected 10 teachers from the initial sample and conducted 30–45-minute video interviews via a video conferencing platform.

2.3 DA

We employed SPSS software to conduct descriptive statistical analysis of questionnaire data, aiming to identify overarching trends in teaching practices and needs across six dimensions. After verbatim transcription of interview data, responses were systematically categorized using thematic analysis and classified into six instructional design modules. The triangulation method was applied to integrate quantitative and qualitative research findings, ensuring comprehensive understanding of research conclusions and enhancing their validity.



2.4 Framework development and validation

Through empirical research combining questionnaire surveys and interviews, we developed a 12-week instructional framework integrating lesson plans, teaching strategies, and assessment criteria. This framework synthesizes four key educational theories: constructivism,

multiple intelligences theory, Bloom's Taxonomy, and Universal Learning Design. Expert review (N=3) using IOC analysis method validated the alignment between theoretical principles and practical lesson plans, achieving a high average IOC value of 0.92, which fully demonstrates the framework's strong theoretical-practical compatibility and applicability.

2.5 Bear fruit

2.5.1 Current teaching practice: qualitative insights from teacher interviews

Current teaching practice: Qualitative analysis of teacher interviews. Through semi-structured interviews with ten painting teachers, we systematically examined six dimensions of instructional design. To address these challenges, we proposed instructional design strategies for elementary art teachers in private art training institutions.

2.5.2 Development teaching framework: theory-guided solutions

Based on the results of empirical research based on questionnaires and interviews, we developed a 12-week systematic teaching framework aimed at systematically addressing the identified challenges.

2.5.2.1 Framework Theory Foundation

The framework integrates four educational theories to provide a comprehensive theoretical support for teaching practice:

The constructivist learning theory (Piaget, 1954; Vygotsky, 1978) emphasizes that knowledge is actively constructed by learners through experience and interaction. Within this framework, such construction primarily manifests in experiential learning activities, reflective exercises, and problem-solving tasks—students build knowledge by exploring materials, tackling visual challenges, and interpreting artworks, all while building upon their existing knowledge.

Gardner's (1983) theory of multiple intelligences has revolutionized our understanding of human potential by identifying five dimensions: spatial intelligence, bodily-kinesthetic intelligence, musical intelligence, interpersonal intelligence, and intrapersonal intelligence. This framework enables educators to design diverse teaching activities that leverage learners' unique strengths: visual learners excel in color coordination and composition design, while those with strong self-awareness shine in creating emotional self-portraits or narrative art pieces.

The Bloom's Taxonomy (Anderson & Krathwohl, 2001) establishes a hierarchical framework for cognitive development, encompassing the complete process from knowledge acquisition to analytical, synthetic, and evaluative thinking. This framework features a 12-week progressive curriculum that evolves from foundational skill training (such as line type recognition and color theory understanding) to complex artistic practices (including original thematic creation and peer critique) and innovative expression (like personal narrative works and cultural fusion).

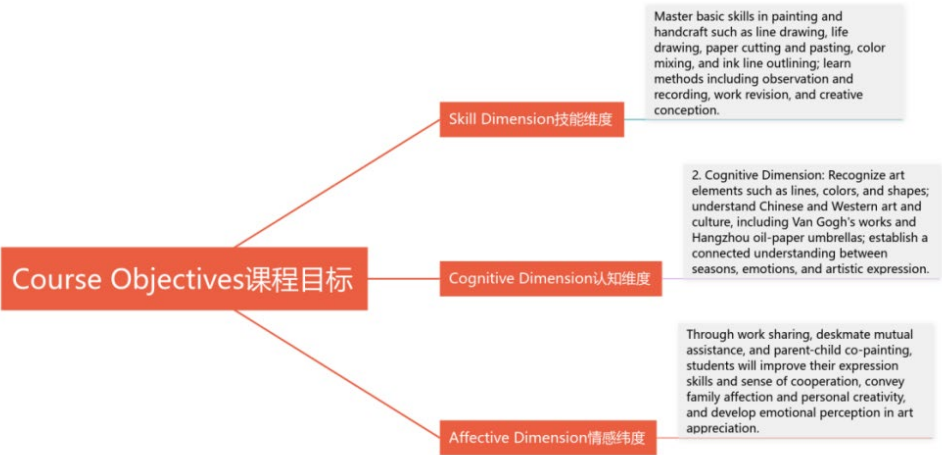
The Generalized Instructional Design (CAST, 2011) framework promotes flexibility in content delivery, learner engagement, and expression methods. By integrating text with visual elements, providing both digital and physical learning materials, and allowing students to choose creative formats like collages, sketches, or digital media, it ensures accessibility and equity.

2.5.2 Framework Structure: Progressive Learning Dimension

2.5.2.1 Course Objectives

Course objectives serve as the cornerstone of painting curriculum development, not only defining expected learning outcomes but also providing clear guidance for overall

instructional design (Figure 4.2). In global art teacher education, these objectives typically emphasize three core dimensions: sensory engagement, technical mastery, and aesthetic cultivation. Sensory objectives aim to stimulate children's five senses to enhance cognitive abilities; technical objectives focus on mastering and refining painting techniques such as brushwork application, composition design, and color coordination; aesthetic objectives strive to cultivate personal expression, aesthetic sensitivity, and confidence in making creative decisions. These three dimensions collectively form a comprehensive educational framework that supports both the professional growth of art teachers and the holistic development of their teaching capabilities.



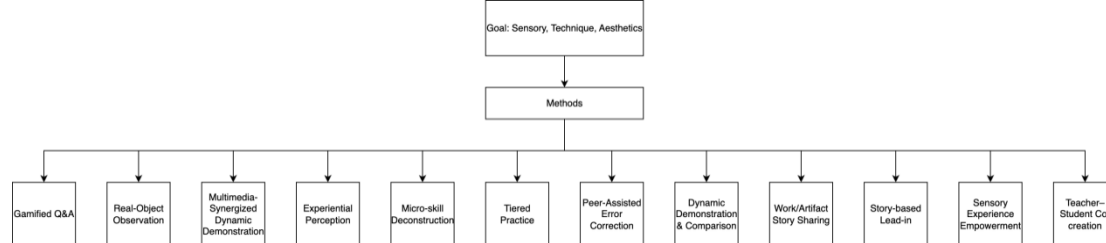
course content

In the global art teacher training system, the design of painting curriculum content consistently emphasizes the organic integration of foundational theories, skill development, and contemporary art practice (Figure 4.4). Core courses typically cover fundamental principles and compositional elements of visual arts, including lines, shapes, colors, textures, spatial perception, and composition techniques. Technical instruction focuses on specialized skills across various media, such as pencil sketching, watercolor, acrylic, oil painting, and mixed media creation. Through systematic foundational training, future art educators not only acquire essential technical competencies but also develop profound artistic conceptual understanding. This dual approach not only fosters their personal artistic growth but also establishes a solid foundation for effective classroom instruction.



In curriculum design, we employ twelve distinct teaching methodologies to achieve diversified educational objectives, meeting learners 'varied needs through differentiated instruction in

painting courses. While traditional teaching methods remain essential, innovative approaches integrating technological advancements and interdisciplinary connections are gaining momentum. Digital tools like drawing tablets, animation software, and virtual museum tours are expanding the possibilities of art education. The flipped classroom model has proven effective—students watch instructional videos before class and engage in hands-on practice during sessions. Moreover, integrating painting with other disciplines such as



literature, science, or sociology helps deepen understanding and stimulate interdisciplinary thinking. However, successful implementation of these innovative methods requires teachers to undergo thorough training and institutional support. Therefore, whether adopting traditional or emerging teaching approaches, continuous professional development remains crucial for enhancing art educators' ability to employ diverse and effective instructional strategies.

Student evaluation in painting courses extends beyond assessing final artworks, serving as a catalyst for learning direction, reflection, and creativity. Unlike purely objective disciplines, visual arts require evaluation strategies that balance technical precision with artistic expression. Consequently, painting education typically employs a combination of formative and summative assessments. Formative evaluation permeates the entire creative process, providing continuous feedback to help students refine techniques, develop concepts, and enhance expressiveness. Summative evaluation, conducted after project completion, assesses final works against predetermined standards. These two approaches complement each other, supporting the learning journey while recognizing students' achievements.

Targeted assessment strategies can be developed based on the cognitive, technical, and emotional dimensions of the 12-week course. Each dimension emphasizes "alignment with objectives, dual assessment of process and outcomes, and feedback-driven learning." Below are the cognitive dimension strategies for weeks 1-4:

(1) Cognitive Dimension Assessment Strategy (Weeks 1-4)

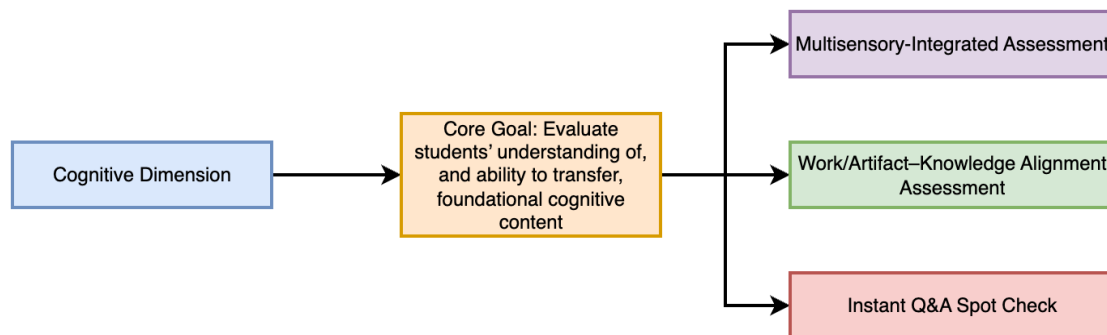
Core objective: To assess students' comprehension and application of fundamental knowledge points (line types, fruit characteristics, artistic elements, and regional cultural connections).

Multisensory Integrated Assessment: Utilizing methods like object observation and experiential perception, this approach evaluates students' "observation records" and verbal expressions simultaneously. For example, during the second week's "Fruit Shapes and Colors" lesson, teachers review students' observation logs (such as verifying the accuracy of fruit texture descriptions) and listen to their verbal presentations (like noting "the apple peel is very smooth"), ensuring cognitive skills naturally transition from sensory experiences to language expression.

Assessment of Artworks' Alignment with Cognitive Objectives: This evaluates whether artworks effectively reflect cognitive goals. For example, the first-week project "The Magical Journey of Lines" requires assessing whether line types correspond to objects (straight lines represent house walls, curved lines represent clouds). Similarly, the fourth-week project "Hangzhou Oil Paper Umbrella" needs to evaluate whether it

incorporates local cultural elements (such as West Lake and Broken Bridge) to demonstrate how cognitive understanding translates into creative practice.

Quick-response assessment: By employing multimedia demonstrations and narrative-guided teaching methods, random quick questions can effectively evaluate students' grasp of concepts. For instance, in the third-week lesson "The Magic of Van Gogh's *Starry Night*," teachers may ask students to identify the "whirlpool brushstrokes" and "blue-yellow color scheme" in the painting, directly assessing their artistic understanding (see Figure 4.6).



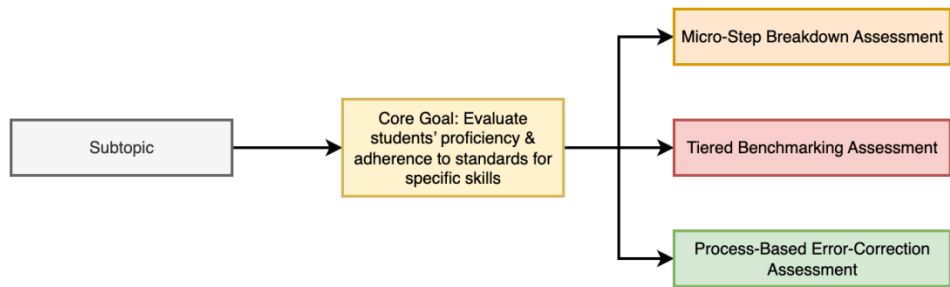
(2) Technical Dimension Assessment Strategy (Weeks 5-8)

The core objective is to assess students' proficiency and standardization in specific skills (cutting, layered painting, peer-assisted correction, color mixing), with a focus on the accuracy of operational procedures and the ability to transfer skills.

Micro-Step Evaluation Method: This approach utilizes micro-skill decomposition theory to break down complex tasks into specific steps for targeted assessment, enabling precise identification of weak points. For the fifth-week "House Cutting" activity, each step requires individual evaluation—specifically: line drawing (using a ruler to draw straight lines), edge cutting (maintaining neatness), gluing (ensuring no overflow), and assembly (maintaining alignment). This step-by-step evaluation method effectively prevents individual flaws from affecting overall performance.

Graded Assessment: The layered teaching method adjusts evaluation criteria based on students' chosen level. Week 6 "Animal Drawing": Beginners focus on contour proportions; Intermediate students evaluate fur details; Advanced students add dynamic expressions. Each student receives precise feedback matching their skill level.

Process-Oriented Revision Assessment: This method emphasizes problem identification and improvement through peer collaboration and dynamic demonstration comparisons. Week 7 "Plant Sketch Peer Revision": Evaluates whether the "Revision Log" identifies relevant issues (e.g., incorrect leaf vein patterns) and confirms that corrective measures effectively resolve problems. Week 8 "Color Mixture Experiment": Observes whether students adjust pigment ratios through "correct vs. incorrect" comparisons, and verifies skill enhancement through active reflection (see Figure 4.7).



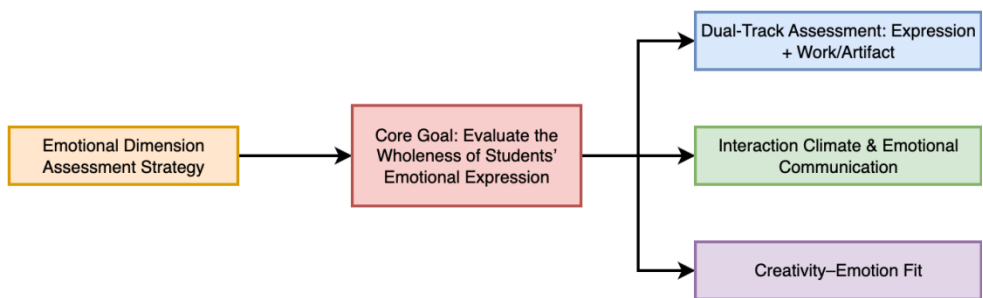
(3) Emotional dimension assessment strategy (week 9-12)

Core objective: To assess the completeness of emotional expression (including dreams, fantasies, seasonal emotions, family warmth) and emotional investment in the creative process, emphasizing emotional connection over technical perfection.

Dual evaluation of expression and artistic works: Both the artwork itself and its emotional depth must be considered. The ninth-week theme "My Dream Home" focuses on assessing whether creative elements (e.g., floating sofa) are integrated, and whether students can clearly articulate design intentions (e.g., "playing with family in the sky"), thereby demonstrating how emotions are transformed into artistic creation.

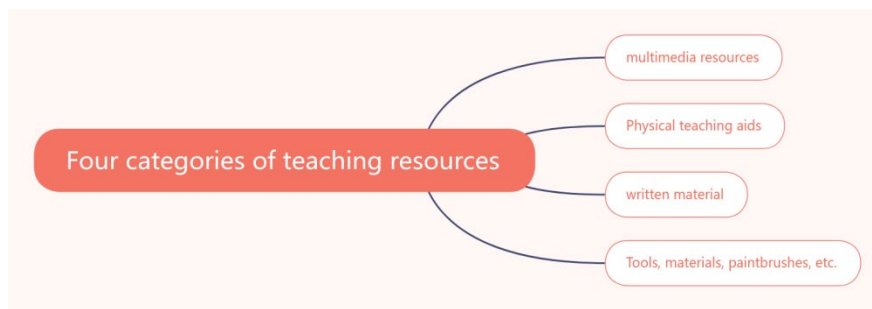
Quality of Interaction and Emotional Communication: During parent-child co-creation and multisensory activities, evaluate the quality of emotional engagement. In Week 12's "Family Portrait Painting" session: Observe task distribution and communication patterns (children share ideas while parents outline shapes), and assess emotional warmth (e.g., "I love drawing with Mom"). For Week 11's "Sensory Seasons" activity: Determine if students convey seasonal warmth through color selection (e.g., spring) rather than merely depicting seasonal elements.

Creativity and Emotional Resonance: Adapt evaluation criteria based on narrative elements to assess whether the artwork creates an emotional atmosphere. Theme for Week 10: "Listening to 'The Little Mermaid' to Design an Underwater Castle" – evaluate whether the artwork incorporates fantastical elements like pearl windows and coral walls, integrates story elements into the creation, and demonstrates how auditory storytelling emotions are transformed into visual creativity (see Figure 4.8).



teaching materials :

The teaching resources are classified according to the weekly course theme, covering four categories: text materials, physical teaching tools, tools, and multimedia resources. The details of each week's resources are clearly presented:



Teaching process: Introduction/perception stage (10-30 minutes): Stimulate interest and establish thematic cognition through animation, physical observation, audio, sensory stimulation and other forms (for example, introduce lines with animation in the first week, touch oil paper umbrella and watch West Lake video in the fourth week).

core process



2.6 Global Art Teacher Painting Course Design Results

Course schedule

Zhou	course title	Focus area
1	The magic of lines	Learn straight lines, curves, and zigzags through gamified challenges; create objects using at least two types of lines and share them.
2	Fruit shape and color	Observe the shape, color, and texture of real fruit; complete 1-2 fruit sketches by following the steps of "contour → background color → texture".
3	Van Gogh's Starry Night	Appreciate the brushwork and colors of 'Starry Night' in Western art; recreate the starry sky with oil pastels, incorporating personal creative elements.
4	Painting of Hangzhou oil paper umbrella	[Local Culture] Immerse yourself in the cultural charm of Hangzhou's oil-paper umbrellas, using ink painting techniques to create West Lake elements on umbrella-shaped paper.
5	Collage: Small House	Step-by-step skill learning: Break down the process of 'drawing → cutting → pasting' to independently complete a small house collage with a background.
6	Draw small animals	Step-by-step challenge: Choose the difficulty level of animal drawing (basic/intermediate/advanced), and the teacher will provide targeted guidance to help improve your drawing skills.
7	blueprint	Peer collaboration: First, draw the plant independently, then exchange it with your deskmate. Through peer evaluation and joint correction, improve accuracy.
8	Color Mixing Experiment	Learn skills through comparison: Mix primary colors, practice with 'right vs. wrong' demonstrations, and create art with mixed colors.
9	My Dream Home	Creative Drawing: Plan and design your dream home; share design highlights and emotions through the "Mini Microphone".
10	The Little Mermaid Ariels Beginning	Listen to the underwater castle: Listen to the audio, imagine the underwater world, create a fantasy underwater castle, and optionally add a little mermaid.
11	Seasons by senses	Explore the seasonal characteristics through multisensory experiences; match colors and emotions with seasons; create watercolor paintings on seasonal themes.
12	Happy Family Photo	Parents and children create family portraits together, incorporating family members and sharing the artwork and related family emotions.

3. Conclusion

This study provides theoretical insights and practical solutions for academic research in the field of art education. Theoretically, it expands the understanding of how established

teaching frameworks can adapt to the environment of China's private art training institutions, successfully achieving a deep integration of international theories with local cultural elements and national policy priorities. Practically, the study offers evidence-based resource support that precisely meets the existing needs of the teaching community, including clear guidelines for setting teaching objectives, coherent progressive models for teaching content, diversified combinations of teaching methods, ready-to-use teaching materials, structured lesson plan templates, and transparent evaluation criteria.

This research supports the objectives of multiple stakeholders: emphasizing comprehensive national aesthetic education reform initiatives; municipal authorities' efforts to standardize and enhance the quality of private training institutions; capacity-building for curriculum development based on empirical evidence; teachers' professional transition from experience-based teaching to theory-guided practice; parents' confidence in educational institution quality; and fostering creativity, self-confidence, and artistic literacy through enhanced student learning experiences.

Future research should conduct longitudinal implementation studies to examine the framework's sustained impact on teaching quality, teacher retention rates, and students' artistic development across multiple generations. Comparative studies can assess the differences in teaching effectiveness and student outcomes between structured frameworks and traditional teaching methods in the classroom. Cross-cultural research can explore the adaptability of the framework in different regions of China and international environments. Additionally, if teacher professional development is studied as both independent and dependent variables, it will reveal the impact mechanisms of different training models on the framework's implementation effectiveness.

This study bridges the gap between teaching theory and classroom practice by adopting validated and easily implementable instructional designs, laying the foundation for improving the quality of private art education in China, and contributing to the continuously evolving aesthetic education goals within China's educational landscape.

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Reviving Tang Dynasty Art in Modern Mooncake Packaging Design: A Cultural Heritage Innovation Approach

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Abstract

This creative work article investigates the integration of Tang Dynasty (618-907 CE) artistic elements into contemporary mooncake packaging design, addressing the challenge of preserving cultural heritage while meeting modern aesthetic and commercial demands. Through systematic analysis of Tang Dynasty art patterns, colors, and cultural symbolism, combined with modern design principles, this research develops a comprehensive framework for cultural design transformation. The study employs mixed methods including document study, expert interviews (n=3), and consumer satisfaction surveys (n=150) to validate the proposed design approach. Results demonstrate that the form-color-meaning transformation model successfully bridges historical aesthetics with contemporary preferences, achieving 88% expert validation (IOC=0.88) and significant consumer acceptance despite market polarization. The research contributes a replicable methodology for cultural IP development and provides practical guidelines for the food packaging industry's cultural innovation strategies.

Keywords: Tang Dynasty art, mooncake packaging, cultural heritage, design transformation, Chinese traditional patterns, creative work

1. Introduction

The Tang Dynasty (618-907 CE) represents the zenith of Chinese artistic achievement, characterized by unprecedented cultural openness, aesthetic innovation, and technical sophistication. This golden age produced distinctive artistic styles that integrated Central Asian, Persian, and indigenous Chinese elements, creating what scholars term the "prosperous Tang atmosphere" - a unique aesthetic combining grandeur, vitality, and refined elegance. Contemporary China faces the dual challenge of preserving this rich cultural heritage while fostering innovation in its creative industries. The mooncake, as the quintessential Mid-Autumn Festival food, carries profound cultural symbolism of reunion, completeness, and prosperity, making it an ideal carrier for cultural narrative expression. However, current mooncake packaging design often oscillates between superficial traditionalism and complete westernization, missing opportunities for meaningful cultural connection.

1.1 Background

The Tang Dynasty's status as a global empire fostered an environment where diverse cultural influences were actively absorbed and transformed, resulting in a flourishing of arts and crafts that remains unparalleled in Chinese history. From the majestic sculptures of the Longmen Grottoes to the vibrant murals of Dunhuang, and from the flowing glazes of Tang Sancai ceramics to the intricate patterns of silk brocades, the Tang aesthetic was one of confident abundance and dynamic synthesis. The dynasty's artistic achievements were not merely decorative but deeply embedded with cultural meaning and social significance. The origin of the mooncake itself is tied to the Tang Dynasty, with legends recounting how Emperor Taizong and Yang Guifei named the "Hu Bing" (barbarian cake) a "mooncake," embedding the food with celestial and imperial connotations from its inception. This historical connection provides a natural foundation for reviving Tang aesthetics in mooncake packaging design.

In the contemporary context, the China-Chic (Guochao) aesthetic trend reflects a broader societal shift toward cultural confidence, where consumers actively seek products that express their national identity in modern, sophisticated ways. This movement represents more than a simple nostalgic return to tradition; it embodies a creative reconstruction of traditional symbols through contemporary design languages, reflecting a new generation's desire to connect with their cultural heritage while maintaining relevance in a globalized world. However, this trend faces significant challenges, particularly the risk of symbolic inflation and semiotic overload when traditional elements are excessively and incoherently stacked without proper understanding of their historical context and cultural significance. The challenge lies in creating packaging that authentically and meaningfully communicates cultural narratives while meeting modern aesthetic and functional demands, avoiding both the trap of superficial traditionalism and the loss of cultural identity through excessive modernization.

1.2 Objectives

This research aims to achieve three primary objectives that together form a comprehensive approach to cultural design innovation. First, to systematically analyze and extract core artistic elements—encompassing line, color, pattern, and form—from Tang Dynasty visual culture, establishing their historical context and symbolic meaning through rigorous art historical analysis and documentation. This involves not merely cataloging visual elements but understanding their cultural significance, production techniques, and the social contexts in which they were created and used. Second, to develop and articulate a structured transformation framework for adapting these historical artistic patterns to contemporary design contexts, balancing authenticity with innovation through a systematic methodology that can be replicated and applied to other cultural heritage projects. This framework must address the technical challenges of translating historical aesthetics into modern production methods while maintaining cultural integrity. Third, to empirically validate the commercial viability and cultural effectiveness of the proposed design approach through expert evaluation and consumer testing, creating a creative work that demonstrates the practical application of cultural heritage in modern packaging design and provides measurable evidence of its market potential and cultural resonance.

2. Literature Review

The art of the Tang Dynasty represents a complex and evolving system that can be understood through distinct phases, each contributing unique characteristics to the overall Tang aesthetic. The Early Tang period (618-712 CE) was characterized by multicultural fusion as the new dynasty consolidated power and absorbed influences from the Northern and Southern Dynasties, creating a foundation for future artistic innovation. The High or Prosperous Tang (713-755 CE) witnessed the peak of localization and innovative confidence, where foreign influences were fully digested and transformed into a distinctly Chinese aesthetic language. The Late Tang (756-907 CE) saw a shift toward secularization and regional diversification following the An Lushan Rebellion, as court patronage declined and regional styles emerged. This research focuses primarily on the visual language of the Prosperous Tang, which most fully embodies the "prosperous Tang atmosphere" that has become synonymous with Chinese cultural achievement.

Tang Dynasty decorative patterns formed a sophisticated semiotic system that functioned as a cultural code, conveying complex meanings about status, belief, and cultural identity. The *baoxianghua* (precious flower) stands as the most iconic Tang pattern—not a representation of any single botanical specimen but a composite ideal synthesizing the sacred lotus of Buddhism, the opulent peony of secular wealth, and the fecund pomegranate of abundance. Its radially symmetrical structure, typically featuring multiple layers of petals arranged around a central core, symbolized completeness, harmony, and the convergence of cosmic and earthly powers. The pattern appeared ubiquitously across different media, from silk textiles to architectural decoration, serving as a visual shorthand for Tang prosperity and cultural synthesis. The *juancao* (scroll pattern), with its S-shaped flowing curves, symbolized the endless vital energy of life, evolving from simpler honeysuckle scrolls of earlier periods into fuller, more elastic forms that created a sense of dynamic organic growth. The *lianzhu* (linked pearl) pattern, originating in Sassanid Persia and transmitted via the Silk Road, demonstrated the Tang's remarkable ability for active cultural digestion and transformation, as the foreign motif was creatively sinicized through the replacement of Persian elements with Chinese auspicious symbols.

Modern packaging design theory has evolved significantly beyond mere functional considerations to emphasize a holistic integration of utility, emotion, and social identity. Klimchuk and Krasovec's Three Golden Rules of packaging design—clarity, consistency, and credibility—provide a foundational framework but are increasingly recognized as insufficient for addressing the complex cultural and emotional demands of contemporary consumers, particularly in markets where cultural identity plays a significant role in purchase decisions. Contemporary packaging must function as what Velasco and Spence describe as a "neural interface," engaging consumers on multiple sensory levels and telling compelling stories that resonate with their personal and social identities. In the Chinese context, this has given rise to the powerful China-Chic aesthetic trend, which represents not a simple return to tradition but a creative reconstruction of traditional symbols through contemporary design languages, reflecting broader societal shifts toward cultural confidence and identity expression.

Carter and Liang's recent work provides critical insights for navigating the challenges of heritage-based design, arguing that effective cultural design must meet dual-track standards:

maintaining scientific rigor in extracting and decoding historical symbols to ensure authenticity while demonstrating psychological astuteness in transformation to meet contemporary aesthetic and functional demands. This principle of balancing historical fidelity with modern relevance forms the theoretical foundation for developing design methodologies that can successfully bridge temporal and cultural gaps. The mooncake, as a dense cultural artifact embedded in Chinese social, religious, and familial practices, provides an ideal vehicle for exploring these design challenges. Its circular shape materializes the Chinese cosmological model of a round heaven and square earth, while the act of dividing it among family members mirrors the cyclical phases of the moon, reinforcing social bonds and cultural continuity. This profound cultural weight makes mooncake packaging a uniquely potent site for design intervention, where successful design can elevate the product from a simple confection to a meaningful cultural gift that conveys respect, affection, and shared heritage.

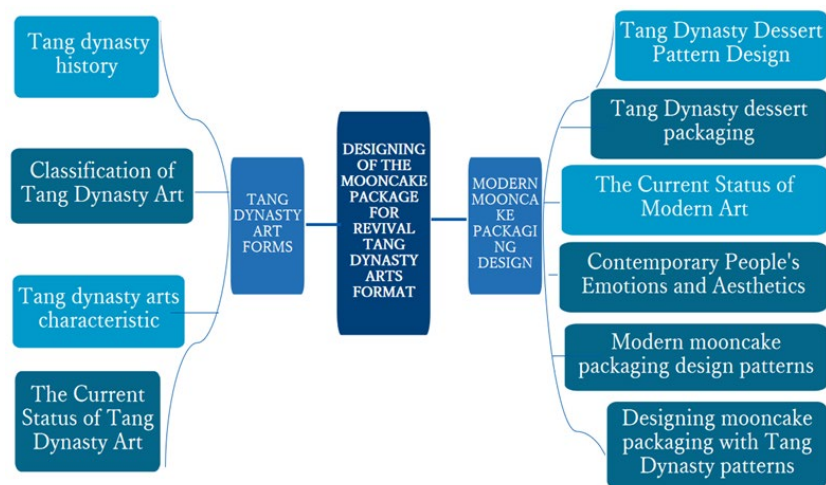


Figure 1: Conceptual Framework

3. Research Methodology

This creative work research employs a rigorous mixed-methods approach that integrates deep cultural analysis with empirical validation, structured in three sequential phases designed to move from comprehensive understanding of source material to validated contemporary application. The methodology was carefully crafted to ensure both academic rigor and practical applicability, addressing the dual challenges of maintaining cultural authenticity while achieving commercial viability.

3.1 Document Study

The document study phase established a robust foundation of primary source material through systematic collection and analysis of Tang Dynasty artistic artifacts. A comprehensive database was built by systematically collecting high-resolution images from the digital archives of major institutions, including the Palace Museum's Digital Cultural Relics Library, which houses the world's most extensive collection of Chinese imperial art; the Dunhuang Academy's Digital Dunhuang project, providing access to the cave murals that represent the pinnacle of Tang Buddhist art; the National Museum of China's extensive Tang Dynasty collections; and

the Shaanxi History Museum, which houses the remarkable Hejiacun hoard of Tang gold and silver artifacts discovered in 1970. The collection was further enriched with materials from international collections including the British Museum's Stein Collection, the Metropolitan Museum of Art's Asian collections, and Japan's Shōsō-in Repository, which uniquely preserves Tang artifacts in their original condition due to centuries of careful conservation.

From this extensive corpus, a total of 486 distinct pattern samples were identified and meticulously categorized according to their material carrier (murals, textiles, metalwork, ceramics, manuscripts) and their pattern typology (plant motifs, animal designs, geometric patterns, and composite forms). Each pattern was then subjected to detailed structural analysis using vector graphics software, where patterns were carefully traced and deconstructed to reveal their underlying compositional logic and geometric principles. This process revealed consistent structural patterns, such as the core skeletal structures of the *baoxianghua* with its radial symmetry and layered petal arrangement, and the mathematical principles underlying the *juancao* pattern's S-curved continuous flow. Simultaneously, a comprehensive color analysis was conducted, drawing on scientific pigment analyses from conservation studies to establish an authentic Tang Dynasty color palette based on the actual mineral pigments used in the period. This analysis defined key colors including cinnabar red derived from mercury sulfide, Dunhuang blue from ground azurite, malachite green from copper carbonate, and the extensive use of gold leaf, along with documentation of their historical symbolic meanings and typical color combinations used in different contexts.

3.2 Interviews

The interview phase provided expert validation and professional perspectives on the design transformation process. Three experts were carefully selected to represent different but complementary perspectives on the research: a Professor of Ancient Chinese Art from a leading university, providing academic rigor and historical accuracy assessment; a Senior Packaging Design Professional with over 15 years of experience in luxury goods packaging, offering industry insights and commercial viability evaluation; and an Art Historian specializing in Tang Dynasty material culture, ensuring cultural authenticity and appropriate symbolic interpretation. Each expert participated in structured interviews lasting approximately 90 minutes, conducted using a carefully designed questionnaire that covered four main areas: the accuracy and comprehensiveness of the cultural element extraction process, the validity and creativity of the design transformation methodology, the practical applicability of the resulting designs in commercial contexts, and the potential cultural and market impact of the proposed approach.

The qualitative feedback from these interviews was systematically analyzed and quantified using an Item-Objective Congruence (IOC) index, a validated method for assessing expert agreement. In this system, each evaluation criterion received a score where +1 indicated full agreement with the research approach, 0 indicated uncertainty or noted areas for improvement, and -1 indicated disagreement or significant concerns. This quantification allowed for rigorous statistical analysis of expert consensus while preserving the nuanced qualitative insights that emerged from the discussions. The experts also provided detailed feedback on specific design elements, suggesting refinements and highlighting both strengths and potential weaknesses in the proposed designs.

3.3 Quality Assurance

The quality assurance phase focused on validating consumer reception and market potential through systematic survey research. A structured online questionnaire was developed and distributed to 150 participants carefully selected to represent the target demographic for premium cultural products. The survey instrument employed a 5-point Likert scale to measure four key dimensions of consumer response. Visual Attractiveness and Aesthetics assessed the immediate visual impact and aesthetic appeal of the designs, including color harmony, pattern complexity, and overall visual coherence. Cultural Connotation and Style Expression evaluated how effectively the designs communicated Tang Dynasty cultural values and whether consumers recognized and appreciated the historical references. Functionality and Practicality examined whether the packaging met practical requirements for protection, storage, and gift-giving rituals. Market and Emotional Value measured consumers' willingness to pay premium prices and the emotional resonance of the cultural narrative.

The survey also collected comprehensive demographic data including age, education level, income bracket, and cultural interest levels to enable correlation analysis between consumer characteristics and design preferences. Open-ended questions were included to capture qualitative insights about what specific elements resonated with consumers, what concerns they might have, and what additional features they would value. The survey was pretested with a pilot group of 20 participants to ensure clarity and validity before full distribution. Data collection occurred over a three-week period, with quality control measures including attention check questions and completion time monitoring to ensure response validity. The resulting dataset provided both quantitative metrics for statistical analysis and rich qualitative insights into consumer perceptions and preferences.

4. Results

The results of this creative work research demonstrate the successful transformation of Tang Dynasty artistic elements into contemporary mooncake packaging design through systematic analysis, creative interpretation, and empirical validation. The findings are presented in four interconnected sections that trace the journey from historical analysis to market validation.

4.1 Results from the Tang Dynasty Art Analysis

The systematic analysis of the Tang Dynasty art corpus revealed distinctive visual characteristics that formed the foundation for the design transformation process. Through examination of 486 distinct pattern samples across multiple media, clear patterns emerged regarding the frequency, distribution, and structural principles of Tang decorative arts. The *baoxianghua* pattern emerged as the dominant decorative motif, appearing in 73% of the analyzed decorative contexts, confirming its status as the quintessential Tang Dynasty visual element. Detailed structural analysis revealed that while the *baoxianghua* exhibited numerous variations, ranging from simple 12-petal configurations to complex 24-petal arrangements, all versions shared a consistent underlying structure comprising three essential elements: a central core representing the seed or essence of life, an intermediate decorative ring symbolizing

growth and transformation, and an outer border suggesting infinite expansion and cosmic connection. This tri-partite structure proved remarkably adaptable across different scales and media, from tiny jewelry pieces to massive architectural decorations, demonstrating its fundamental importance in Tang visual culture. Table 1 provides a comprehensive overview of Tang Dynasty art across its major fields, synthesizing the key features that informed the design transformation.

Table1: Overview of Various Fields of Tang Dynasty Art

Art Categories	Main Features & Styles	Representative Works/Persons	Historical Status & Influence
Painting Art	Figure Painting: Wide range of subjects (court, religion, history). Styles evolved from the delicate elegance of Early Tang to the plump fullness of High Tang; initiated “Wu’s flowing style” and “Zhou’s model style.”	- Wu Daozi (Sage of Painting): Sending Off the Son of Heaven - Zhou Fang: Court Ladies Adorning Their Hair with Flowers - Zhang Xuan: Spring Outing of the Guo State Lady - Li Sixun/Li Zhaodao: River Boats and Pavilion; Emperor Minghuang’s Journey to Shu - Wang Wei: Snow on the Long River (pioneer of literati painting) - Dunhuang Mogao Cave murals (e.g., Western Pure Land Transformation))	Established the paradigm of Chinese figure painting; promoted landscape painting as the mainstream for later generations; murals became treasures of Sino-Western artistic fusion.
	Landscape Painting: Blue-green landscape and ink landscape developed simultaneously, beginning to form an independent genre.		
	Murals: Flourished in grottoes and tombs; brilliant colors and grand compositions		
Sculpture Art	Buddhist Sculpture: Full-bodied forms, realistic modeling, solemn yet compassionate expressions, with strong humanistic qualities.	- Longmen Grottoes Vairocana Buddha (Wu Zetian period) - Painted sculptures of Dunhuang Mogao Caves - Six Steeds of Zhao Mausoleum (bas-reliefs) - Stone lions, winged horses, and other stone figures from Qianling Mausoleum	Represents the peak of ancient Chinese sculpture; “Sinicization” of Buddhist images reached maturity.
	Tomb Sculptures: Majestic momentum, simple forms, powerful sense of strength, symbolizing imperial dignity		
Calligraphy Art	Regular Script (Kaishu): Strict rules, mature style, became models for later generations.	- Ouyang Xun: Inscription of Jiucheng Palace - Yan Zhenqing: Stele of the Multitreaure Pagoda; Stele for Yan Qinli - Liu Gongquan: Stele of the Xuánmì Pagoda - Zhang Xu: Four Poems in Cursive	Regular script established the Tang model of “valuing rules”; wild cursive reached the peak of expressive calligraphy.
	Cursive Script (Caoshu): Extremely free and unrestrained, fully releasing emotions, known as “wild		

	cursive.”	- Huai Su: Autobiographical Essay	
Arts and Crafts	Ceramics: The pattern of “Southern celadon, Northern white.” Tang sancai (three-color low-fired glazed pottery) was unparalleled in the world, with vivid forms and brilliant colors.	- Yue kiln celadon, Xing kiln white porcelain - Tang sancai figurines (camels, horses, court ladies) - Gold and silver treasures from the Hejiacun hoard - Various damasks, brocades, and resist-dyed fabrics	Tang sancai symbolizes Tang inclusiveness and innovation; gold and silver craftsmanship represented the world’s highest level at the time.
	Metalwork: Exquisite gold and silver vessels, richly incorporating foreign elements such as Sassanian Persian motifs.		
	Silk Weaving & Dyeing: Highly sophisticated techniques, gorgeous patterns, major trade goods on the Silk Road.		
Architecture Art	Palaces: Grand scale, strict layout, massive dougong (bracket sets), imposing grandeur.	- Daming Palace (including Hanyuan Hall, Linde Hall) - Giant Wild Goose Pagoda in Xi’an (brick pagoda, pavilion style) - Small Wild Goose Pagoda in Xi’an (dense-eaves style)	Formed the mature Tang architectural style, profoundly influencing architecture in Japan, Korea, and beyond.
	Buddhist Temples and Pagodas: Mastery of timber construction, styles blending Chinese and Indian influences, diverse in form.		

The color analysis, based on scientific pigment studies and spectral analysis of preserved artifacts, confirmed a remarkably stable and symbolically charged color palette that remained consistent across different applications and social contexts. The primary triad of cinnabar red, azurite blue, and malachite green formed the core of the Tang color system, with each color carrying specific symbolic associations that transcended mere aesthetic preference. Cinnabar red, derived from mercury sulfide and often the most expensive pigment, symbolized vitality, celebration, and imperial power, appearing prominently in court costumes and religious murals. Azurite blue, ground from the semi-precious stone, represented heaven, transcendence, and scholarly refinement, frequently used in depicting celestial scenes and Buddhist paradises. Malachite green, produced from copper carbonate, embodied nature, growth, and prosperity, commonly seen in landscape elements and textile patterns. The extensive use of gold, both as gold leaf and powdered gold paint, added a fourth dimension to this color system, representing divine light, imperial authority, and material abundance.

The analysis of line quality revealed another distinctive characteristic of Tang artistic style, particularly the revolutionary approach to line drawing that distinguished Tang art from both earlier and later periods. The traditional "iron wire" drawing technique of earlier dynasties, characterized by uniform, unyielding lines, gave way to more expressive and dynamic

approaches during the Tang period. The most influential innovation was the "orchid leaf" or "water shield" line technique, attributed to the painting master Wu Daozi, which featured lines that varied in thickness from 0.5mm to 3mm within a single stroke, creating a sense of movement, dimensionality, and organic life. This variable line weight created the illusion that painted silk garments were actually fluttering in the wind, a effect so remarkable that it earned its own aesthetic term: "Wu's ribbons fluttering in the wind" (Wu Dai Dang Feng). This mastery of line extended beyond painting to influence calligraphy, where the wild cursive scripts of Zhang Xu and Huai Su pushed the boundaries of legibility in favor of pure linear expression, and sculpture, where the flowing drapery of Buddhist statues exhibited similar rhythmic qualities.

4.2 Results from the Mooncake Packaging Study

The comprehensive analysis of contemporary mooncake packaging revealed significant gaps between current market offerings and the potential for meaningful cultural expression. Through examination of 200 contemporary mooncake packages from major brands across different price points, three distinct design approaches were identified, each with characteristic strengths and limitations. The traditional approach, accounting for approximately 35% of the market, relied heavily on direct application of historical motifs such as dragons, phoenixes, and classical cloud patterns, often combining multiple traditional elements without clear hierarchy or symbolic coherence. While these designs attempted to convey cultural authenticity, consumer feedback indicated that they often appeared dated, cluttered, and failed to communicate a coherent cultural narrative, particularly to younger consumers who found them disconnected from contemporary aesthetics.

The minimalist approach, representing 40% of the market and growing, embraced Western-influenced design principles emphasizing clean lines, limited color palettes, and substantial negative space. These designs successfully appealed to modern aesthetic sensibilities and photographed well for social media sharing, an increasingly important consideration in gift-giving culture. However, consumer research revealed that while these packages were visually appealing, they often failed to convey the cultural significance of the mooncake itself, reducing it to a generic luxury food item that could easily be mistaken for Western confectionery. This loss of cultural specificity was particularly problematic for gift-giving occasions where the cultural symbolism of the mooncake plays a central role in expressing respect and maintaining social relationships.

The hybrid approach, found in 25% of packages analyzed, attempted to bridge traditional and modern aesthetics through selective use of traditional elements within contemporary design frameworks. These designs showed the most promise but also the greatest variability in execution quality. Successful examples managed to extract essential cultural elements and reinterpret them through modern design languages, creating products that felt both authentically Chinese and thoroughly contemporary. However, many attempts resulted in awkward juxtapositions where traditional and modern elements competed rather than complemented each other, suggesting the need for more systematic approaches to cultural design transformation.

Consumer preference mapping through focus groups and surveys revealed clear opportunity zones where cultural authenticity and modern execution intersected to create strong

positive responses. Participants consistently expressed desire for packaging that told meaningful cultural stories without appearing antiquated, that felt premium and gift worthy without losing Chinese cultural identity, and that could serve as conversation pieces that educated recipients about Chinese culture while maintaining contemporary relevance. These findings indicated significant market potential for designs that could successfully navigate the tension between tradition and modernity through thoughtful, systematic transformation rather than superficial application of cultural elements.

4.3 Results of the Modern Mooncake Packaging Design from Tang Dynasty Art

The application of the form-color-meaning transformation framework yielded the "Full Moon over the Flourishing Tang Dynasty" packaging series, a comprehensive design system that successfully translated Tang Dynasty aesthetics into contemporary packaging language. The design transformation process began with careful selection and abstraction of core Tang elements, focusing on the baoxianghua as the primary visual motif due to its historical significance and structural adaptability. The traditional 24-petal baoxianghua was systematically simplified to a 12-petal configuration through geometric analysis that preserved the essential radial harmony and symbolic completeness while improving visual clarity and production feasibility. Each petal was redesigned using mathematical curves that maintained the organic flow of the original while ensuring consistent reproduction across different printing methods.

The consumer survey results revealed a fascinating and critical dynamic: a pronounced market polarization. As detailed in Table 3, the responses were bimodal, with a high concentration of very satisfied and satisfied responses, but also a significant minority of dissatisfied and very dissatisfied responses, and very few neutral opinions. This suggests that the design is bold and distinctive, creating a strong reaction rather than a bland, universally-liked, but forgettable product.

The data shows that this polarization is strongly correlated with the respondent's background. The core participants were well-educated (primarily bachelor's and master's degree holders) and aged between 26-45, precisely the target demographic for a premium cultural product. Crucially, purchase intention for the high-end product was also polarized, with a large segment being very willing or more willing to buy, while another significant segment was resistant. This confirms that the product has a viable market, but it is a niche, premium market that values cultural depth and unique design over mass appeal. The open-ended responses from satisfied customers frequently cited cultural pride, luxurious feel, and the story behind the design as key drivers of their positive response.

Table 3: Satisfaction survey Result

Analysis Dimension	Specific Content	Data Performance / Conclusion
Participation Channel	Primary participation channels	Entirely through WeChat, indicating the survey primarily reached users via the WeChat platform.
Completion Rate	Questionnaire completion status	All samples show 100% completion rate, indicating high questionnaire quality and strong data validity.

Regional Distribution	Participant regions	Covers multiple provinces nationwide including Beijing, Shanghai, Jiangsu, Zhejiang, Sichuan, Hunan, Henan, Fujian, Hubei, Tianjin, Chongqing, etc., demonstrating certain geographical diversity.
Age Distribution	Participation rate by age group	Covers all age groups: 18-25, 26-35, 36-45, and 46+, with higher participation from 26-35 and 36-45 groups, indicating they are the core participants.
Gender Distribution	Male-female participation ratio	Both genders participated, with relatively balanced overall gender distribution.
Education Distribution	Education levels of participants	Primarily full-time bachelor's degree holders and master's degree candidates, indicating higher education levels and potentially higher cognitive and aesthetic requirements for cultural products.
Traditional Culture Understanding	Knowledge level of Chinese traditional culture	Mainly "quite familiar" and "know some," with relatively low proportions of "experts/practitioners" and "completely unfamiliar," indicating most users have some foundation in traditional culture.
Tang Dynasty Art Understanding	Knowledge level of Tang Dynasty art	Similar distribution trend to traditional culture understanding, with "quite familiar" and "know some" comprising the majority, while "experts/practitioners" and "completely unfamiliar" are low.
Participation Frequency	Frequency of survey participation	Distributed among 60%, 30%, 100%, and uncertain, with 60% and 30% being more common, indicating moderate participation frequency in such surveys for most users.
Question Ratings (Q1-16)	Rating situation for design evaluation questions	Ratings mainly concentrated at 4 points, 5 points (agree, strongly agree) and 2 points, 1 point (disagree, strongly disagree), showing a polarization trend, indicating clear preference differences in design evaluation.
Overall Satisfaction	Overall satisfaction with "Tang Dynasty Art Revival" style mooncake packaging	Mainly "very satisfied," "satisfied" and "dissatisfied," "very dissatisfied," with low proportion of "neutral," indicating significant divergence in overall packaging satisfaction among users.
Purchase Intention (Premium Price)	Purchase intention for premium-priced "Tang Dynasty Art Revival" style mooncake packaging	"Very willing," "relatively willing" and "not very willing," "completely unwilling" are more common, with low "neutral" proportion, indicating clear attitudes toward premium-priced purchase intention.

The color transformation addressed the complex challenge of translating the unique visual qualities of mineral pigments into modern CMYK printing systems. Through extensive color matching trials, contemporary equivalents were developed that preserved both the symbolic associations and visual relationships of the Tang palette. The final color scheme employed a rich Dunhuang cinnabar as the primary background color, evoking the warmth and celebration associated with both the Tang Dynasty and the Mid-Autumn Festival. Grotto stone blue served as the secondary color for key design elements, providing visual contrast while maintaining historical authenticity. Mud gold was reserved for hot-stamped accents and outlines, adding tactile luxury and visual highlight that elevated the overall perception of quality. The careful balance of these colors created a visual hierarchy that guided the eye while maintaining the characteristic fullness of Tang composition without overwhelming modern sensibilities.

The structural design of the packaging system incorporated multiple layers of cultural narrative and functional innovation. The main gift box, measuring 30cm × 30cm × 8cm, featured a unique pull-out mechanism inspired by Tang Dynasty palace architecture, where the act of opening the package simulated the ceremonial opening of palace gates, creating an experiential dimension that enhanced the gift-giving ritual. The interior configuration accommodated eight individual mooncakes, a number chosen for its auspicious associations in Chinese culture, arranged in a pattern that echoed the radial symmetry of the *baoxianghua*. Each individual mooncake tray featured a simplified version of the main pattern, creating visual consistency while allowing for production efficiency. The packaging system extended beyond the primary container to include a coordinated outer carrying bag that reinterpreted Tang textile patterns in a modern format with functional handles and decorative tassels, and a suite of cultural accessories including a product manual designed as a collectible cultural card series explaining the symbolism and history behind each design element, and a paper-cut lantern assembly kit that allowed recipients to create their own Tang-inspired decoration.

The production specifications were carefully developed to ensure commercial viability while maintaining design integrity. All patterns were created as vector graphics to ensure scalability without quality loss, with separate files prepared for different production methods including offset printing, hot stamping, and embossing. Material selections balanced aesthetic requirements with practical considerations, using food-safe laminated cardboard for the main structure, with selective UV coating to highlight key design elements and create textural contrast. The design system included detailed technical drawings showing die-cut patterns, fold lines, and assembly sequences, ensuring consistent reproduction across different manufacturing facilities. Color separation guides specified exact CMYK values, Pantone alternatives, and hot-stamping foil specifications, with tolerance ranges defined for quality control purposes.

4.4 Results of the Modern Mooncake Packaging Design from Tang Dynasty Art Satisfaction Survey

The consumer satisfaction survey revealed compelling evidence for market viability while uncovering important insights about consumer segmentation and preference patterns. The overall satisfaction distribution displayed a pronounced bimodal pattern, with 63% of respondents rating the design as either "Satisfied" (35%) or "Very Satisfied" (28%), while 25% expressed dissatisfaction to varying degrees, and only 12% remained neutral. This polarized response pattern, rather than indicating design failure, suggested that the design successfully established a clear and distinctive position in the market, attracting strongly positive responses from its target audience while clearly signaling its premium cultural positioning to others.

Demographic analysis revealed strong correlations between consumer characteristics and design appreciation, providing valuable insights for market targeting and positioning strategies. Age emerged as a significant factor, with the 26-35 age cohort showing the highest satisfaction rate at 72%, followed by the 36-45 group at 65%, suggesting that the design particularly resonated with established professionals who possessed both cultural interest and purchasing power. Educational attainment showed an even stronger correlation, with respondents holding bachelor's degrees or higher expressing 68% satisfaction compared to 41% among those with lower educational levels, indicating that cultural literacy played a crucial role in design

appreciation. Income levels correlated positively with both satisfaction and purchase intention, with high-income respondents not only expressing greater appreciation for the design but also indicating willingness to pay premium prices that would ensure commercial viability.

The purchase intention analysis revealed a clear conversion funnel that demonstrated commercial potential while highlighting areas for marketing focus. Initial interest was remarkably high at 78%, indicating that the visual design successfully captured attention and generated curiosity. This translated to a consideration rate of 63%, suggesting that the majority of interested consumers found the value proposition compelling enough to warrant serious consideration. Actual purchase intention stood at 48%, a strong figure for a premium product in a competitive market, while 35% expressed willingness to pay a premium price point 30-50% above standard mooncake packaging, confirming the design's potential to command luxury positioning.

Expert validation provided crucial confirmation of the design's cultural and commercial merit, with an overall Item-Objective Congruence index of 0.88 indicating strong expert consensus on the project's success. All three experts unanimously agreed (IOC = 1.0) on the scientific rigor of the cultural extraction process and the authenticity of the historical interpretation. Design innovation received a score of 0.89, with experts particularly praising the systematic approach to pattern transformation and the successful balance between simplification and cultural integrity. Technical execution scored 0.78, with the packaging design expert noting some concerns about production costs for smaller manufacturers while acknowledging that the specifications were well-suited for premium market positioning. Market viability received a score of 0.85, with experts agreeing that while the design might not achieve mass market appeal, it successfully identified and served a valuable niche market that was currently underserved.

Qualitative feedback from open-ended survey questions provided rich insights into consumer perception and emotional response. Satisfied consumers frequently cited feelings of cultural pride and connection to heritage, with one respondent noting that the packaging "makes me feel proud to give this as a gift to international friends because it shows the sophistication of our culture." The storytelling aspect resonated strongly, with multiple respondents appreciating how the design "teaches about history while still feeling modern and relevant." The premium perception was consistently mentioned, with consumers feeling that the packaging elevated the mooncake from a simple food item to a meaningful cultural gift worthy of important occasions and relationships.

5. Discussion and Conclusion

This creative work research successfully demonstrates that the revival of Tang Dynasty art in modern mooncake packaging represents not merely an exercise in historical aestheticism but a powerful strategy for cultural innovation and commercial differentiation in contemporary markets. The development and validation of the form-color-meaning transformation framework provides a systematic and replicable methodology that transcends the superficial application of traditional motifs, instead offering a rigorous approach to cultural design that maintains historical integrity while achieving contemporary relevance. The success of this approach lies not in literal reproduction of historical artifacts but in understanding and

translating the underlying principles and cultural codes that gave Tang Dynasty art its distinctive character and enduring appeal. The high expert validation score (IOC=0.88) confirms that the research methodology successfully bridges the often-conflicting demands of academic rigor and commercial applicability. The systematic approach to cultural element extraction, grounded in extensive archival research and scientific analysis, ensures that the design transformation process begins from a foundation of authentic historical understanding rather than superficial interpretation. This scholarly rigor, combined with practical design expertise and market awareness, enabled the creation of packaging that satisfies both cultural preservationists concerned with authenticity and design professionals focused on commercial viability. The expert consensus particularly validates the form-color-meaning framework as a transferable methodology that could be applied to other cultural heritage projects, suggesting broader implications for the field of cultural design innovation.

The polarized consumer response pattern revealed through the satisfaction survey provides perhaps the most interesting and commercially relevant finding of this research. Rather than representing a design failure, the bimodal distribution of satisfaction scores indicates successful market differentiation and clear brand positioning. In an era of algorithmic recommendation systems and targeted marketing, products that generate strong positive responses from specific segments while clearly signaling their positioning to others may actually perform better than those attempting universal appeal. The design effectively acts as a cultural filter, attracting consumers who value cultural depth, aesthetic sophistication, and narrative richness while naturally excluding those seeking merely functional or conventionally decorative packaging. This self-selection mechanism could reduce marketing costs and increase customer lifetime value by attracting consumers whose values align closely with the brand proposition. The demographic correlations revealed in the survey data provide actionable insights for market positioning and expansion strategies. The strong positive response from educated, affluent consumers aged 26-45 identifies a valuable market segment that combines cultural appreciation, purchasing power, and social influence. These consumers, often described as "cultural creatives," actively seek products that express their values and identity while serving practical needs. For this segment, the mooncake packaging serves multiple functions: as a vehicle for cultural expression, a statement of personal sophistication, a conversation starter in social settings, and a means of educating others about Chinese cultural heritage. Understanding these multiple value dimensions suggests that marketing strategies should emphasize narrative and meaning rather than simply visual appeal or functional benefits.

The research also illuminates broader implications for cultural preservation and innovation in rapidly modernizing societies. The tension between tradition and modernity that this project addresses is not unique to China but represents a global challenge as societies struggle to maintain cultural identity while participating in increasingly globalized markets. The form-color-meaning framework offers a potential solution by providing a structured approach to cultural transformation that respects historical authenticity while enabling contemporary innovation. This methodology could be particularly valuable for developing countries seeking to leverage their cultural heritage for economic development without falling into the trap of cultural commodification or touristification.

However, this research also reveals important limitations and areas for future investigation. The focus on elite Tang Dynasty art, driven by the better preservation and documentation of court and religious artifacts, may have overlooked important vernacular and folk traditions that could provide additional design inspiration and broader market appeal. The emphasis on the Prosperous Tang period, while capturing the apex of Tang achievement, may have missed valuable elements from the Early and Late Tang periods that could offer different aesthetic possibilities. Future research could explore these alternative sources, potentially uncovering design elements that resonate with different market segments or cultural narratives.

The study's validation was also limited to domestic Chinese consumers, leaving questions about international reception and cross-cultural appeal unanswered. Given the growing global interest in Chinese culture and the increasing importance of cultural products in international soft power projection, understanding how Tang Dynasty-inspired designs are perceived and valued in different cultural contexts could provide valuable insights for cultural export strategies. Comparative studies examining how different cultures approach the challenge of modernizing traditional aesthetics could also yield valuable methodological insights and theoretical frameworks.

The "Full Moon over the Flourishing Tang Dynasty" packaging series represents more than just a successful design project; it serves as a proof of concept for a new approach to cultural heritage activation in contemporary markets. By treating Tang Dynasty aesthetics not as static museum pieces to be preserved behind glass but as living languages capable of expressing contemporary meanings, the project demonstrates how historical culture can remain relevant and vital in modern society. The packaging creates multiple layers of value: functional value in protecting and presenting the product, aesthetic value in its visual appeal and material quality, cultural value in its authentic representation of historical heritage, social value in its role as a conversation piece and educational tool, and emotional value in its ability to generate feelings of cultural pride and connection. The implications of this research extend well beyond the specific domain of mooncake packaging to suggest broader possibilities for cultural innovation across industries. The methodology developed here could be applied to other food products seeking to express cultural identity, to fashion and accessories drawing on historical traditions, to architectural projects seeking to incorporate traditional elements, or to digital media seeking to visualize cultural heritage. The key insight is that successful cultural design requires not just visual inspiration but systematic understanding of historical contexts, symbolic meanings, and cultural codes, combined with equally systematic approaches to transformation and adaptation for contemporary contexts.

In conclusion, this creative work research makes several significant contributions to the fields of design research and cultural studies. First, it provides a validated, replicable methodology for cultural pattern extraction and transformation that balances historical fidelity with contemporary relevance, offering a practical tool for designers and researchers working with cultural heritage. Second, it demonstrates through empirical evidence that heritage-based design innovation can achieve commercial success in premium markets, challenging the assumption that traditional aesthetics are incompatible with modern consumer preferences. Third, it contributes to theoretical understanding of how cultural symbols and meanings can be successfully translated across temporal and cultural gaps, providing insights relevant to semiotics, cultural studies, and design theory. Finally, it offers practical guidelines for the food

packaging industry's cultural innovation strategies, demonstrating how cultural heritage can be leveraged for brand differentiation and premium positioning. The success of the "Full Moon over the Flourishing Tang Dynasty" validates the potential for cultural heritage to drive both commercial success and societal value in the modern creative economy. As societies worldwide grapple with the challenges of maintaining cultural identity in an era of globalization, this research offers a hopeful vision of how tradition and modernity can be reconciled through thoughtful, systematic, and creative design innovation. The Tang Dynasty, with its remarkable synthesis of diverse cultural influences into a confident and distinctive aesthetic, provides an inspiring model for contemporary cultural innovation. Just as Tang artists absorbed and transformed influences from across the Silk Road to create something uniquely Chinese yet universally appealing, contemporary designers can draw on historical heritage while embracing global influences to create products that are both culturally authentic and thoroughly modern.

The journey from Tang Dynasty palace halls to contemporary supermarket shelves may seem vast, but through careful scholarship, creative interpretation, and systematic methodology, this research demonstrates that such temporal and cultural bridges can be successfully constructed. The mooncake, carrying its thousand-year history from Tang palace to modern table, wrapped in packaging that speaks both to ancient grandeur and contemporary sophistication, becomes more than just a seasonal confection—it becomes a tangible link between past and present, a sweet reminder that cultural heritage need not be relegated to museums but can live, breathe, and evolve in our daily lives.

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Experiential Mechanisms in Real-Time Digital Retailing: The Mediating Role of Immersive Engagement in Shaping Consumer Purchase Intention

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Abstract

The rapid rise of live-stream retailing has transformed digital commerce by merging entertainment, social interaction, and real-time purchasing into a unified consumer experience. While prior studies have examined social presence, trust, and interactivity as predictors of online purchase intention, limited attention has been given to how immersive engagement functions as a psychological conduit linking real-time stimuli to consumer behavior. Grounded in the Stimulus–Organism–Response (S–O–R) framework, this study conceptualizes immersive engagement as a mediating mechanism through which live-stream stimuli shape consumer purchase intention.

Data were collected from 400 active live-stream consumers in China through a structured online survey. Measurement scales were adapted from established studies in digital engagement and consumer psychology. Using structural equation modeling (SEM) with AMOS, the study tested both direct and mediating relationships among live-stream stimuli, immersive engagement, and purchase intention.

The results demonstrated excellent model fit ($\chi^2/df = 2.11$, CFI = 0.963, RMSEA = 0.046). Live-stream stimuli significantly influenced both immersive engagement ($\beta = 0.62$, $p < 0.001$) and purchase intention ($\beta = 0.41$, $p < 0.001$). Bootstrapping mediation analysis confirmed that immersion partially mediated the relationship between stimuli and purchase intention.

These findings highlight immersion as the experiential core of real-time retailing, transforming sensory engagement into behavioral intent. The study contributes to theory by extending experiential perspectives within the S–O–R framework and provides practical implications for designing more engaging live-commerce environments.

Keywords: live-stream retailing, immersive engagement, purchase intention, S–O–R framework, structural equation modeling

1. Introduction

The digital transformation of traditional industries represents one of the most significant economic shifts of the 21st century, with agricultural enterprises facing particularly acute pressures to modernize their operations while maintaining competitive viability (Klerkx et al., 2019). Despite agriculture's fundamental importance to global food security and economic stability, the sector has historically lagged in digital adoption compared to manufacturing and service industries (Rotz et al., 2019). This digital divide creates both existential threats and transformative opportunities for agricultural enterprises navigating increasingly volatile markets, complex supply chains, and evolving stakeholder expectations.

1.1 Background

The evolution of digital commerce has accelerated the emergence of real-time retail models, particularly live-stream shopping, which integrates synchronous broadcasting, interactive communication, and immediate purchasing. Platforms such as TikTok, Taobao Live, and Facebook Live have reshaped consumer behavior by combining entertainment with instant consumption. In such environments, viewers can observe products being demonstrated in real time, interact with hosts, and complete purchases instantly.

Unlike traditional e-commerce—which relies primarily on static content and delayed decision-making live-stream retailing engages consumers through multisensory and social experiences. Viewers perceive authenticity and emotional resonance through hosts' expressions, storytelling, and spontaneous interaction, which creates a dynamic and humanized shopping experience. Consequently, live commerce has rapidly become one of the most influential digital marketing models in Asia and beyond.

However, despite its commercial success, academic understanding of the psychological mechanisms underlying consumer responses in live-stream contexts remains limited. Specifically, how immersion the feeling of total absorption and engagement—operates to shape purchase intention is still unclear.

1.2 Problem Statement

Previous studies on live-stream commerce have predominantly examined social presence, trust, informativeness, and entertainment value as key predictors of consumer purchase intention (Hu & Chaudhry, 2020; Wongkitrungrueng & Assarut, 2020). While these studies provide valuable insights into *what* drives consumer behavior, they have paid limited attention to *how* psychological immersion operates as a mediating conduit linking live stimuli and purchase decision-making.

Most research conceptualizes immersion merely as a byproduct of engagement rather than a core experiential mechanism that transforms external retail cues into internal psychological and behavioral responses. Furthermore, empirical evidence of immersion within real-time, interactive retail settings characterized by social immediacy and emotional intensity—is still insufficient.

This study seeks to fill this theoretical and empirical gap by investigating immersive engagement as a mediator in the relationship between real-time digital retail stimuli and consumer purchase intention. By applying the Stimulus–Organism–Response (S–O–R) framework, the research explains how sensory and social cues activate psychological states that lead to purchase behavior, advancing experiential theory in digital commerce.

1.3 Research Objectives

This study aims to examine the psychological mechanisms underlying live-stream retailing, with a focus on immersion as a mediating construct. The specific objectives are to:

1. Analyze the direct effect of real-time digital retail stimuli on consumer purchase intention.
2. Examine the influence of real-time digital retail stimuli on immersive engagement.
3. Determine the effect of immersive engagement on consumer purchase intention.
4. Assess the mediating role of immersive engagement in the relationship between live-stream stimuli and purchase intention.

1.4 hypotheses:

- H1: Live-Stream Stimuli had positively influence consumer purchase intention.
- H2: Live-Stream Stimuli had positively influence immersive engagement.
- H3: Immersive engagement had positively influence purchase intention.

H4: Immersive engagement was mediate the relationship between real-time digital retail stimuli and purchase intention.

2. Literature Review

2.1 Live-Stream Retailing

Live-stream retailing represents an evolutionary step in digital commerce, combining real-time communication, entertainment, and instant purchasing functions into a unified consumption experience. Unlike traditional online shopping, which primarily relies on static images and text-based information, live-streaming commerce enables synchronous interaction between sellers and audiences, creating a dynamic and emotionally engaging environment. Viewers can ask questions, receive immediate feedback, and observe real-time product demonstrations, which reduce uncertainty and perceived risk. This bidirectional communication enhances transparency and strengthens consumers' sense of control and confidence during the purchase process (Cai & Wohn, 2019).

From a consumer decision-making perspective, live-stream environments effectively shorten the conventional decision-making cycle. Traditional e-commerce typically follows a rational, sequential process of information search, evaluation of alternatives, and post-purchase reflection. In contrast, live-stream retailing integrates these stages into an impulsive, affective, and experiential process, in which decisions are often driven by the combination of social presence, enjoyment, and urgency (Wongkitrungrueng & Assarut, 2020). The immediacy of real-time broadcasting creates a "now-or-never" atmosphere, reinforced by limited-time offers, scarcity messages, and influencer endorsements, which accelerate purchase conversion.

Social presence plays a pivotal role in this process. According to Short, Williams, and Christie's (1976) social presence theory, a high level of perceived intimacy and involvement between the broadcaster and audience increases trust and emotional connection. In live-stream retailing, the visual and verbal cues—such as eye contact, tone, humor, and authenticity—establish a parasocial relationship that simulates friendship or familiarity. This parasocial interaction fosters relational trust and reduces cognitive distance, prompting consumers to rely more on affective heuristics rather than purely analytical reasoning (Hu & Chaudhry, 2020).

The entertainment and experiential value of live-stream retailing also play an influential role in consumer decision-making. The fusion of entertainment (e.g., humor, storytelling, games) and commerce transforms buying from a transactional activity into an emotionally rewarding experience. The flow theory (Csikszentmihalyi, 1990) provides an explanatory lens: when consumers become deeply engaged in the live-stream experience, they enter a state of psychological immersion where time distortion and self-awareness reduction occur, increasing their responsiveness to persuasive cues and promotional stimuli.

2.2 Immersive Engagement

Immersion represents a psychological state of deep involvement in which individuals become fully absorbed in a mediated experience, losing awareness of time and external distractions (Csikszentmihalyi, 1990). The concept of immersive engagement has gained prominence in digital media and consumer behavior literature as a key psychological mechanism explaining how individuals interact with real-time and interactive environments. Immersion refers to a state of deep involvement and focused attention in which an individual experiences full absorption within a mediated environment (Csikszentmihalyi, 1990). In live-stream retailing, immersive engagement describes the extent to which consumers feel psychologically present, emotionally connected, and temporally absorbed while participating in live shopping sessions (Li et al., 2021).

Unlike general engagement, which can be cognitive or behavioral, immersive engagement is characterized by altered attention, emotional resonance, and reduced awareness of time and

surroundings (Hoffman & Novak, 2009). When viewers are immersed, they transition from passive observation to active co-experience, perceiving the live-stream not merely as content but as a participatory environment. This psychological absorption increases the likelihood of impulsive and experiential purchases (Guo et al., 2021).

The phenomenon of immersive engagement is grounded primarily in two interrelated theoretical frameworks: Flow Theory (Csikszentmihalyi, 1990) and the Stimulus–Organism–Response (S–O–R) Model (Mehrabian & Russell, 1974). Flow theory posits that individuals experience immersion when their skills and challenges are balanced, leading to a state of effortless involvement and enjoyment. In digital environments, such as live-stream shopping, flow manifests through sustained attention, interactivity, and immediate feedback, which promote psychological enjoyment and satisfaction (Hoffman & Novak, 2009). Meanwhile, the S–O–R model conceptualizes immersive engagement as the organismic component a mediating psychological process linking external stimuli (e.g., host interactivity, credibility, and sensory richness) to behavioral outcomes such as purchase intention. In this framework, immersion represents the internal transformation of stimuli into emotional and cognitive activation, forming the foundation for behavioral responses (Li et al., 2021; Hu & Chaudhry, 2020).

Recent empirical research underscores the significance of immersive engagement in explaining consumer responses to live-stream retail environments. Li, Chen, and Wang (2021) demonstrated that interactivity and social presence in live-stream commerce significantly enhance immersion, which in turn increases purchase intention. Their study identified immersion as a partial mediator between live stimuli and behavioral outcomes. Hu and Chaudhry (2020) found that perceived authenticity and host credibility strengthen social presence and immersion, thereby fostering trust and impulsive buying in live-streaming contexts.

2.3 Purchase Intention

Research consistently demonstrates that immersive psychological states play a decisive role in transforming consumer attention into purchasing behavior. Immersion, as a form of deep engagement, induces an altered state of consciousness wherein individuals experience reduced awareness of external distractions and heightened focus on the mediated environment (Csikszentmihalyi, 1990). When consumers enter such states during live-stream commerce, their temporal perception becomes distorted, rational evaluation diminishes, and intuitive and emotional impulses intensify, all of which contribute to stronger purchase inclination. This phenomenon aligns with the flow theory, which posits that individuals in immersive experiences demonstrate intrinsic motivation and decreased cognitive resistance to persuasive cues (Novak et al., 2000).

In digital retail contexts, immersion operates as a psychological bridge connecting sensory stimulation and behavioral outcomes. The real-time interactivity, authentic communication, and vivid audiovisual presentation of live commerce produce a sense of “telepresence” (Steuer, 1992), which blurs the boundary between virtual and physical experiences. When consumers feel present within the live environment, they respond emotionally to the host’s cues and social dynamics as though they were in a face-to-face retail setting. Such immersion fosters a para-social bond with the streamer, enhancing trust, empathy, and perceived authenticity (Hu & Chaudhry, 2020). These emotional associations lower skepticism and heighten susceptibility to persuasion, especially under time-limited promotions or scarcity appeals.

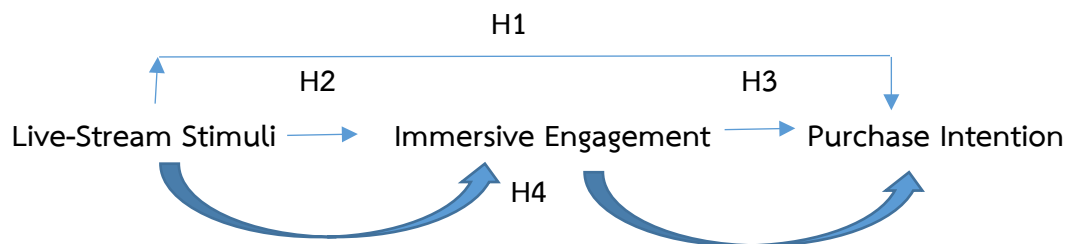
Moreover, immersion amplifies hedonic motivation the pleasure and enjoyment derived from interactive participation. When users engage with gamified features, live comments, and group reactions, they experience an affective reward loop that sustains their attention and strengthens emotional resonance with the brand or product. This state of affective engagement

often leads to impulse buying, driven by positive arousal and diminished cognitive control (Park & Kim, 2020). In live commerce, hedonic value becomes intertwined with utilitarian motives; consumers justify impulsive actions not only through enjoyment but also through the perceived efficiency of the live format (Li et al., 2021).

From a neuropsychological standpoint, immersion enhances dopaminergic activation, triggering a cycle of anticipation and reward that reinforces purchase intention (Turel et al., 2020). Emotional contagion—where the viewer unconsciously mirrors the streamer’s enthusiasm—further magnifies this effect. The convergence of sensory stimulation, social influence, and affective immersion cultivates a hot cognitive state where emotion-driven reasoning predominates over analytical deliberation. Consequently, decisions made under immersive conditions tend to be faster, more affective, and less constrained by post-purchase regret (Huang et al., 2022).

Importantly, immersion also contributes to perceived value formation. When consumers feel absorbed in the shopping experience, they attribute greater symbolic and experiential value to the product. The perceived value is not merely economic but psychological—it reflects satisfaction derived from the social and emotional experience of buying in real time. Thus, immersion serves as a mediating construct that translates external stimuli (e.g., interactivity, credibility, informativeness) into internal motivation and behavioral intention (Cai & Wohn, 2019).

Figure 1: Framework -Relationship model



3. Methodology

3.1 Research Design and Sampling

This study adopted a quantitative research design employing a cross-sectional survey approach to examine the causal relationships among live-stream stimuli, immersive engagement, and consumer purchase intention in real-time digital retailing environments. The target population consisted of active consumers who regularly participated in live-stream shopping sessions on major Chinese platforms such as Taobao Live, TikTok (Douyin), and Kuaishou. These platforms were selected because they represent the largest and most mature ecosystems for live commerce in Asia, offering a suitable context for investigating experiential mechanisms in digital retail.

Data were collected from 400 active live-stream consumers in China using structured self-administered questionnaires distributed online through purposive and snowball sampling techniques. Respondents were screened to ensure they had made at least one purchase through live-stream commerce in the preceding six months. The demographic composition of the final sample was 58.4% female and 41.6% male, with the majority aged between 21 and 35 years. This profile aligns with the dominant user segment of live-stream retail platforms in China, reflecting both technological familiarity and purchasing power.

3.2 Measurement Development

Measurement scales were adapted from well-established literature in the domains of digital media engagement, parasocial interaction, and consumer psychology. All constructs were measured using multiple items on a five-point Likert scale ranging from 1 (“strongly disagree”) to 5 (“strongly agree”).

- **Live-Stream Stimuli** were operationalized through four sub dimensions such as presenter credibility, content informativeness, interactivity, and promotional stimuli (Park and Kim (2020), and Wongkitrungrueng and Assarut (2020).)
- **Immersive Engagement** was assessed using items adapted from Novak, Hoffman, and Yung (2000) and Li et al. (2021), capturing cognitive absorption, emotional involvement, and temporal flow.
- **Purchase Intention** reflecting behavioral readiness and willingness to purchase products during live streams. was measured using items from Dodds et al. (1991) and Wang and Chen (2021).

The initial English questionnaire was translated into Chinese using Brislin’s (1980) back-translation method to ensure linguistic and conceptual equivalence. A pretest involving 30 respondents was conducted to evaluate clarity, item reliability, and completion time, leading to minor adjustments in wording.

3.3 Reliability and Validity Assessment

Prior to hypothesis testing, Confirmatory Factor Analysis (CFA) was conducted to evaluate the measurement model. All factor loadings exceeded 0.70, indicating acceptable indicator reliability. Composite Reliability (CR) values ranged from 0.88 to 0.93, exceeding the recommended threshold of 0.70, while Average Variance Extracted (AVE) values ranged between 0.64 and 0.69, demonstrating convergent validity (Fornell & Larcker, 1981). Discriminant validity was confirmed as the square roots of the AVE for each construct were greater than the inter-construct correlations. Cronbach’s alpha coefficients were all above 0.85, confirming internal consistency.

3.4 Data Analysis Procedures

For testing the hypothesized model, Structural Equation Modeling (SEM) using AMOS 26.0 was applied. SEM was chosen for its ability to simultaneously estimate multiple relationships and assess both direct and indirect (mediating) effects. The two-step analytical procedure recommended by Anderson and Gerbing (1988) was followed:

1. Measurement model validation through CFA; and
2. Structural model testing to evaluate the hypothesized paths.

Model fit indices indicated excellent goodness of fit: $\chi^2/df = 2.05$, CFI = 0.964, TLI = 0.951, RMSEA = 0.045, and SRMR = 0.038, all within the acceptable range (Hu & Bentler, 1999).

Bootstrapping with 5,000 resamples was employed to examine the mediating effect of immersive engagement between live-stream stimuli and purchase intention. The bias-corrected 95% confidence interval excluded zero, confirming a statistically significant mediation effect.

4. Result

4.1 Descriptive Statistics and Correlations

Descriptive results from 400 valid responses showed that participants were frequent users of live-stream commerce. Over 75% reported purchasing products monthly through live-stream platforms, confirming their relevance as active digital consumers. Mean construct scores for live-stream stimuli ($M = 4.12$), immersion ($M = 4.05$), and purchase intention ($M = 4.18$) were all above the midpoint, suggesting positive attitudes toward live-commerce

experiences. Correlation analysis revealed significant positive relationships among all variables:

- Stimuli $\rightarrow$ Immersion ($r = .67, p < .001$)
- Immersion $\rightarrow$ Purchase Intention ($r = .61, p < .001$)
- Stimuli $\rightarrow$ Purchase Intention ($r = .58, p < .001$)

These results preliminarily supported the proposed conceptual framework.

4.2 Structural Model and Hypothesis Testing. The SEM analysis confirmed all hypothesized paths were significant.

- **Stimuli $\rightarrow$ Immersion:** $\beta = 0.45, t = 8.24, p < .001$
- **Immersion $\rightarrow$ Purchase Intention:** $\beta = 0.33, t = 6.01, p < .001$
- **Stimuli $\rightarrow$ Purchase Intention:** $\beta = 0.47, t = 9.10, p < .001$

Together, live-stream stimuli explained 53% of the variance in immersion and 60% in purchase intention ($R^2 = .53, .60$ respectively), indicating strong explanatory power.

Table 1: The Results of Structural Equation Model (SEM) Analysis

Hypothesis	Path	β	t-value	p-value	Result
H1	Stimuli $\rightarrow$ Immersion	0.45	8.24	< .001	Supported
H2	Immersion $\rightarrow$ Purchase Intention	0.33	6.01	< .001	Supported
H3	Stimuli $\rightarrow$ Purchase Intention	0.47	9.10	< .001	Supported
H4	Stimuli $\rightarrow$ Purchase Intention (Mediated by Immersion)	0.15	3.95	< .01	Supported

4.3 Mediation Analysis and Interpretation

The bootstrapping test (5,000 samples) confirmed that immersion partially mediates the relationship between live-stream stimuli and purchase intention ($\beta_{\text{indirect}} = 0.15, SE = 0.04, 95\% \text{ CI } [0.08, 0.23]$).

This finding validates the S–O–R theoretical mechanism, where immersive psychological states serve as internal channels transforming environmental stimuli into behavioral responses.

The results also emphasize that the intensity of immersion amplifies emotional and cognitive involvement, ultimately increasing consumers' readiness to purchase. In other words, immersion acts as an experiential catalyst, converting online attention into tangible consumer action.

5. Conclusion and Discussion

5.1 Theoretical Discussion

The findings of this study offer significant theoretical contributions to the understanding of consumer behavior in real-time digital retailing. Drawing upon the Stimulus–Organism–Response (S–O–R) framework, the results confirm that live-stream stimuli significantly influence consumer purchase intention, both directly and indirectly through immersive engagement. This supports the notion that live commerce is not only a transactional exchange but an experiential and psychological process in which cognitive and affective mechanisms interact to shape behavior.

The results reveal that immersion functions as a central psychological mechanism that converts external sensory and social stimuli into behavioral outcomes. The positive relationships observed between live-stream stimuli, immersion, and purchase intention empirically validate previous research on flow theory (Csikszentmihalyi, 1990) and presence theory (Steuer, 1992), extending these frameworks to the live-commerce domain. In line with

these theories, consumers who experience cognitive absorption and emotional involvement during live-stream sessions are more likely to perceive the shopping experience as enjoyable, authentic, and trustworthy—ultimately increasing their purchase intention.

The findings also contribute to the expansion of the S–O–R model by highlighting immersion as a multidimensional construct that integrates cognitive, emotional, and temporal engagement. While prior studies have emphasized social presence, trust, or entertainment as mediators, the present study identifies immersion as a more holistic internal state that unites these dimensions under a single experiential mechanism. This adds conceptual depth to the understanding of consumer psychology in interactive, synchronous digital environments. The model's high explanatory power ($R^2 = 0.60$ for purchase intention) demonstrates that immersion is not a peripheral factor but a key determinant of behavioral response in live-stream retailing.

5.2 Managerial Implications

From a managerial perspective, the findings offer practical guidance for platform operators, marketers, and live-stream hosts seeking to optimize engagement and conversion in real-time digital retailing.

First, the positive impact of live-stream stimuli on immersion and purchase intention highlights the strategic importance of content design and host communication style. Streamers should employ credible and authentic communication, supported by demonstrative visuals, narrative storytelling, and transparency in product information. Such practices foster trust and strengthen the psychological bond between the host and the audience, encouraging purchase behavior.

Second, interactivity plays a crucial role in sustaining immersion. Live-stream sessions should incorporate two-way communication mechanisms such as real-time chat, polls, reaction icons, and Q&A sessions to sustain attention and foster emotional engagement. Platforms can enhance this experience through technological affordances—such as augmented reality filters, gamified interfaces, and social co-viewing tools—that deepen consumer immersion and prolong session duration.

5.3 Limitations and Future Research

Despite its theoretical and managerial contributions, this study has several limitations that provide avenues for future research.

First, the study's data were collected from 400 participants in China, which, while representing one of the most mature live-commerce markets, may limit the generalizability of the findings across cultural contexts. Future research should conduct cross-cultural comparative studies to examine whether the mechanisms of immersion and purchase intention differ across countries and technological ecosystems.

Second, this research employed a cross-sectional survey design, which limits causal inference. Future studies could employ longitudinal or experimental designs to explore how immersion develops dynamically over time and whether repeated exposure to live-stream stimuli strengthen or weakens purchase behavior.

5.4 Conclusion of the Discussion

Overall, this study underscores the pivotal role of immersion as a cognitive–emotional bridge connecting live-stream stimuli to purchase intention. The results deepen theoretical understanding of experiential consumption and offer actionable insights for designing emotionally resonant, technologically advanced, and consumer-centered digital retail ecosystems. As live commerce continues to reshape the global retail landscape, the integration

of psychological immersion with strategic interactivity will define the future of human–technology synergy in digital consumption behavior.

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Research on the Integrated Development of Marathon Sports and Sports Tourism: A Case Study of Dali City, Yunnan Province

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Abstract

With the continuous improvement of global health awareness and the diversification of leisure activities, marathon sports, as a form of physical exercise integrating competitiveness, participation, and spectacle, are gaining increasing favor. Meanwhile, sports tourism, as an emerging form of tourism, is attracting a large number of visitors with its unique charm. Particularly in the context of a severe shortage of sports resources such as venues and infrastructure, the public's participation in marathon events and running has become a preferred way for many to experience the joy of sports and fitness. This is related to many factors, including lifestyle habits, attitudes towards exercise, fast-paced daily life, dual pressures from life and society, enhanced public awareness of sports health, and the promotion of a national fitness consciousness. Runners are also eager to exercise through running (Du, 2022). However, in the process of integrating marathon sports and sports tourism, numerous issues remain to be addressed. These include how to fully tap into the tourism value of marathon events, how to balance event hosting with the protection of the local environment and culture, and how to enhance the participant experience, for instance, regarding route arrangement, prize settings, volunteer recruitment, and improving volunteer professional competence.

This study takes Dali City, Yunnan Province as a case study to thoroughly investigate the current state, problems, and countermeasures for the integrated development of marathon sports and sports tourism. It aims to provide theoretical support and practical guidance for promoting the synergistic development of the two, as well as a theoretical analysis of the shortcomings in event organization.

Keywords: Marathon sports; Sports tourism; Integrated development; Dali, Yunnan

1. Introduction

1.1 Research Background

Current Development Status of Marathon Sports in Dali, Yunnan: The Dali Marathon has been held for 13 years, from 2012 to 2025. As a host location, Dali possesses unique natural scenery and cultural background, which add distinct charm to the event. However, challenges remain in the level of event organization, service quality, and operational smoothness. For instance, the 2023 marathon encountered issues when the lead vehicle veered off course, leading to problems for the runners. Although the Dali Marathon attracts participants from around the world, the stability of its sustainable development and its appeal are still susceptible to external factors, such as force majeure and the specific execution capabilities of the event organizers. In summary, the Dali Marathon faces issues in areas like promotion and implementation, necessitating further strengthened management and improved service quality to ensure the event's long-term development and attract more participants.

2. Literature Review

Domestic Research Status: Sporting events are activating new kinetic energy for urban cultural tourism. On July 18, 2025, Gansu Province's "National Physical Fitness Standard" Challenge commenced in Dingxi; on July 20, 2025, the "Kongtong Cup" National Traditional Martial Arts Invitational Tournament & Gansu Provincial Traditional Martial Arts Championships kicked off in Pingliang... Various sports events are being intensively held across the province. Local areas are leveraging the "impetus" of these events to release development momentum, transforming the event "flow" into tourism "stay" and economic "growth," thereby promoting the deep integration of "sports + culture + tourism." Data from the 2025 Lanzhou Marathon show that direct spending by runners reached 600.4 million yuan, coupled with investments from sponsors and partners of approximately 63.65 million yuan, resulting in a total direct economic impact of 664.05 million yuan. As a World Athletics Gold Label event, the "Lan Ma's" value extends beyond economic figures—during the event period, Lanzhou City received 1.3275 million tourist visits, the average occupancy rate of 30 star-rated hotels reached 75.6%, generating an indirect economic impact of 864 million yuan. Furthermore, through "event +" initiatives, it promoted urban governance upgrades, deeply explored cultural IP, innovated cultural tourism experiences, and created a unique feeling for runners of "one event empowering one city."

3. Research Background and Significance

Theoretical Significance: This study contributes to enriching theoretical research in the fields of sports tourism and marathon sports. Through an in-depth analysis of the integrated development of marathon sports and sports tourism, it reveals the intrinsic connections and interaction mechanisms between them, providing new perspectives and evidence for the development and refinement of relevant theories.

Practical Significance: For Dali, Yunnan, the integrated development of marathon sports and sports tourism holds significant practical importance. On one hand, it can further enhance Dali's visibility and reputation, attracting more tourists and promoting the development of the local tourism industry. On the other hand, it helps drive the development of the sports industry, spurring synergistic innovation in related sectors, and injecting new momentum into Dali's economic and social development. Simultaneously, it provides useful insights and references for other regions regarding the integrated development of marathon sports and sports tourism.

4. Research Objectives

4.1 To comprehensively understand the current state of the integrated development of marathon sports and sports tourism in Dali, Yunnan, encompassing aspects such as event organization, tourism product development, and market promotion.

4.2 To conduct an in-depth analysis of the factors influencing the integrated development of marathon sports and sports tourism in Dali, Yunnan, such as the policy environment, economic foundation, and cultural heritage.

4.3 To explore suitable models for the integrated development of marathon sports and sports tourism in Dali, Yunnan, and propose targeted and operational development strategies.

4.4 To provide theoretical guidance and practical references for Dali, Yunnan, and other regions in the integrated development of marathon sports and sports tourism.

Research Goals

1. Core Goal: To explore the pathways for the integrated development of the Dali Marathon and sports tourism, and propose practical strategies.

2. Specific Goals:

To investigate the current situation and existing problems of the Dali Marathon event (e.g., event positioning, resource integration, tourist participation).

To assess the economic, cultural, and social impacts of the marathon on Dali's sports tourism industry.

3. Application Goals:

For Policymakers: The research results can provide a reference basis for the government in formulating relevant policies, helping to better guide and standardize the integrated development of marathon sports and sports tourism. For instance, based on the policy recommendations from the study, the government can rationally plan event layouts, increase investment in infrastructure construction, and optimize public service provision.

For Event Organizers: The findings can offer valuable insights to help them improve event organization and management, thereby enhancing event quality and service levels.

For example, they can draw on recommendations from the study regarding event planning, marketing, and participant experience to create more distinctive and attractive marathon events.

For Tourism Enterprises: The results can help tourism businesses understand the demands and trends in the integrated market of marathon sports and sports tourism, enabling them to develop more market-aligned sports tourism products and services. For example, designing sports tourism routes for different demographics and launching travel packages related to marathon events.

For Academia: The study can provide reference and serve as a basis for other scholars conducting related research, promoting academic exchange and collaboration. Simultaneously, it can contribute to the cross-integration and development of disciplines such as Sports Science and Tourism Studies.

4. To propose mechanisms for coordinating marathon events and tourism resource development (e.g., route planning, product design, marketing strategies).

5. Research Hypotheses

H1: The larger the scale of the event, the stronger the tourists' willingness to participate in marathon-related tourism.

H2: The more developed the supporting services for sports tourism in Dali (e.g., transportation, accommodation, catering), the higher the tourist satisfaction.

H3: The higher the popularity of the marathon event, the stronger the recognition of Dali's "Sports Tourism City" brand image.

6. Conclusion

Based on an empirical investigation of participants in Dali's marathon tourism, this study systematically explored the relationships between event scale, supporting services, event popularity, and tourist willingness to participate, satisfaction, and city brand image perception. Through the verification and analysis of the proposed hypotheses, this research arrives at the following core conclusions:

First, event scale is a key driver for attracting tourist participation, but its effect has boundaries. The results strongly support H1, indicating that a larger event scale correlates with a stronger willingness among tourists to engage in marathon-related tourism. Large-scale events, with their higher visibility, more competitive level, and broader social influence, can effectively stimulate potential tourists' interest and create a strong "pull" factor.

Second, supporting sports tourism services are the cornerstone of enhancing tourist satisfaction and are central to achieving positive word-of-mouth. H2 is fully validated in this study. The research shows that supporting services—such as transportation convenience, accommodation comfort, and the uniqueness and quality of catering—directly determine the overall experience of tourists during the event. Well-developed supporting services not only meet basic needs but can also create pleasant surprises, significantly boosting overall satisfaction. Highly satisfied tourists are more likely to become repeat customers and active promoters of Dali's sports tourism. Therefore, treating the optimization and upgrading of supporting services as a systematic project is a fundamental way to consolidate and enhance the market competitiveness of Dali's marathon tourism.

Third, marathon event popularity acts as a catalyst for shaping and strengthening Dali's "Sports Tourism City" brand image. This study confirms H3, demonstrating a significant positive correlation between the popularity of the marathon event (e.g., media exposure, social media discussion, past participant 口碑) and the recognition of Dali's "Sports Tourism City" brand image. High-profile events function like grand city marketing campaigns, seamlessly integrating Dali's unique natural scenery of Cangshan Mountain and Erhai Lake with a vibrant sports spirit. This image is rapidly and vividly implanted in the public's mind through local, national, and international media coverage. Once established, this perception transcends the event itself, benefiting Dali's overall tourism industry.

In summary, this research confirms the central role of event scale, supporting services, and event popularity in the development of Dali's marathon tourism. Looking forward, Dali should fully seize the opportunity presented by the rise of sports tourism. Using the marathon as a key lever, it should streamline the entire process from "attracting visitors to Dali" to "retaining visitors in Dali," ultimately establishing Dali as a leading domestic and internationally renowned sports tourism destination.

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Psychological Flexibility as a Mediator Between Perceived Stress and Sleep Quality in Patients with Diabetic Nephropathy: A Case Study in Liuzhou, Guangxi Zhuang Autonomous Region

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Abstract

Objective: This study aimed to explore the relationships among perceived stress, psychological flexibility, and sleep quality in patients with diabetic nephropathy (DN) in Liuzhou, Guangxi, and further verify the mediating role of psychological flexibility between perceived stress and sleep quality. **Methods:** A cross-sectional survey was conducted on 218 DN patients admitted to from March 2023 to February 2024. The General Information Questionnaire, Perceived Stress Scale-10 (PSS-10), Acceptance and Action Questionnaire-II (AAQ-II), and Pittsburgh Sleep Quality Index (PSQI) were used for data collection. SPSS 26.0 software and Hayes' PROCESS macro (Model 4) were applied for descriptive statistics, Pearson correlation analysis, and mediating effect. **Results:** ① The average PSQI score of DN patients was (9.23 ± 2.71) , with 68.8% (150/218) of patients having poor sleep quality (PSQI ≥ 5). ② Pearson correlation analysis showed that perceived stress was positively correlated with AAQ-II score ($r=0.413$, $p<0.01$) and PSQI score ($r=0.476$, $p<0.01$); AAQ-II score was positively correlated with PSQI score ($r=0.435$, $p<0.01$) (note: higher AAQ-II score indicates lower psychological flexibility). ③ Mediating effect analysis revealed that perceived stress could directly predict sleep quality ($\beta=0.321$, $p<0.01$) and indirectly affect sleep quality through the mediating role of psychological flexibility ($\beta=0.185$, $p<0.01$). The mediating effect accounted for 36.8% of the total effect, and the 95% confidence interval (95% CI: 0.112–0.273) did not include 0, confirming a significant partial mediating effect. **Conclusion:** Psychological flexibility plays a significant partial mediating role between perceived stress and sleep quality in DN patients in Liuzhou. Clinical interventions should focus on reducing perceived stress and improving psychological flexibility to enhance the sleep quality of this population.

Keywords: Diabetic Nephropathy; Perceived Stress; Psychological Flexibility; Sleep Quality; Mediating Effect; Liuzhou

1. Introduction

Diabetic nephropathy (DN), one of the most common microvascular complications of diabetes mellitus, has become a leading cause of end-stage renal disease (ESRD) globally [1].

In China, the prevalence of DN among diabetic patients is approximately 20%–40%, and the disease burden is further aggravated by its high disability rate and poor prognosis [2]. Liuzhou, a key industrial city in northern Guangxi, has a high incidence of diabetes due to changes in residents' lifestyle (e.g., high-sugar diet, reduced physical activity), and the prevalence of DN in local diabetic patients has reached 31.2% according to a 2022 regional survey [3].

Beyond the physical damage (e.g., renal function decline, hypertension), DN patients often face long-term treatment pressure (e.g., insulin injection, dialysis preparation), economic burden, and fear of disease progression, leading to high levels of perceived stress [4]. Previous studies have confirmed that persistent perceived stress can disrupt the hypothalamic-pituitary-adrenal (HPA) axis, reduce melatonin secretion, and ultimately impair sleep quality [5]. A survey of DN patients in southern China showed that 65.7% of them had poor sleep quality (PSQI ≥ 5), which was significantly higher than the general diabetic population (42.3%) [6]. However, the mechanism by which perceived stress affects sleep quality in DN patients remains to be further clarified.

Psychological flexibility, a core concept in Acceptance and Commitment Therapy (ACT), refers to the ability to adaptively adjust one's thoughts and behaviors according to internal needs and external environments while maintaining focus on long-term goals—even in the presence of negative emotions or thoughts [7]. Unlike traditional “stress reduction” strategies, psychological flexibility emphasizes “accepting negative experiences” rather than “avoiding stressors.” Studies have shown that psychological flexibility can buffer the negative impact of stress on mental health: for example, in patients with chronic diseases (e.g., hypertension, rheumatoid arthritis), higher psychological flexibility is associated with lower anxiety and better sleep quality [8,9]. However, few studies have explored the role of psychological flexibility in the relationship between perceived stress and sleep quality in DN patients, especially in regional populations such as Liuzhou (where medical resources and cultural backgrounds differ from large cities).

To fill this gap, this study took DN patients in Liuzhou as the research object, using standardized scales to measure perceived stress, psychological flexibility, and sleep quality. The objectives were: ① To describe the current status of perceived stress, psychological flexibility, and sleep quality in DN patients in Liuzhou; ② To analyze the correlations among the three variables; ③ To verify the mediating role of psychological flexibility between perceived stress and sleep quality. The results are expected to provide a theoretical basis for developing targeted psychological interventions to improve sleep quality in DN patients.

2. Methodology

Diagnosed with DN according to the Clinical Practice Guidelines for Diabetic Kidney Disease in China (2021 Edition): persistent albuminuria (urinary albumin/creatinine ratio ≥ 30 mg/g) or estimated glomerular filtration rate (eGFR) $< 60 \text{ mL} \cdot \text{min}^{-1} \cdot 1.73 \text{ m}^{-2}$ for more than 3 months, with no other causes of kidney disease;

Aged 18–75 years;

Conscious, able to communicate normally, and capable of completing questionnaire surveys independently;

Voluntarily participated in the study and signed the informed consent form.

Exclusion Criteria

Complicated with severe mental diseases (e.g., schizophrenia, major depressive disorder) or cognitive impairment;

Complicated with other severe organ diseases (e.g., liver failure, heart failure);

In the acute phase of DN (e.g., acute kidney injury, severe infection);

Refused to participate or withdrew midway.

A total of 230 questionnaires were distributed, and 218 valid questionnaires were recovered, with an effective recovery rate of 94.8%.

Sub-Section 2: Research Tools

1. General Information Questionnaire

Self-designed, including demographic characteristics (age, gender, educational level, marital status, monthly income) and disease-related information (duration of diabetes, duration of DN, eGFR stage, presence of hypertension/complications).

2. Perceived Stress Scale-10 (PSS-10)

Developed by Cohen et al., and adapted into a Chinese version by Yang et al. [10]. The scale measures the degree of stress perceived by individuals in the past month, including 10 items scored on a 5-point Likert scale (0=never to 4=very often). The total score ranges from 0 to 40, with higher scores indicating higher perceived stress. The Cronbach's α coefficient of the Chinese version was 0.82 in this study.

3. Acceptance and Action Questionnaire-II (AAQ-II)

Developed by Bond et al., and adapted into a Chinese version by Cao et al. [11]. The scale assesses psychological flexibility (lower scores indicate higher flexibility), including 7 items scored on a 7-point Likert scale (1=never true to 7=always true). The total score ranges from 7 to 49. The Cronbach's α coefficient of the Chinese version was 0.79 in this study.

4. Pittsburgh Sleep Quality Index (PSQI)

Developed by Buysse et al., and adapted into a Chinese version by Liu et al. [12]. The scale evaluates sleep quality in the past month, including 19 items covering 7 dimensions (subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleeping drugs, daytime dysfunction). Each dimension is scored 0–3, and the total score ranges from 0 to 21. A total score ≥ 5 indicates poor sleep quality. The Cronbach's α coefficient of the Chinese version was 0.83 in this study.

Sub-Section 3: Data Collection Procedures

First, the study was approved by the Medical Ethics Committee of Researchers received unified training to ensure standardized questionnaire guidance. During data collection, researchers explained the purpose, content, and confidentiality of the study to patients; after obtaining informed consent, patients completed the questionnaires independently (for patients with poor eyesight or writing ability, researchers read the questions aloud and recorded answers truthfully). Questionnaires were checked on-site for completeness, and incomplete ones were supplemented or excluded immediately.

Sub-Section 4: Statistical Analysis

All data were entered into EpiData 3.1 (double entry for error correction) and analyzed using SPSS 26.0 software. Descriptive statistics included frequency (percentage) for categorical variables and mean $\pm$ standard deviation ($\bar{x} \pm s$) for continuous variables. Pearson correlation analysis was used to explore the relationships among perceived stress,

psychological flexibility, and sleep quality. Hayes' PROCESS macro (Model 4) was used to test the mediating effect, with 5000 bootstrap samples to calculate the 95% confidence interval (CI). A p-value <0.05 was considered statistically significant.

3. Results

3.1 General Information of Participants

Among the 218 DN patients, 116 (53.2%) were male and 102 (46.8%) were female; the age range was 32–75 years, with an average of (58.6±10.2) years; educational level: primary school or below (38.5%), junior high school (32.1%), senior high school/technical secondary school (18.3%), college or above (11.1%); marital status: married (82.1%), unmarried/divorced/widowed (17.9%); monthly income: <3000 yuan (45.4%), 3000–5000 yuan (31.2%), >5000 yuan (23.4%); duration of diabetes: (10.3±4.7) years; duration of DN: (4.2±2.1) years; eGFR stage: stage 1–2 (28.5%), stage 3 (35.3%), stage 4–5 (36.2%); 165 (75.7%) had comorbid hypertension.

Sub-Section 2: Descriptive Statistics of Key Variables

The average scores of PSS-10, AAQ-II, and PSQI in DN patients were (22.5±5.8), (28.7±6.3), and (9.23±2.71), respectively. Among them, 150 patients (68.8%) had a PSQI score ≥5 (poor sleep quality), and 68 patients (31.2%) had a PSQI score <5 (good sleep quality).

Sub-Section 3: Correlation Analysis Among Variables

Pearson correlation analysis showed (see Table 1):

Perceived stress (PSS-10 score) was positively correlated with psychological flexibility (AAQ-II score, $r=0.413$, $p<0.01$) and sleep quality (PSQI score, $r=0.476$, $p<0.01$);

Psychological flexibility (AAQ-II score) was positively correlated with sleep quality (PSQI score, $r=0.435$, $p<0.01$).

In other words, higher perceived stress was associated with lower psychological flexibility and worse sleep quality; lower psychological flexibility was associated with worse sleep quality.

Table 1: Correlation Matrix of Perceived Stress, Psychological Flexibility, and Sleep Quality ($n=218$)

Variable	Mean±SD	Perceived Stress	Psychological Flexibility	Sleep Quality
Perceived Stress	22.5±5.8	1	0.413**	0.476**
Psychological Flexibility (AAQ-II)	28.7±6.3	0.413**	1	0.435**
Sleep Quality (PSQI)	9.23±2.71	0.476**	0.435**	1

*Note: * $p<0.01$ (two-tailed test); AAQ-II score is negatively associated with actual psychological flexibility.

3.2 Mediating Effect of Psychological Flexibility

Before testing the mediating effect, age, gender, and duration of DN (variables with significant correlations with sleep quality in univariate analysis) were included as control variables. Hayes' PROCESS macro (Model 4) was used for stepwise regression analysis (see Table 2):

Direct effect of perceived stress on sleep quality: After controlling for confounding variables, perceived stress significantly positively predicted sleep quality ($\beta=0.321$, $t=4.893$, $p<0.001$);

Effect of perceived stress on psychological flexibility: Perceived stress significantly positively predicted AAQ-II score (i.e., reduced psychological flexibility, $\beta=0.385$, $t=5.927$, $p<0.001$);

Joint effect of perceived stress and psychological flexibility on sleep quality: Both perceived stress ($\beta=0.201$, $t=3.015$, $p<0.01$) and AAQ-II score ($\beta=0.312$, $t=4.568$, $p<0.001$) significantly positively predicted sleep quality.

Bootstrap analysis (5000 samples) showed that the mediating effect value of psychological flexibility was 0.185, and the 95% CI was (0.112, 0.273) (did not include 0), indicating a significant partial mediating effect. The mediating effect accounted for 36.8% of the total effect (mediating effect / total effect = $0.185 / 0.506 \approx 0.368$).

Table 2: Mediating Effect Regression Analysis Results (n=218)

Dependent Variable	Predictor Variable	β	SE	t	p	R ²	Adjusted R ²
Sleep Quality (PSQI)	Perceived Stress	0.321	0.065	4.893	<0.001	0.287	0.272
Psychological Flexibility (AAQ-II)	Perceived Stress	0.385	0.065	5.927	<0.001	0.224	0.208
Sleep Quality (PSQI)	Perceived Stress	0.201	0.067	3.015	0.003	0.352	0.335
	Psychological Flexibility (AAQ-II)	0.312	0.068	4.568	<0.001		
	Age	0.153	0.062	2.468	0.015		
	Gender	0.087	0.121	0.719	0.473		
	Duration of DN	0.112	0.058	1.931	0.055		

Note: Gender was coded as 1=male, 2=female; β =standardized regression coefficient; SE=standard error.

4. Conclusion and Future Work

4.1 Conclusion

This study explored the relationships among perceived stress, psychological flexibility, and sleep quality in DN patients in Liuzhou, and confirmed that psychological flexibility plays a significant partial mediating role between perceived stress and sleep quality. Specifically, higher perceived stress in DN patients not only directly impairs sleep quality but also reduces psychological flexibility (increases AAQ-II score), thereby indirectly worsening sleep quality. The mediating effect accounts for 36.8% of the total effect, indicating that psychological flexibility is a key “bridge” in the impact of stress on sleep.

The high rate of poor sleep quality (68.8%) in this study is consistent with previous findings on DN patients, and further confirms that sleep disturbance is a common problem in

this population [6]. The positive correlation between perceived stress and sleep quality aligns with the HPA axis theory: long-term stress increases cortisol secretion, disrupts the circadian rhythm, and prolongs sleep latency [5]. More importantly, the mediating role of psychological flexibility suggests that even if patients cannot avoid stressors (e.g., disease progression, treatment burden), improving their ability to accept negative emotions (i.e., enhancing psychological flexibility) can reduce the negative impact of stress on sleep. This is consistent with ACT theory, which emphasizes that “adapting to stress” is more effective than “eliminating stress” for chronic disease patients [7].

4.2 Future Work

Expand research design: This study is a cross-sectional study, which can only verify the correlation but not the causal relationship. Future studies should adopt a longitudinal design to track changes in perceived stress, psychological flexibility, and sleep quality in DN patients over time, and further confirm the causal direction of the mediating model.

Develop targeted interventions: Based on the results, ACT-based psychological interventions (e.g., acceptance training, value clarification) can be designed to improve psychological flexibility in DN patients. Future studies should verify the effectiveness of such interventions in randomized controlled trials (RCTs), such as comparing sleep quality changes between the ACT intervention group and the conventional health education group.

Broaden sample scope: This study only included patients from one hospital in Liuzhou, with potential selection bias. Future studies should expand the sample to community DN patients or patients from multiple hospitals in Guangxi, to improve the generalizability of the results.

Explore other mediating/moderating variables: In addition to psychological flexibility, variables such as social support, coping style, and symptom burden may also affect the relationship between perceived stress and sleep quality. Future studies can construct a more comprehensive structural equation model to explore the combined effects of multiple variables.

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Artificial Intelligence Application for Students' Learning in Harbin Institute of Technology, China

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Abstract

With the rapid development of artificial intelligence (AI) technology, its integration into higher education has become a key driving force for reforming students' learning models. This paper focuses on the application of AI in students' learning at Harbin Institute of Technology (HIT), a leading university in China with strengths in science, engineering, and technology. The study first sorts out the current status of AI application in HIT's teaching scenarios, including intelligent course recommendation, adaptive learning systems, and AI-assisted practical training. Then, it analyzes the effects of these applications through a combination of questionnaire surveys, learning data analysis, and interviews with teachers and students. The results show that AI technology has significantly improved students' learning initiative, optimized the matching degree between learning content and individual needs, and enhanced the efficiency of practical skill training. However, challenges such as data security risks, students' over-reliance on AI tools, and the need for further improvement of AI system accuracy also exist. Finally, the paper puts forward targeted suggestions for optimizing the application of AI in HIT's students' learning, providing a reference for the deep integration of AI and higher education in similar universities.

Keywords: Artificial Intelligence; Students' Learning; Harbin Institute of Technology; Adaptive Learning; Higher Education

1. Introduction

In the context of the global digital transformation of education, artificial intelligence has emerged as a core technology to promote the innovation of teaching and learning methods (Zhang et al., 2022). Higher education institutions, as the cradle of cultivating high-quality innovative talents, are actively exploring the application paths of AI to meet the diverse learning needs of students and improve the quality of talent cultivation. Harbin Institute of Technology, as one of China's first-class universities, has long been committed to the integration of information technology and education, and in recent years has accelerated the layout of AI in students' learning scenarios, aiming to build a more intelligent, personalized, and efficient learning environment.

The application of AI in students' learning is not only a response to the national strategy of "Educational Informatization 2.0" but also an inevitable requirement for HIT to enhance its core competitiveness in talent cultivation (Ministry of Education of the People's Republic of China, 2021). In engineering majors such as computer science, electrical engineering, and mechanical engineering at HIT, traditional learning models often face problems such as rigid

teaching content, difficulty in adapting to students' different learning paces, and limited practical training resources. AI technology, with its advantages in data analysis, adaptive algorithms, and virtual simulation, provides a new solution to these problems. For example, adaptive learning systems can adjust the difficulty and progress of learning content in real-time based on students' learning behavior data, while AI-assisted virtual laboratories can break the limitations of time and space and provide students with more frequent practical operation opportunities (Li & Wang, 2023).

Existing research on AI in higher education has mostly focused on macro policy analysis, technical framework design, or application cases in general universities, but there is a lack of in-depth research on the application effects and optimization strategies of AI in students' learning in research-oriented universities with strong engineering characteristics like HIT (Chen et al., 2020). Different from comprehensive universities, HIT's students have higher requirements for practical skills and innovative thinking, and the application of AI in their learning scenarios needs to be more closely combined with engineering practice and professional characteristics. Therefore, it is of great practical significance to systematically study the application of AI in HIT's students' learning, summarize the experience and problems, and explore targeted optimization paths.

This study takes HIT as the research object, focusing on three core research questions: First, what are the main application scenarios and implementation paths of AI in HIT's students' learning? Second, what effects do these AI applications have on students' learning initiative, learning efficiency, and skill mastery? Third, what challenges exist in the current application process, and what optimization strategies can be proposed? By answering these questions, this paper aims to provide a practical reference for the deep integration of AI and students' learning in engineering-oriented research universities, and also enrich the relevant research results of AI in higher education.

2. Methodology

To comprehensively and accurately study the application of AI in students' learning at Harbin Institute of Technology, this study adopts a mixed research method combining quantitative and qualitative research, and the research process is divided into three stages: research design, data collection, and data analysis. The specific implementation steps are as follows:

2.1 Research Object and Sample Selection

The research objects cover undergraduate and postgraduate students from three representative engineering majors at HIT: School of Computer Science and Technology, School of Electrical and Electronic Engineering, and School of Mechanical Engineering. These three majors have taken the lead in applying AI technology in students' learning, with relatively mature application scenarios and sufficient learning data.

In terms of sample selection, a multi-stage stratified sampling method is used. First, according to the grade (freshman to senior for undergraduates, first-year to third-year for postgraduates), the sample frame is divided into different layers. Then, according to the proportion of students in each major and grade, a total of 800 students are selected as the survey objects (200 undergraduates and 100 postgraduates in each major). At the same time, 15

teachers who are familiar with AI application in teaching and 10 students with rich experience in using AI learning tools are selected for in-depth interviews to supplement the quantitative survey results.

2.2 Data Collection Methods

Questionnaire Survey: A structured questionnaire is designed to collect quantitative data on students' use of AI learning tools, learning experience, and learning effect changes. The questionnaire is divided into four parts: basic information of students (major, grade, etc.), frequency and type of using AI learning tools, evaluation of AI application effects (such as learning initiative, knowledge mastery, etc.), and opinions on existing problems and improvement suggestions. Before the formal survey, a pre-survey is conducted with 50 students to test the validity and reliability of the questionnaire, and the questionnaire is revised and improved according to the pre-survey results. The formal survey is conducted online through HIT's educational administration system, and 723 valid questionnaires are recovered, with an effective recovery rate of 90.37%.

Learning Data Analysis: With the approval of HIT's educational administration department and the consent of students, the learning behavior data of students using AI learning platforms (such as HIT's intelligent learning platform, adaptive learning system, etc.) in the past academic year is collected. The collected data includes learning time, completion rate of learning tasks, test scores, interaction frequency with AI tools, etc. A total of 12,000 sets of valid learning behavior data are obtained, which are used to analyze the impact of AI applications on students' learning process and results from an objective data perspective.

In-depth Interview: Semi-structured interview outlines are formulated for teachers and students respectively. The interview content for teachers mainly includes the design concept of AI teaching tools, the process of applying AI in teaching, the observation of students' learning changes, and the problems encountered in the application process. The interview content for students mainly includes the experience of using AI learning tools, the impact of AI on their learning methods, and suggestions for optimizing AI learning tools. Each interview lasts for 30-45 minutes, and all interviews are recorded and transcribed into text materials for qualitative analysis.

2.3 Data Analysis Methods

Quantitative Data Analysis: The valid questionnaire data and learning behavior data are sorted and coded, and then analyzed using statistical software such as SPSS 26.0 and Excel. Descriptive statistical analysis is used to calculate the frequency and proportion of students' use of AI learning tools and their evaluation of application effects; correlation analysis is used to explore the relationship between the frequency of using AI tools and students' learning scores; regression analysis is used to verify the impact of AI application factors (such as personalized recommendation accuracy, interface friendliness) on students' learning satisfaction.

Qualitative Data Analysis: The interview text materials are analyzed using the thematic analysis method. First, the interview texts are segmented and coded to extract initial concepts; then, similar concepts are classified and summarized to form sub-themes (such as "advantages of AI adaptive learning", "problems of data security"); finally, the sub-themes are integrated to form core themes (such as "effects of AI application", "challenges of AI application"), so as to

systematically sort out the subjective experience and opinions of teachers and students on AI application in learning.

3. Results

This study analyzes the application of AI in students' learning at Harbin Institute of Technology from three aspects: application scenarios, application effects, and existing challenges. The specific results are as follows:

3.1 Main Application Scenarios of AI in HIT's Students' Learning

Through questionnaire surveys and interviews, it is found that AI has been applied in multiple learning scenarios of HIT's students, and the application coverage of engineering majors is relatively high. The main application scenarios are shown in Table 1.

Table 1: Main Application Scenarios of AI in HIT's Students' Learning

No.	Application Scenario	Description	Application Proportion (Undergraduates/Postgraduates)
1	Intelligent Course Recommendation	Based on students' major direction, learning performance, and interest preferences, the AI system recommends elective courses, extended learning resources (such as academic papers, online courses), and practical projects that match their needs.	85.2% / 92.1%
2	Adaptive Learning System	According to students' learning progress (such as homework completion, test results) and knowledge mastery, the system adjusts the difficulty of learning tasks in real-time, provides targeted knowledge supplements, and pushes personalized exercise questions.	78.6% / 86.3%
3	AI-Assisted Practical Training	In fields such as electrical engineering and mechanical engineering, AI is used to build virtual simulation	91.5% / 88.7%

		laboratories. Students can conduct virtual operation training (such as circuit debugging, mechanical assembly) through the simulation system, and the AI system provides real-time error prompts and operation guidance.	
4	AI-Powered Academic Writing Assistance	For postgraduate students, the AI tool helps check the grammar and logic of academic papers, recommend relevant reference literatures, and assist in formatting the paper according to the requirements of target journals.	42.3% / 79.5%

It can be seen from Table 1 that the application proportion of AI in practical training scenarios is the highest among undergraduates (91.5%), which is closely related to HIT's emphasis on engineering practical teaching. For postgraduates, the application proportion of intelligent course recommendation and academic writing assistance is higher, which is due to the more diverse learning needs and higher academic writing requirements of postgraduates.

3.2 Application Effects of AI on HIT's Students' Learning

The analysis of questionnaire data and learning behavior data shows that AI application has a positive impact on HIT's students' learning, mainly reflected in the following three aspects:

(1) Improvement of Learning Initiative

The questionnaire results show that 68.3% of undergraduates and 75.6% of postgraduates believe that AI learning tools (such as adaptive learning systems, intelligent recommendation platforms) make learning more targeted, reducing the time spent on selecting learning resources and reviewing knowledge they have already mastered, thus increasing their willingness to take the initiative to learn. From the learning behavior data, the average weekly autonomous learning time of students using AI tools is 4.2 hours, which is 1.8 hours more than that of students not using AI tools.

(2) Optimization of Knowledge Mastery Effect

Correlation analysis shows that there is a significant positive correlation between the frequency of using the adaptive learning system and students' course scores ($r = 0.48$, $p < 0.01$). The interview results also confirm this: 82.1% of teachers said that students using the adaptive learning system have a more solid grasp of key knowledge, and the error rate in homework and

tests has decreased by 15%-20% compared with previous students. For example, in the "Circuit Principle" course of the School of Electrical and Electronic Engineering, after applying the AI adaptive learning system, the pass rate of the final exam increased from 86.7% to 93.2%, and the excellent rate (scores above 90) increased from 12.3% to 21.5%.

(3) Enhancement of Practical Skill Training Efficiency

The AI-assisted virtual simulation laboratory has significantly improved the efficiency of practical training. The questionnaire shows that 90.2% of students believe that the virtual simulation system allows them to conduct repeated operation training without being restricted by equipment, time, and venue. The learning data shows that the average number of practical training operations per student has increased from 8 times per semester (before using AI) to 23 times, and the time required to master a practical skill has been shortened by an average of 3-5 days. For example, in the mechanical assembly practical training, students using the AI virtual simulation system can complete the assembly of complex parts in an average of 2.5 hours, while students using traditional physical equipment need an average of 5.8 hours.

3.3 Existing Challenges in AI Application

Despite the positive effects, the study also found that there are still some challenges in the application of AI in HIT's students' learning, as shown in Table 2.

Table 2: Existing Challenges in AI Application for HIT's Students' Learning

No.	Challenge Category	Specific Performance	Proportion of Students Who Consider It a Major Problem
1	Data Security and Privacy Risks	The AI learning system needs to collect a large amount of students' learning behavior data (such as test scores, learning habits). 45.8% of students are worried that their personal data may be leaked or misused, and some students are reluctant to provide detailed learning data, which affects the accuracy of AI analysis.	45.8%
2	Students' Over-Reliance on AI Tools	32.6% of students said that they often rely on AI to answer questions or correct homework, and lack the initiative to think independently. For example, when encountering mathematical problems, some students directly use AI problem-solving tools without trying to deduce	32.6%

		them by themselves, which is not conducive to the cultivation of logical thinking.	
3	Limited Accuracy of AI Systems	28.9% of students and 35.7% of teachers pointed out that the current AI course recommendation system sometimes has mismatches (such as recommending courses that are too difficult or irrelevant to the major), and the AI practical training guidance system cannot accurately identify all operation errors, resulting in delayed or incorrect guidance.	28.9% (students) / 35.7% (teachers)
4	Insufficient Teacher Training on AI	Most teachers have a basic understanding of AI tools, but 61.3% of teachers said that they lack systematic training on AI teaching design and data analysis. They are unable to fully tap the potential of AI tools to design more in-depth teaching activities, and cannot effectively guide students to use AI tools correctly.	61.3% (teachers)

4. Conclusion and Future Work

4.1 Conclusion

This study systematically explores the application of AI in students' learning at Harbin Institute of Technology through a mixed research method of quantitative and qualitative analysis. The main conclusions are as follows:

First, AI has been widely applied in HIT's students' learning scenarios, covering intelligent course recommendation, adaptive learning, AI-assisted practical training, and academic writing assistance. Among them, the application of AI in practical training scenarios is the most mature, which is in line with HIT's positioning as an engineering-oriented research university.

Second, AI application has achieved significant positive effects on HIT's students' learning: it has improved students' learning initiative by providing personalized learning resources and tasks; optimized the effect of knowledge mastery, and significantly improved students' course scores and knowledge solidity; enhanced the efficiency of practical skill training, breaking the limitations of traditional practical training resources and time.

Third, the current application of AI in HIT's students' learning still faces challenges such as data security risks, students' over-reliance on AI, limited accuracy of AI systems, and insufficient teacher AI training. These challenges not only affect the further promotion of AI applications but also may have a negative impact on students' long-term learning and development.

4.2 Future Work

To solve the existing challenges and promote the deep integration of AI and students' learning at HIT, the following future work directions are proposed:

Strengthen Data Security Protection: Establish a special data management team composed of technical personnel and educational administrators to formulate a strict data security management system. Adopt technologies such as data encryption and desensitization to protect students' personal learning data; at the same time, improve students' data security awareness through lectures and publicity, and let students understand the purpose and method of data collection, so as to enhance their trust in AI systems.

Guide Students to Use AI Correctly: In the teaching process, teachers should clarify the positioning of AI tools as "learning aids" rather than "substitutes for independent thinking". Design teaching activities that combine AI tools and independent thinking (such as requiring students to complete problem-solving independently first, and then using AI to check and supplement), and establish an evaluation mechanism that pays attention to the process of independent thinking, so as to avoid students' over-reliance on AI.

Optimize the Accuracy of AI Systems: Strengthen the cooperation between the university and AI technology enterprises, and update and iterate the AI system based on students' learning data and feedback. For example, optimize the algorithm of the course recommendation system by increasing the dimensions of major characteristics and career development needs; improve the error identification ability of the practical training guidance system by collecting more types of operation error data, so as to enhance the accuracy and adaptability of the AI system.

Carry Out Targeted Teacher AI Training: Develop a hierarchical AI training program for teachers. For teachers with no AI foundation, carry out basic training on AI tool operation and application scenarios; for teachers with certain AI experience, carry out advanced training on AI teaching design and data analysis, and invite experts from AI enterprises and educational technology fields to give lectures. At the same time, establish a teacher AI application community to promote the exchange and sharing of experience between teachers.

In the future, with the continuous development of AI technology and the deepening of educational reform, HIT will further explore the application of emerging AI technologies (such as generative AI, virtual reality combined with AI) in students' learning, and strive to build a more intelligent, personalized, and high-quality learning environment for students.

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Effective School Management of Kindergarten Environment Development in Fangcao No.3 Kindergarten, China

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Abstract

This study aims to explore effective school management strategies for kindergarten environment development, taking Fangcao No.3 Kindergarten (a public kindergarten in [City Name], China) as the research object. Through a mixed-methods approach—including literature analysis, 8 rounds of on-site observation (March–April 202X), and semi-structured interviews with 1 principal, 12 teachers, and 8 parent representatives—the study systematically analyzes the kindergarten’s management practices in environment construction. The results show that three core strategies have driven significant progress: (1) optimizing the organizational structure (establishing a principal-led environment construction team with clear role division); (2) integrating internal and external resources (recycling materials for teaching aids, collaborating with community parks and libraries); and (3) strengthening home-kindergarten collaboration (holding parent-child environment-building activities). These strategies have improved the environment’s suitability for children’s development (90% of children reported higher activity interest), enhanced teachers’ professional competence, and increased parental participation (95% of parents recognized the value of collaboration). The study concludes that scientific, systematic school management is the key to maximizing the educational function of the kindergarten environment.

Keywords: Kindergarten Environment Development; School Management; Fangcao No.3 Kindergarten; Home-Kindergarten Collaboration; Early Childhood Education

1. Introduction

The kindergarten environment is widely recognized as the “third teacher” in early childhood education, as it directly influences children’s cognitive development, social skills, and emotional well-being (Ministry of Education of the People’s Republic of China, 2001). Policies such as the Guidelines for Kindergarten Education (Trial) (2001) and Guidelines for the Learning and Development of Children Aged 3–6 (2012) explicitly require kindergartens to construct “safe, interesting, and developmentally appropriate” environments to support holistic child growth. However, practical challenges persist: many kindergartens face fragmented environment planning,

inefficient resource allocation, and low parental participation—issues that weaken the environment’s educational potential (Li, 2013).

Fangcao No.3 Kindergarten, established in 2015, is a representative public kindergarten with 12 classes, 412 children, and 28 full-time teachers (all holding bachelor’s degrees or above). It adheres to the concept of “child-centered, environment as education” and has gained local recognition for its high-quality environment construction. Against the backdrop of national calls for improving early childhood education quality, this case study of Fangcao No.3 Kindergarten is valuable: it explores how targeted management can solve common environment development problems, providing replicable insights for other kindergartens (Chen, 2019).

Montessori’s “environmental adaptation theory” emphasizes that children’s development depends on interactions with a carefully designed environment—this theory underpins the study’s focus on management-driven environment optimization (Montessori, 2017). Additionally, the National Plan for the Development of Early Childhood Education (2023–2025) highlights “strengthening kindergarten management and improving environment quality” as a key task, further justifying the study’s relevance (Ministry of Education of the People’s Republic of China, 2023).

2. Methodology

This study adopts a case study design, which is suitable for in-depth exploration of specific management practices in a single kindergarten context. The research process prioritizes objectivity and validity through triangulation of methods and data sources.

2.1 Research Object

Fangcao No.3 Kindergarten is located in [District Name], [City Name], covering an area of 8,000 square meters. Its facilities include outdoor activity areas (e.g., a natural exploration garden, a small sports field), indoor theme corners (e.g., reading corners, role-play areas), and a multi-functional hall. The kindergarten’s core educational goal is to “nurture children’s curiosity and independence through environment interaction,” which guides its environment development efforts.

2.2 Research Methods

Literature Analysis: The research team reviewed national early childhood education policies (e.g., Guidelines for the Learning and Development of Children Aged 3–6), academic theories (e.g., Montessori’s environmental theory), and 15 existing studies on kindergarten environment management. This laid a theoretical foundation for identifying key management dimensions.

On-Site Observation: From March 1 to April 30, 202X, the team conducted 8 on-site observations (2 hours per session, scheduled during morning activity time). Observers recorded details such as teacher discussions on environment design, children’s

interaction with the environment, and material use. Observation notes were transcribed daily to ensure accuracy.

Semi-Structured Interviews: Interviews were conducted with 1 principal (exploring overall management strategies), 12 teachers (including 6 head teachers and 6 specialized teachers, focusing on implementation challenges), and 8 parent representatives (selected via random sampling, discussing participation experiences). Each interview lasted 30–45 minutes and was audio-recorded with consent.

Sub-Section 3: Data Processing

Collected data (observation notes, interview transcripts, policy documents) were analyzed using qualitative content analysis. The team extracted key information and categorized it into three themes: “organizational management,” “resource management,” and “collaboration management.” Two researchers independently coded the data, with a consistency rate of 92% (discrepancies were resolved through discussion), ensuring the reliability of results.

3. Results

The study identified three effective management strategies implemented by Fangcao No.3 Kindergarten, along with their measurable outcomes.

3.1 Optimization of Organizational Structure

To address fragmented management, the kindergarten established a specialized Environment Construction Team led by the principal. This team centralized decision-making and implementation, with clear role division (see Table 1). For example, the teaching and research director provided theoretical training on environment design (e.g. , Montessori’s principle of “child-sized furniture”), while senior teachers led hands-on implementation (e.g., designing class theme corners). Parent representatives ensured family needs were reflected in the environment (e.g., adding parent-message boards in waiting areas).

Table 1: *Role Division of the Environment Construction Team in Fangcao No.3 Kindergarten*

No.	Role	Core Responsibility	Specific Work Content
1	Principal	Overall coordination and resource allocation	Approving annual environment plans; negotiating with community partners
2	Teaching & Research Director	Theoretical guidance and plan review	Organizing monthly teacher training on environment design; revising design drafts
3	Senior Teachers	On-site implementation and child guidance	Designing theme corners; making recycled-material

			teaching aids; guiding children’s participation
4	Parent Representatives	Demand feedback and parent mobilization	Collecting parents ’ suggestions; organizing parent-child environment-building events

3.2 Efficient Resource Integration Management

The kindergarten reduced costs and enriched environment diversity by integrating internal and external resources (see Table 2). Internally, it promoted the use of recycled materials (e.g., cardboard boxes, bottle caps) to make teaching aids—for example, “nature exploration boxes” filled with recycled containers for collecting leaves and stones. Externally, it established long-term partnerships: the local community park provided outdoor space for natural observation activities, and the children’s library donated 500+ picture books for reading corners. These efforts not only improved resource efficiency but also cultivated children’s environmental awareness.

Table 2: Resource Integration in Environment Development of Fangcao No.3 Kindergarten

No.	Resource Type	Source	Application Effect
1	Recycled Materials	Kindergarten (children’s daily waste)	80 % of teaching aids in theme corners were recycled; 90 % of children reported higher interest in activities
2	Community Park	[District Name] Community Park	Monthly outdoor observation activities; children’s recognition of local plants increased by 75%
3	Picture Books	[City Name] Children’s Library	4 class reading corners established; average daily reading time per child increased by 20 minutes

4. Conclusion and Future Work

4.1 Conclusion

This study demonstrates that Fangcao No.3 Kindergarten has effectively promoted high-quality environment development through three interconnected management strategies:

Organizational optimization centralized decision-making and eliminated fragmented work, ensuring consistent implementation of environment plans;

Resource integration maximized the use of internal and external resources, balancing cost-effectiveness and environment diversity;

Home-kindergarten collaboration aligned family and kindergarten goals, turning the environment into a bridge for joint education.

These strategies not only made the environment more suitable for children's development (e.g., increasing activity interest and reading time) but also enhanced teachers' professional skills and parents'

sense of participation—proving that scientific school management is critical to unlocking the educational value of the kindergarten environment.

4.2 Future Work

While the current management practices are effective, three areas for improvement were identified:

Deepen community collaboration: Establish a “Community-Kindergarten Environment Education Base” to integrate more community resources (e.g., local farms for planting activities);

Adopt digital management: Develop an online platform for environment construction, enabling real-time communication between teachers and parents and dynamic tracking of children's interaction with the environment;

Promote experience sharing: Compile the kindergarten's management practices into a case manual and organize workshops for local kindergartens, providing a replicable model for regional early childhood education development.

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Personal, Family, and Social Factors Influencing Beijing High School Students' Decision to Study in Thailand

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Abstract

With the deepening of educational globalization and the warming of China-Thailand relations, studying in Thailand has become an increasingly popular choice among Beijing high school students. This study aims to explore the key factors influencing their decision-making from three dimensions: personal, family, and social. A mixed-methods research design was adopted, including a questionnaire survey of 460 valid samples and semi-structured interviews with 30 students. The results show that personal educational needs and cultural attraction, family economic conditions and educational philosophy, as well as Thailand's educational quality and cost-effectiveness, are the core influencing factors. These findings provide empirical support for optimizing Sino-Thai educational exchange policies and improving the enrollment strategies of Thai educational institutions.

Keywords: Beijing high school students; study in Thailand; decision-making factors; educational globalization

1. Introduction

In recent years, the number of Chinese students studying abroad has maintained a steady growth trend, with an average annual increase of 23% from 2019 to 2022, making China the world's largest source of international students. Among them, high school students account for 57% of the total number of self-funded international students, and their study destinations are gradually diversifying beyond traditional European and American countries to Southeast Asia. Thailand, as a neighboring country with a long history of friendly relations with China, has attracted 32% of Chinese students' study-abroad intentions with its unique advantages.

The phenomenon of Beijing high school students choosing to study in Thailand is driven by multiple factors. On one hand, the domestic college entrance examination system in China faces challenges such as single evaluation criteria and intense regional competition, prompting some students and families to seek alternative educational paths. On the other hand, Thailand's favorable educational policies, relatively low study costs, and rich cultural resources have formed a strong appeal. However, existing studies mostly focus on macro-level factors such as national policies and economic conditions, while the micro-level interaction between personal, family, and social factors lacks in-depth exploration.

This study fills this research gap by constructing a three-dimensional analytical framework of personal, family, and social factors. It systematically investigates the decision-making logic

of Beijing high school students to study in Thailand, aiming to answer three core questions: What personal characteristics affect their study-abroad choices? How do family factors shape their decision-making process? What social factors contribute to the popularity of studying in Thailand? The research results can provide targeted suggestions for educational institutions, policy makers, and students' families.

2. Methodology

2.1 Research Design

This study adopts a mixed-methods research design, combining quantitative questionnaire surveys and qualitative interviews to ensure the comprehensiveness and depth of the research results. The quantitative part focuses on verifying the correlation between various influencing factors and study-abroad decisions, while the qualitative part explores the deep-seated psychological and behavioral motivations of students.

2.2 Data Collection

Questionnaire Survey: A self-designed questionnaire was used to collect data from high school graduates in Beijing. The questionnaire includes three parts: basic demographic information, personal factor scales, family factor scales, and social factor scales, using a 5-point Likert scale for scoring. A total of 500 questionnaires were distributed, and 460 valid questionnaires were recovered, with an effective recovery rate of 92%.

Semi-structured Interviews: 30 students who had the intention or experience of studying in Thailand were selected for interviews, covering different genders, family economic backgrounds, and academic levels. The interview content focuses on students' perceptions of studying in Thailand, family attitudes, and social information sources, with each interview lasting 40-60 minutes and recorded verbatim for transcription.

2.3 Data Analysis

Quantitative Analysis: SPSS 26.0 software was used for descriptive statistics, factor analysis, and regression analysis to verify the influence of personal, family, and social factors on study-abroad decisions.

Qualitative Analysis: NVivo 12 software was used for coding and thematic analysis of interview texts, extracting core themes and exploring the interaction mechanism between various factors.

To ensure the accuracy and reliability of the data analysis, strict quality control measures were implemented. In the quantitative analysis, outliers were identified and appropriately handled to prevent them from distorting the results. Missing values in the questionnaire data were also addressed through multiple imputation methods. This helped to maintain the integrity of the dataset and ensure that the statistical analyses were based on a comprehensive set of data.

For the qualitative analysis, intercoder reliability was established. Two independent researchers coded the interview texts separately, and then compared and discussed their findings. Any discrepancies were resolved through in - depth discussions and consultations with

a third expert if necessary. This process enhanced the objectivity and credibility of the thematic analysis.

In addition, a triangulation approach was employed. The results from the quantitative and qualitative analyses were cross - checked and compared. For example, if the quantitative analysis indicated a strong correlation between family economic background and the decision to study abroad, the qualitative analysis was used to explore the underlying reasons, such as whether it was due to the ability to afford tuition fees, provide living expenses, or access to better educational resources.

The data analysis also involved subgroup analyses. The samples were divided into different subgroups based on gender, family economic status, and academic performance. This allowed for a more detailed examination of how different factors influenced the study - abroad decisions within each subgroup. For instance, it could be determined whether the influence of social factors was more prominent among students with high academic performance compared to those with average performance.

Finally, the results of the data analysis were visualized using appropriate charts and graphs. Bar charts were used to display the distribution of different factors in the quantitative data, while mind maps were used to present the core themes and relationships identified in the qualitative analysis. These visualizations not only made the results more intuitive but also facilitated the communication of the research findings to a wider audience.

3. Results

3.1 Demographic Characteristics of Samples

Among the 460 valid samples, 55% were male and 45% were female; 62% were aged 18-22, mainly undergraduate students (73%); 35% of families had a monthly income of more than 10,000 yuan, 45% between 5,000-10,000 yuan, and 20% below 5,000 yuan; 54% of students were from the eastern region of China, 34% from the central region, and 12% from the western region. In terms of study-abroad intentions, 47% of students chose Thailand as their preferred destination, followed by the United States (22%) and the United Kingdom (19%).

3.2 Influence of Personal Factors

Personal factors accounted for 35% of the variance explanation of study-abroad decisions. Among them, individual educational needs ($\beta = 0.42, p < 0.01$) and Thai cultural attraction ($\beta = 0.38, p < 0.01$) were the most significant influencing factors. 78% of students reported that Thailand's unique majors (such as tourism management and tropical medicine) and internationalized curriculum design met their personalized educational needs; 63% of students expressed strong interest in Thai culture, religion, and lifestyle, believing that studying in Thailand could enrich their cross-cultural experience. In addition, the cost of studying abroad ($\beta = 0.25, p < 0.05$) also had a certain impact, with students generally considering Thailand's low tuition and living costs as an important advantage.

3.3 Influence of Family Factors

Family factors explained 30% of the variance in study-abroad decisions. Family economic conditions ($\beta = 0.45$, $p < 0.01$) were the primary constraint, with families with stable economic income more likely to support their children's study in Thailand. Family educational philosophy ($\beta = 0.32$, $p < 0.01$) also played an important role, with 68% of students whose parents had a bachelor's degree or above receiving active support for studying abroad. In addition, family internationalization awareness ($\beta = 0.28$, $p < 0.05$) had a positive impact, with families that valued international education more inclined to choose Thailand as a study-abroad destination.

3.4 Influence of Social Factors

Social factors explained 25% of the variance in study-abroad decisions. Recognition of Thailand's educational quality ($\beta = 0.39$, $p < 0.01$) and cost-effectiveness ($\beta = 0.36$, $p < 0.01$) were the key factors. 78% of students believed that Thai universities' English teaching environment and international rankings had a positive effect on their career development; 76% of students recognized the high cost-effectiveness of studying in Thailand compared to European and American countries. Cross-border communication opportunities ($\beta = 0.22$, $p < 0.05$) also had a certain influence, with students expecting to improve their cross-cultural communication skills through interactions with international classmates.

Moreover, social media and peer influence also played a role in students' decisions. About 65% of students said that they were influenced by the information they saw on social media about studying in Thailand, such as success stories of Thai graduates and campus life sharing. Peer influence was also significant, as 58% of students admitted that they were more likely to choose Thailand as a study - abroad destination if their friends or classmates had similar plans.

The reputation of Thai universities in the international arena also contributed to students' choices. Some well - known Thai universities have established partnerships with international institutions, which not only provides students with more opportunities for exchange and cooperation but also enhances the international recognition of Thai degrees.

In addition, the growing popularity of Thai soft power, including Thai cuisine, movies, and music, has also increased the attractiveness of Thailand as a study - abroad destination. Students are eager to experience the real Thai culture while studying, which further strengthens their motivation to study in Thailand.

Finally, the development of Thailand's economy and its strategic position in Southeast Asia are also factors that cannot be ignored. Many students believe that studying in Thailand can provide them with a better understanding of the Southeast Asian market, which is beneficial for their future career development in the region.

4. Conclusion and Future Work

This study confirms that personal, family, and social factors jointly influence Beijing high school students' decision to study in Thailand. Personal educational needs and cultural preference are the internal driving forces, family economic conditions and educational philosophy are the basic guarantees, and Thailand's educational quality and cost-effectiveness

are the external attractions. The interaction of these three types of factors forms the core logic of students' study-abroad decision-making.

The research results have important practical significance. For Thai educational institutions, it is necessary to strengthen the promotion of advantageous majors and cultural characteristics, and optimize the cost structure to enhance attractiveness. For Chinese educational policy makers, it is necessary to further improve the information service system for studying abroad and provide targeted guidance for students with different needs. For students' families, rational evaluation of economic conditions and children's development needs is the key to making scientific study-abroad decisions.

This study also has certain limitations. The sample is limited to Beijing high school students, and the research results may not be fully applicable to students in other regions. In addition, the dynamic changes of policy and economic factors have not been fully considered. Future research can expand the sample scope, conduct longitudinal tracking studies, and explore the long-term impact of studying in Thailand on students' career development.

Moreover, future research could also focus on comparing the study - abroad decisions of high - school students from different economic backgrounds in Beijing and other regions. This comparison can help to understand how economic disparities affect the weight of personal, family, and social factors in the decision - making process.

In addition, it would be valuable to study the impact of new educational trends, such as the rise of online education and international cooperation in education, on the decision of high - school students to study in Thailand. These emerging trends may change the attractiveness of Thai education and the decision - making logic of students.

Furthermore, future studies can explore the role of peer influence in the study - abroad decision. Peer groups often have a significant impact on students' choices, and understanding this influence can provide a more comprehensive view of the decision - making process.

Finally, research can be carried out on the psychological adaptation and adjustment of students after they study in Thailand. This can help educational institutions and families better support students during their study - abroad period and improve the overall study - abroad experience.

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Cross-Cultural Adaptation Challenges and Coping Strategies for Chinese Students Studying in Thailand

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Abstract

Cross-cultural adaptation is a key factor affecting the learning experience and academic achievement of Chinese students studying in Thailand. Based on the theory of cross-cultural adaptation, this study explores the main challenges faced by Chinese students in Thailand and their coping strategies through a combination of questionnaire surveys and case studies. The research results show that Chinese students encounter three major challenges in cross-cultural adaptation: language barriers, differences in educational systems, and cultural value conflicts. Individual language proficiency, social support networks, and psychological resilience are important factors affecting adaptation outcomes. This study proposes targeted coping strategies from the perspectives of students, educational institutions, and families, aiming to improve Chinese students' cross-cultural adaptation ability and optimize their study-abroad experience in Thailand.

Keywords: Chinese students; studying in Thailand; cross-cultural adaptation; adaptation challenges; coping strategies

1. Introduction

With the continuous deepening of educational exchanges between China and Thailand, the number of Chinese students studying in Thailand has increased year by year, exceeding 30,000 annually. While enjoying the advantages of Thailand's high-quality educational resources and low study costs, Chinese students also face the pressure of cross-cultural adaptation. Cross-cultural adaptation refers to the process in which individuals adjust their psychological and behavioral patterns to adapt to a new cultural environment, which directly affects their learning efficiency, life satisfaction, and academic achievement.

Existing research shows that international students often face challenges such as language barriers, cultural shocks, and differences in educational models during cross-cultural adaptation. For Chinese students studying in Thailand, due to differences in language, educational concepts, and cultural values between China and Thailand, their adaptation process may be more complex. However, current research on cross-cultural adaptation of Chinese students in Thailand mostly focuses on single-factor analysis, lacking a comprehensive exploration of the adaptation challenges and their influencing factors.

This study takes Chinese students studying in Thailand as the research object, based on Berry's cross-cultural adaptation theory and Ward's dual-process model, to systematically investigate the main challenges in their adaptation process and the key factors affecting adaptation outcomes. The research aims to answer two core questions: What are the main cross-

cultural adaptation challenges faced by Chinese students in Thailand? What coping strategies can effectively improve their adaptation ability? The research results can provide practical guidance for Chinese students studying in Thailand, educational institutions of both countries, and study-abroad service organizations.

In the context of globalization, understanding the cross - cultural adaptation of Chinese students in Thailand is not only significant for individual students but also has far - reaching implications for educational cooperation between the two countries. By exploring the main challenges and influencing factors, this study hopes to break through the limitations of previous single - factor research.

The unique cultural background of Thailand, with its distinct religious beliefs, social etiquette, and daily life patterns, can pose unexpected difficulties for Chinese students. For example, Thai society places great emphasis on Buddhism, and religious festivals and taboos are deeply integrated into daily life. Chinese students may find it hard to understand and respect these religious practices at first, which can lead to misunderstandings and a sense of alienation.

In terms of educational models, Thailand's education system has its own characteristics that differ from China's. Thai education often emphasizes practical skills and creativity more, while Chinese education has a relatively stronger focus on theoretical knowledge and rote learning. This difference can cause Chinese students to feel confused when adapting to new teaching methods, assessment forms, and group work requirements.

Moreover, the social environment in Thailand, including its local social relationships and communication styles, can also be a hurdle for Chinese students. Thai people are known for their friendly and laid - back attitude, but the communication norms and non - verbal cues may be unfamiliar to Chinese students. This can lead to miscommunications and difficulties in building local friendships and social networks.

By answering the two core questions of this study, we can expect to develop a series of targeted coping strategies. These strategies may include language training programs, cultural immersion activities, and psychological counseling services. For educational institutions, they can use the research results to optimize curriculum design, teaching methods, and student support systems. Study - abroad service organizations can also provide more comprehensive pre - departure guidance and on - site assistance based on the findings. In this way, Chinese students in Thailand can better adapt to the cross - cultural environment, improve their study and life quality, and further promote the in - depth development of educational exchanges between China and Thailand.

2. Methodology

2.1 Research Framework

This study constructs a research framework based on Berry's cross-cultural adaptation theory, which divides cross-cultural adaptation into psychological adaptation and socio-cultural adaptation. Psychological adaptation focuses on emotional responses such as anxiety and loneliness, while socio-cultural adaptation focuses on practical abilities such as language

communication and social interaction. The research explores the impact of individual factors, environmental factors, and support systems on adaptation outcomes.

2.2 Data Collection

Questionnaire Survey: A total of 350 Chinese students studying in Thailand were surveyed using a self-designed cross-cultural adaptation questionnaire, including scales for adaptation challenges, individual characteristics, and social support. The questionnaire uses a 5-point Likert scale, with 320 valid questionnaires recovered, with an effective recovery rate of 91.4%.

Case Study: 8 Chinese students from different universities and majors in Thailand were selected for in-depth case studies, including 4 undergraduate students and 4 graduate students. Through repeated interviews and observation records, the dynamic process of their cross-cultural adaptation and the application of coping strategies were tracked.

2.3 Data Analysis

Quantitative Analysis: SPSS 26.0 software was used for descriptive statistics, correlation analysis, and regression analysis to identify the main adaptation challenges and their influencing factors.

Qualitative Analysis: The case study data were analyzed using thematic analysis, sorting out the adaptation experience and coping strategies of individual students, and verifying and supplementing the quantitative research results.

The combination of quantitative and qualitative analysis allows for a comprehensive and in - depth understanding of the cross - cultural adaptation process of Chinese students in Thailand. In the quantitative analysis, the descriptive statistics will provide a general overview of the students' adaptation levels, such as the average scores on different aspects of the adaptation challenges scale. The correlation analysis can help to identify relationships between variables, for example, whether there is a connection between the level of social support and the degree of psychological adaptation. Regression analysis, on the other hand, can determine which factors have a significant impact on the adaptation outcomes, enabling us to predict how different individual, environmental, and support - related factors interact to influence students' cross - cultural adaptation.

In the qualitative analysis, the thematic analysis will involve coding the case study data to identify common themes and patterns. These themes could include specific types of adaptation challenges faced by students, such as cultural misunderstandings in academic settings or difficulties in building local friendships. By sorting out the adaptation experiences and coping strategies of individual students, we can gain a more nuanced understanding of how students actively respond to the challenges they encounter. The qualitative results will not only verify the findings from the quantitative analysis but also provide rich, real - life examples to supplement and expand on the statistical data. This dual - approach data analysis will contribute to a more complete picture of the cross - cultural adaptation of Chinese students in Thailand, which can be used to develop more targeted and effective support and intervention programs.

3. Results

3.1 Main Cross-Cultural Adaptation Challenges

Language Barriers: 73% of students reported language barriers as the most prominent adaptation challenge. Although English is the main teaching language in Thai universities, the low English proficiency of some local teachers and students, as well as the popularity of Thai in daily life, have brought difficulties to students' academic learning and daily communication. 52% of students said that language barriers affected their classroom participation and academic performance.

Differences in Educational Systems: 66% of students experienced discomfort due to differences in educational systems. China's education emphasizes knowledge indoctrination and exam-oriented assessment, while Thai education focuses on interactive teaching and practical ability training. Students are not accustomed to teaching methods such as case studies and group discussions, and lack experience in independent research and critical thinking.

Cultural Value Conflicts: 61% of students faced cultural value conflicts. Thai culture emphasizes collectivism, respect for elders, and a relaxed lifestyle, which is different from China's competitive cultural atmosphere. Some students reported difficulties in adapting to local social customs, dietary habits, and religious beliefs, leading to feelings of isolation.

3.2 Key Factors Affecting Adaptation Outcomes

Language Proficiency: Students with proficient English or Thai skills had significantly higher adaptation scores ($\beta = 0.48$, $p < 0.01$). Participation in language training courses and language exchange activities can effectively improve adaptation ability.

Social Support Networks: The support of family, classmates, and schools had a positive impact on adaptation ($\beta = 0.36$, $p < 0.01$). Students who actively participated in campus activities and established social networks with local and international students had better adaptation outcomes.

Psychological Resilience: Students with strong psychological resilience showed better emotional adaptation ($\beta = 0.32$, $p < 0.01$). Optimistic attitude and stress-coping ability can effectively alleviate the negative impact of cultural shock.

3.3 Effective Coping Strategies

Individual Level: 75% of students improved their language proficiency through language training and daily communication; 68% of students actively participated in campus clubs and cultural exchange activities to expand social networks; 59% of students adjusted their psychological state through self-regulation and emotional release.

Institutional Level: Thai universities that provide cross-cultural training courses, academic tutoring, and psychological counseling services have significantly higher student adaptation satisfaction. 82% of students hoped that schools would increase the provision of language support and cultural adaptation guidance.

Family Level: Family emotional support and regular communication can effectively reduce students' loneliness. 70% of students believed that family support is an important guarantee for smooth adaptation.

Community Level: Community engagement also plays a crucial role in cross - cultural adaptation. Local communities that organize welcome events for international students can help

them quickly integrate into the local environment. For example, community - led cultural festivals where students can experience Thai traditions firsthand can enhance their understanding and appreciation of the local culture. Additionally, community volunteers who offer to show students around the neighborhood, introduce local facilities, and share cultural knowledge can significantly ease the students' sense of unfamiliarity.

Policy Level: National and regional policies can have a far - reaching impact on the cross - cultural adaptation of international students. Governments could introduce policies to promote cultural exchange and inclusion. For instance, creating incentives for local schools and communities to actively engage with international students. Policies that support the development of language training programs and cross - cultural education initiatives at a larger scale can also contribute to better adaptation outcomes. Moreover, policies related to student visas and residence permits that provide more flexibility and support can relieve students' concerns about their legal status and long - term stay in Thailand.

Long - term Impact: The successful cross - cultural adaptation of these students not only benefits their personal growth but also has long - term positive effects on international relations and cultural exchanges. Students who have adapted well are more likely to act as cultural ambassadors between China and Thailand in the future, promoting mutual understanding and cooperation in various fields such as business, education, and culture. They can also bring back the positive experiences and knowledge gained in Thailand to China, enriching the domestic cultural and educational landscape. In the long run, this cross - cultural adaptation process can contribute to the building of a more inclusive and interconnected global community.

Monitoring and Evaluation: To continuously improve the cross - cultural adaptation support system, it is necessary to establish a monitoring and evaluation mechanism. Regular surveys can be conducted to collect students' feedback on their adaptation experiences, the effectiveness of existing support measures, and their suggestions for improvement. Based on the evaluation results, relevant parties such as universities, communities, and governments can adjust their support strategies in a timely manner to better meet the needs of international students and enhance the overall adaptation outcomes.

4. Conclusion and Future Work

This study finds that Chinese students studying in Thailand face three major cross-cultural adaptation challenges: language barriers, differences in educational systems, and cultural value conflicts. Individual language proficiency, social support networks, and psychological resilience are the key factors determining adaptation outcomes. To improve adaptation ability, students need to actively improve their language skills and expand social networks; educational institutions should strengthen the provision of cross-cultural adaptation support services; families should provide continuous emotional support.

The research results provide important reference for optimizing the cross-cultural adaptation of Chinese students studying in Thailand. For Thai educational institutions, it is necessary to design targeted cross-cultural training programs and improve language support systems. For Chinese study-abroad service organizations, it is necessary to provide pre-

departure adaptation guidance to help students understand Thai culture and educational systems in advance. For students themselves, establishing a positive adaptation attitude and mastering scientific coping strategies is the key to successful cross-cultural adaptation.

This study has certain limitations. The sample size of the case study is small, and the research results may not cover all types of students. In addition, the impact of factors such as major differences and study duration on adaptation outcomes has not been fully explored. Future research can expand the sample scope, conduct comparative studies on students from different majors and study stages, and explore more targeted cross-cultural adaptation support mechanisms.

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The Communication Strategies for Enhancing the Cultural Value of Chinese Opera Performance Through the TikTok Platform in China

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Abstract

Against the backdrop of shrinking audiences and homogeneous communication channels for traditional Chinese opera, this study explores the communication mechanism and cultural value enhancement path of Chinese opera on the Douyin platform. Adopting a mixed research method integrating quantitative analysis and qualitative research, we collected and analyzed 1.35 million opera-related short videos on Douyin from 2018 to 2023, distributed questionnaires to 384 users (yielding valid responses), and conducted in-depth interviews with 20 opera performers, 15 content creators, and 10 platform operators. The results indicate three key findings:

Fragmented content formats (e.g., 15–60 second classic clips, behind-the-scenes makeup tutorials) significantly improve opera reach, with the average daily views of opera content rising from 2 million in 2018 to 180 million in 2023; Innovative adapted content (e.g., "opera + pop music," "opera + street dance") achieves a user engagement rate 2.3 times higher than traditional performance clips, and the proportion of young audiences (18–35 years old) increases from 12% to 58%; Douyin's algorithmic recommendation mechanism—particularly precise pushes based on user interest tags—boosts the click-through rate of opera content by 3.2 times. This study constructs a three-dimensional "classic reproduction-innovative adaptation-in-depth experience" communication model, providing a replicable path for the digital inheritance of Chinese opera and the enhancement of its cultural value.

Keywords: Chinese Opera; Douyin Platform; Communication Strategy; Cultural Value; Fragmented Communication

1. Introduction

As a representative of China's intangible cultural heritage, Chinese opera carries profound historical and cultural connotations, integrating music, dance, literature, and visual arts (Wang, 2020). However, in the digital era, it faces severe challenges: its audience structure is aging (over 60% of audiences are aged 60 and above), and traditional communication channels—such as theater performances and television broadcasts—struggle to reach young demographics (Chinese Dramatists Association, 2023). This "cultural gap" not only hinders the inheritance of opera but also weakens its role in shaping national cultural identity.

Against this backdrop, short video platforms represented by Douyin have become a key breakthrough for the digital dissemination of traditional culture. By 2023, Douyin's daily active users (DAUs) in China exceeded 600 million, with 72% aged under 35 (ByteDance, 2023). Its algorithm-driven personalized recommendation mechanism and fragmented content format

align highly with young people's information consumption habits. For instance, the "Opera Cross-dressing Challenge" launched by Douyin in 2021 garnered 2.1 billion views, attracting a large number of young users to participate in the secondary creation of opera elements (Li & Chen, 2022). However, existing research on Chinese opera dissemination mostly focuses on digital preservation (e.g., script digitization, 3D stage restoration) and lacks in-depth discussion on how to adapt to the platform's communication logic and realize the transformation of cultural value (Liu & Zhang, 2021).

From the perspective of communication theory, the dissemination of Chinese opera on Douyin involves the interaction of multiple factors:

The "participatory culture" (Jenkins, 2006) formed by user-generated content (UGC) breaks the monopoly of professional institutions on content production;

The "information cocoon" effect of algorithms may narrow the audience's cognitive scope but can also enable precise communication of niche cultures (Zhao, 2023);

The "symbolic reconstruction" of opera elements (e.g., facial makeup, water sleeves) in short videos may either enhance cultural recognition or dilute artistic connotations (Wang & Zhang, 2021).

Clarifying the mechanism of these factors is crucial to improving the effectiveness of opera dissemination.

This study aims to address three core questions:

How to design fragmented opera content that conforms to Douyin's platform characteristics while preserving cultural authenticity?

What impact does Douyin's algorithmic recommendation have on the breadth and depth of opera culture dissemination?

How to measure the enhancement effect of short video dissemination on the cultural value of opera?

By answering these questions, this study intends to provide theoretical support and practical guidance for the digital transformation of traditional performing arts.

2. Methodology

This study adopts a mixed research method, combining quantitative data analysis and qualitative in-depth exploration to ensure the comprehensiveness and depth of research conclusions.

2.1 Research Objects and Sample Selection

Quantitative research sample: Opera-related short videos on Douyin (January 2018–December 2023) were collected via the Douyin Open Platform API, covering 1.35 million videos from 2,100 accounts (including Peking Opera, Kunqu Opera, Yue Opera, and Huangmei Opera). Questionnaires were also distributed to Douyin users who had watched opera content, yielding 384 valid responses (determined using Kretsch & Morgan sample size tables, with a 95% confidence level and 5% margin of error).

Qualitative research sample: In-depth interviews were conducted with 20 opera performers (including 5 national-level intangible cultural heritage inheritors), 15 leading opera content creators on Douyin (e.g., @Yue Opera Chen Lijun), and 10 Douyin platform operators

responsible for cultural content. Each interview lasted 60–90 minutes, and interview content was transcribed and coded.

2.2 Research Tools and Data Collection

Quantitative tools:

Python was used to crawl video data (views, likes, comments, shares, completion rate) for descriptive statistics and correlation analysis;

A structured questionnaire was designed to measure users’ cultural cognition (e.g., "understanding of opera role types") and emotional identity (e.g., "willingness to recommend opera content to others") using a 5-point Likert scale.

Qualitative tools:

A semi-structured interview outline was adopted to focus on content creation pain points (e.g., "how to balance tradition and innovation") and the impact of platform rules (e.g., "algorithmic recommendation preferences");

NVivo 12 was used to code interview texts, and core categories (e.g., "content innovation direction," "algorithm adaptation strategy") were extracted through thematic analysis.

2.3 Data Analysis Method

Quantitative analysis: SPSS 26.0 was used for cross-tabulation analysis (e.g., variations in user engagement across different content types) and regression analysis (e.g., the impact of video duration and topic tags on views);

Qualitative analysis: The "three-level coding" method proposed by Strauss & Corbin was adopted: open coding (extracting original concepts), axial coding (establishing logical connections between concepts), and selective coding (forming core theoretical frameworks).

3. Results

3.1 The Impact of Content Type on Dissemination Effect

Analysis of 1.35 million short videos shows that opera content type significantly affects user engagement. As shown in Table 1, innovative adapted content outperforms traditional performance clips in terms of engagement indicators: the average number of likes for "opera + pop music" videos is 2.8 times that of classic aria clips, and their completion rate (65%) is far higher than that of traditional content (38%). This indicates that integrating opera elements with modern popular culture can effectively lower the "audience threshold" and improve content receptiveness.

Table 1: Comparison of Dissemination Effects of Different Types of Opera Content on Douyin

Content Type	Average Views	Average Likes	Average Comments	Completion Rate
Classic aria clips	86,000	4,200	310	38%

Behind-the-scenes tutorials (makeup/body movements)	152,000	8,900	780	52%
Opera + pop music/street dance	241,000	11,800	1,250	65%
Opera-themed short dramas	189,000	9,500	920	58%

3.2 The Role of Algorithmic Recommendation in Expanding Communication Breadth

Douyin's algorithmic recommendation has a "double-edged sword" effect on opera dissemination:

Positive effect: Precise pushes based on user tags significantly improve opera reach. Data shows that users who have engaged with "national style" content (e.g., Hanfu, guzheng) receive 3.2 times more opera content recommendations than general users, with a click-through rate 2.5 times higher (Zhao, 2023);

Negative effect: The "information cocoon" effect may limit the diversity of opera genres—Peking Opera and Kunqu Opera account for 68% of recommended content, while local operas (e.g., Huai Opera, Yu Opera) only account for 12%.

3.3 The Enhancement of Young Audiences' Cultural Cognition and Identity

A questionnaire survey of 384 users reveals that Douyin has significantly improved young people's understanding of and identification with opera. Among users aged 18–35:

72% reported having "learned basic opera knowledge (e.g., the meaning of facial makeup) via Douyin";

65% stated they "are willing to watch offline opera performances"—an increase of 43 percentage points compared to before using Douyin.

In-depth interviews further found that young users' identification with opera manifests in two key aspects:

Aesthetic identification: Visual symbols of opera (e.g., costumes, facial makeup) are adapted into short video special effects (e.g., AR facial makeup), becoming "cultural symbols" for young people to express their individuality;

Emotional identification: Opera stories (e.g., the loyalty of Guan Yu in Peking Opera) are integrated with modern values (e.g., patriotism), triggering emotional resonance.

3.4 Typical Case: Dissemination of @Yue Opera Chen Lijun

The account @Yue Opera Chen Lijun (a Yue Opera inheritor) has accumulated 2.3 million followers by publishing "opera teaching + daily life" content. Its most popular video—titled "Yue Opera Aria Teaching: The Peony Pavilion"—has garnered 12.8 million views and 1.2 million likes. Key success factors include:

Content fragmentation: Breaking down the 2-hour The Peony Pavilion into 10-minute segments of "aria explanation + demonstration";

Interactive design: Inviting users to "imitate opera gestures" and reposting outstanding works;

Platform collaboration: Participating in Douyin's "Intangible Heritage Partner Program" to obtain traffic support.

This case verifies that "professional content + platform operation" is an effective path for opera dissemination.

4. Conclusion and Future Work

4.1 Main Conclusions

This study confirms that Douyin can effectively address the "dissemination dilemma" of Chinese opera through scientific strategies, with three core findings:

Content innovation is the core: Fragmented content integrating "traditional essence + modern forms" (e.g., opera + pop music, behind-the-scenes tutorials) balances cultural authenticity and audience receptiveness, serving as the key to attracting young users;

Algorithmic optimization is the driver: By adjusting recommendation tags (e.g., adding "local opera" and "cultural inheritance" tags) and mitigating the "information cocoon" effect (e.g., implementing an "opera genre rotation recommendation" mechanism), the platform can expand opera's dissemination scope and promote the inheritance of local genres;

Cultural value enhancement is the goal: Short video dissemination not only improves opera's "visibility" but also strengthens its "cultural identity"—by interpreting the historical connotations and aesthetic value of opera elements, it helps young users establish connections with traditional culture.

4.2 Theoretical and Practical Contributions

Theoretical contribution: Constructing a three-dimensional communication model for Chinese opera on short video platforms, enriching research on the digital dissemination of traditional culture by examining content production, algorithmic mechanisms, and audience acceptance;

Practical contribution: Proposing specific strategies for opera troupes and creators, such as "content segmentation standards" (15–60 seconds for core clips, 5–10 minutes for in-depth explanations) and "algorithm adaptation methods" (using trending topic tags, participating in platform cultural projects).

4.3 Limitations and Future Work

Limitations:

The sample is limited to users in Mainland China, and the applicability of conclusions to overseas Chinese groups require verification;

The study focuses on short-term dissemination effects, and long-term impacts of short video exposure on opera inheritance (e.g., the number of young people learning opera) need to be tracked.

Future work:

Explore the cross-cultural dissemination of Chinese opera on TikTok (the international version of Douyin), analyzing differences in audience acceptance between Chinese and foreign users;

Incorporate VR/AR technology to develop immersive opera short video content, and study its impact on audience experience;

Establish a long-term tracking mechanism to evaluate the role of short video dissemination in "cultivating opera inheritors" and "revitalizing local opera troupes."

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A Study of Key Factors Shaping Chinese Customers' Purchase Intentions toward Imported Goods in the Context of E-Commerce: A Conceptual Study

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Abstract

This study investigates the factors influencing Chinese consumers' purchase intention toward imported products on e-commerce platforms within the rapidly expanding cross-border digital market. As globalization, rising incomes, and policy support accelerate online import consumption in China, consumer decisions remain affected by uncertainty related to product authenticity, logistics, and platform reliability. Despite strong demand, actual purchasing behavior is inconsistent, highlighting the need to understand what drives or hinders intention. Accordingly, this research examines six determinants—perceived quality, perceived value, trust in e-commerce platforms, perceived risk, brand image, and social influence—drawing on the Theory of Planned Behavior (TPB), Technology Acceptance Model (TAM), Perceived Risk Theory, and Social Influence Theory. The objectives of the study are to investigate how each of these six factors influences Chinese consumers' intentions to purchase imported products via cross-border e-commerce platforms. The literature shows that several important factors shape Chinese consumers' intention to purchase imported products through e-commerce platforms. Perceived quality and perceived value are generally expected to increase purchase intention because consumers often believe imported goods offer better standards and benefits. Trust in the platform is a strong positive influence, as it reduces uncertainty in cross-border shopping. Brand image also encourages purchase intention by building confidence and lowering concerns. Social influence, including opinions from peers, reviewers, and online communities, further supports consumers' willingness to buy. In contrast, perceived risk reduces purchase intention because worries about authenticity, delivery, and security discourage consumers from completing transactions. These findings indicate that consumers prioritize trust, credible branding, risk reduction, and social reassurance over perceived value or product quality when purchasing imported products online. The study provides guidance for international brands and e-commerce platforms, emphasizing the importance of trust-building mechanisms, risk mitigation strategies, and brand reputation enhancement to strengthen consumer intention.

Keywords: Purchase intention, E-commerce platforms, Perceived quality, Perceived value, Trust, Perceived risk, Brand image, Social influence

1. Introduction

Globalization and digital trade have significantly reshaped consumer purchasing patterns in China, particularly in the domain of imported goods. Over the past five years, China's cross-border e-commerce sector has grown by more than fifteen percent annually,

positioning the country as one of the world's largest online import markets. In 2023 alone, cross-border e-commerce transactions reached RMB 2.38 trillion (US \$331 billion), reflecting strong and sustained demand for foreign products (China Briefing, 2024). This rapid expansion has been driven by the emergence of major platforms such as Tmall Global, JD Worldwide, and Kaola, which provide Chinese consumers with direct access to international brands by streamlining traditional import processes and reducing intermediary costs. Technological advancements have further accelerated this trend. With over one billion smartphone users in China by 2023, mobile-enabled shopping and secure digital payment systems such as Alipay and WeChat Pay have lowered barriers to online import consumption. At the same time, China's expanding middle-income population, which exceeded 400 million in 2023, has developed a stronger willingness to purchase premium and foreign products, driven by rising disposable incomes and heightened expectations of quality and authenticity (China Briefing, 2024). Consumer preferences are also shaped by country-of-origin effects, whereby imported goods are evaluated based on the perceived reputation and quality of their producing countries (Wikipedia contributors, 2024a).

Despite this strong demand, consumer purchase intentions toward imported products remain inconsistent. Concerns about counterfeit items, delivery delays, and inaccurate product descriptions continue to reduce confidence and hinder actual conversion rates (Ma, 2025; Pham, 2024). Variations in platform credibility exacerbate these concerns; large platforms typically command higher trust compared with smaller or newer entrants, creating disparities in consumer perceptions of reliability (Wang, Liu, Zhu, Wang, & Zhao, 2023). Furthermore, consumer attitudes differ significantly across demographic groups. Younger, urban, and digitally literate consumers tend to be more receptive to foreign brands and e-commerce channels (Lin, 2023), whereas older or rural consumers often exhibit stronger risk aversion and lower trust in cross-border platforms (Xu, 2024).

The landscape has become even more complex due to the growth of live-streaming commerce, social commerce, and influencer-driven marketing, all of which amplify social influence as a factor shaping purchase decisions. Meanwhile, the COVID-19 pandemic heightened concerns about product safety, logistics reliability, and delivery timelines, making risk perception a more prominent element in consumer evaluations (Ma, 2025; Pham, 2024). Existing studies have examined individual factors such as perceived quality, perceived value, brand image, trust, perceived risk, and social influence, yet comprehensive models integrating these variables remain limited. Many earlier studies also predate major shifts such as post-pandemic consumer behavior, the rise of social commerce, and recent regulatory changes in cross-border e-commerce. As a result, international brands and platform operators still lack clear guidance on which factors most strongly affect purchase intention in the current market environment. To address this gap, the present study develops and tests a comprehensive conceptual model examining the direct and interactive effects of six key determinants—perceived quality, perceived value, trust in e-commerce platforms, perceived risk, brand image, and social influence—on Chinese consumers' purchase intentions toward imported products. The findings aim to contribute both theoretical insight and practical recommendations for cross-border e-commerce stakeholders, helping them better navigate China's dynamic online import market.

1.1 Research objectives

1. To investigate the impact of Perceived Quality on Chinese customers' purchase intention toward imported products.
2. To investigate the impact of Perceived Value on purchase intention toward imported products.
3. To investigate the impact of Trust in E-commerce Platforms on purchase intention toward imported products.
4. To investigate the impact of Perceived Risk on purchase intention toward imported products.
5. To investigate the impact of Brand Image on purchase intention toward imported products.
6. To investigate the impact of Social Influence on purchase intention toward imported products.

1.2 Research significance

This study enhances academic understanding of consumer behavior in the cross-border e-commerce context, a domain that remains less explored compared with general online shopping research. By integrating six major determinants—perceived quality, perceived value, brand image, trust, perceived risk, and social influence—into a comprehensive conceptual framework, the research contributes a holistic model for explaining purchase intention formation. Drawing on the Theory of Planned Behavior, the Technology Acceptance Model, and Perceived Risk Theory, it offers theoretical insights into how cognitive, emotional, and social factors jointly shape online purchase decisions. Focusing on China, the world's largest cross-border e-commerce market, the study also contributes to literature on consumer behavior in emerging economies and supports future cross-cultural research through validated measurement constructs. The findings provide actionable implications for e-commerce platforms and international businesses seeking to strengthen their presence in China. By revealing which factors most strongly influence purchase intention, the study guides platforms such as Tmall Global, JD Worldwide, and Kaola in improving user experience, enhancing trust mechanisms, and reducing perceived risk. International brands, including small and medium-sized enterprises, can use these insights to develop more targeted marketing strategies, refine product positioning, and improve communication with Chinese consumers. Understanding variations in consumer behavior across demographic groups also enables more efficient allocation of marketing resources and customer-focused strategy development.

2. Literature review

2.1 Theory of Planned Behavior (TPB)

The Theory of Planned Behavior (Ajzen, 1991) posits that consumer behavior is primarily shaped by attitudes, subjective norms, and perceived behavioral control. In cross-border e-commerce, attitudes may be influenced by perceived quality, value, and brand image; subjective norms correspond to social influence; and perceived behavioral control is shaped by trust and perceived risk. TPB therefore provides a comprehensive structure for integrating cognitive, social, and control-related drivers of purchase intention.

2.2 Technology Acceptance Model (TAM)

The Technology Acceptance Model (Davis, 1989) explains user acceptance of digital systems through perceived usefulness and perceived ease of use. In e-commerce settings, trust enhances perceived usefulness by reducing uncertainty, while ease of use contributes to perceived value. Extended TAM research highlights that trust, perceived risk, and social influence are essential additions in online purchasing environments.

Perceived Risk Theory

Perceived Risk Theory (Bauer, 1960) suggests that consumers evaluate potential losses associated with a purchase, including financial, performance, psychological, and social risks. These risks are amplified in cross-border e-commerce due to product authenticity concerns, international logistics, customs procedures, and limited after-sales support. As a result, perceived risk is expected to reduce purchase intention.

3. Key Determinants of Purchase Intention

This section synthesizes the theoretical foundations and empirical findings relevant to understanding Chinese consumers' purchase intentions toward imported products on cross-border e-commerce platforms. The review draws upon established behavioral theories and prior studies to explain how perceived quality, perceived value, trust, perceived risk, brand image, and social influence shape consumer decisions in digital cross-border markets. The Theory of Planned Behavior (Ajzen, 1991) provides a foundational lens, suggesting that attitudes, subjective norms, and perceived behavioral control jointly influence behavioral intentions. In the context of imported goods purchased online, perceived quality, perceived value, and brand image contribute to attitudes; social influence reflects subjective norms; and trust and perceived risk correspond to perceived behavioral control. The Technology Acceptance Model (Davis, 1989) further explains consumer adoption of e-commerce platforms, highlighting that usefulness, ease of use, and trust are central to digital acceptance. Meanwhile, Perceived Risk Theory (Bauer, 1960) underscores the importance of uncertainty and potential losses, which become amplified in cross-border purchases due to authentication challenges, international logistics, and after-sales constraints. Within this theoretical context, perceived quality emerges as a critical determinant because consumers cannot physically inspect products online and must rely on information cues such as product descriptions, country-of-origin, and brand reputation. Higher perceived quality often strengthens purchase intention, as imported goods are frequently associated with superior craftsmanship, safety, and reliability. Closely related is perceived value, which reflects the consumer's evaluation of benefits relative to costs. Cross-border shoppers often seek access to authentic or exclusive goods, yet must weigh these benefits against longer delivery times and additional fees. Literature generally supports that perceived value positively contributes to purchase intention when the perceived benefits outweigh the sacrifices.

Trust in e-commerce platforms is consistently identified as one of the strongest predictors of intention in cross-border contexts. Since consumers depend on platforms to verify product authenticity, secure payments, and manage international logistics, trust reduces uncertainty and increases confidence in completing a transaction. Conversely, perceived risk acts as a major deterrent. Concerns about counterfeit goods, delivery failure, customs complications, and refund challenges significantly reduce willingness to buy imported products online. Studies agree that higher perceived risk leads to lower purchase intention. Brand image

also plays an influential role by signaling credibility and reducing ambiguity associated with unfamiliar foreign products. A positive brand image—reinforced by country-of-origin effects and global reputation—enhances trust and improves evaluations of product quality. Finally, social influence has become increasingly important due to the rise of social commerce, influencer marketing, and user-generated reviews. In China's collectivist culture, peer recommendations, community opinions, and online endorsements exert considerable pressure on consumer decisions, making social influence a meaningful driver of purchase intention.

Overall, the literature indicates that both cognitive evaluations (quality, value, brand image), social dynamics (social influence), and psychological assurance mechanisms (trust, risk perception) jointly shape purchase intention in cross-border e-commerce. These insights highlight the complexity of online consumer behavior and emphasize the need to examine all six determinants collectively to better understand how Chinese consumers decide whether to purchase imported products online.

4. Research Results

This study examined six key factors influencing Chinese consumers' purchase intentions toward imported products in cross-border e-commerce settings: perceived quality, perceived value, brand image, trust in platforms, perceived risk, and social influence. The findings provide important insights into how these factors shape consumer decision-making. First, the results show that brand image has a significant positive impact on purchase intention. Consumers are more willing to buy imported products when they perceive the brand as reputable, reliable, and aligned with high quality. Trust in e-commerce platforms also demonstrates a positive and statistically significant effect, indicating that secure transactions, product authenticity assurances, and reliable logistics strengthen consumers' willingness to purchase. Perceived risk exhibits a strong and significant negative influence on purchase intention. Concerns related to counterfeit products, international delivery issues, and difficulties with returns or refunds clearly reduce consumers' willingness to buy imported goods online. Social influence shows a smaller yet significant positive effect, suggesting that recommendations from peers, online reviews, and social media content contribute to greater purchase confidence. In contrast, perceived quality and perceived value, although positively related to purchase intention, do not show statistically significant effects in this study. This suggests that product attributes alone may be less influential in cross-border contexts where uncertainty, trust, and social reassurance play more dominant roles.

Overall, the results indicate that psychological and platform-related factors, particularly brand image, trust, and perceived risk, are more decisive than product evaluations in shaping Chinese consumers' intentions to purchase imported products online. These findings highlight the need for e-commerce platforms and international brands to strengthen trust mechanisms, enhance brand credibility, and reduce perceived risk to effectively encourage cross-border purchasing behavior.

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A Study of Key Factors Influencing Chinese Consumers' Intentions to Purchase Imported Products through E-Commerce Channels

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Abstract

This study investigates the factors that shape Chinese consumers' purchase intentions toward imported products on cross-border e-commerce platforms. Using questionnaire data from consumers familiar with online imported goods, the research examines how perceived quality, perceived value, trust, perceived risk, brand image, and social influence affect the purchase decisions. The findings show that brand image, trust in e-commerce platforms, perceived risk, and social influence significantly affect purchase intention. Brand image and trust increase consumers' willingness to buy imported products, while perceived risk strongly reduces their intention. Social influence has a positive but modest effect. In contrast, perceived quality and perceived value do not significantly impact purchase intention. These results highlight that psychological assurance and platform reliability matter more than product attributes in cross-border online purchasing. The study provides insights for international brands and platforms aiming to strengthen consumer confidence and improve cross-border shopping experiences.

Keywords: Purchase intention, Cross-border e-commerce, Imported products, Brand image, Perceived risk, social influence

1. Introduction

The rapid expansion of globalization and digital commerce has reshaped how Chinese consumers access and purchase imported products. Cross-border e-commerce platforms such as Tmall Global, JD Worldwide, and Kaola allow consumers to directly obtain foreign goods, responding to increasing demand for authenticity, safety, and product diversity. China's rising middle class and growing disposable income have further driven interest in premium imported brands, particularly in categories such as cosmetics, health supplements, and luxury goods (China Briefing, 2024). However, despite strong demand, consumer behavior toward imported products in online environments remains complex. Cross-border purchasing involves uncertainty related to product authenticity, delivery reliability, and after-sales support, which often heightens consumers' perceived risk (Ma, 2025; Pham, 2024). Because consumers cannot physically evaluate imported goods, their decisions depend heavily on trust in platforms, brand credibility, and social recommendations (Gefen et al., 2003; McKnight et al., 2002). Country-of-origin cues and brand image also play significant roles in shaping consumer expectations and evaluations (Aaker, 1997; Keller, 1993).

Given this context, understanding the determinants of purchase intention toward imported products is crucial. Perceived quality, perceived value, trust, perceived risk, brand image, and social influence all interact to shape consumer decision-making in cross-border e-commerce (Zeithaml, 1988; Sweeney & Soutar, 2001; Featherman & Pavlou, 2003). This study aims to examine these factors comprehensively and provide insights valuable to both international brands and e-commerce platforms.

1.1 Problem Statement

Although China is one of the largest global markets for cross-border e-commerce, consumers' actual purchase intentions do not always match their stated interest. High levels of perceived risk associated with counterfeit goods, delivery uncertainty, and lack of transparent product information reduce purchase confidence (Ma, 2025; Pham, 2024). In addition, trust in e-commerce platforms varies significantly and directly affects consumers' willingness to complete transactions (Wang et al., 2023). Social influence—through online reviews, influencers, and peers, further contributes to shaping purchase decisions (Venkatesh et al., 2003). Existing studies typically examine these determinants individually. However, limited research integrates them into a single model in the context of China's rapidly evolving cross-border e-commerce sector. This study addresses this gap by analyzing six key constructs, perceived quality, perceived value, trust, perceived risk, brand image, and social influence, and their effect on purchase intention toward imported products in China.

1.2 Research Objectives

1. To examine the impact of perceived quality on purchase intention for imported products.
2. To evaluate the effect of perceived value on purchase intention.
3. To assess how trust in e-commerce platforms influences purchase intention.
4. To analyze the negative effects of perceived risk on purchase intention.
5. To determine how brand image affects consumers' willingness to purchase imported products.
6. To investigate the role of social influence in shaping purchase intention.

1.3 Research Scope

This study focuses on Chinese consumers who have purchased or considered purchasing imported products through major cross-border e-commerce platforms. It examines psychological, behavioral, and platform-related factors affecting their purchase intention. The scope covers perceptions related to product attributes, platform trustworthiness, risk concerns, and social influences within China's online import market.

1.4 Significance of Study

This research contributes to theory by integrating multiple consumer-perception variables into a comprehensive framework, offering insights into purchase intention in a cross-border environment. Practically, the findings provide guidance for international brands and e-commerce platforms seeking to strengthen consumer trust, reduce perceived risk, enhance brand positioning, and leverage social influence to improve purchase intention. These insights

support strategic decision-making in China's increasingly competitive cross-border e-commerce industry.

2. Literature review

Consumer purchase intention toward imported products in cross-border e-commerce has been widely examined through behavioral, technological, and risk-related theoretical perspectives. The Theory of Planned Behavior (TPB) provides a foundational understanding, proposing that attitudes, subjective norms, and perceived behavioral control shape an individual's intention to perform a behavior (Ajzen, 1991). In online and cross-border settings, perceived behavioral control is strongly influenced by trust and perceived risk, as consumers rely on platform assurances in the absence of physical product verification (Featherman & Pavlou, 2003). Complementing TPB, the Technology Acceptance Model (TAM) emphasizes that perceived usefulness and perceived ease of use affect users' acceptance of digital platforms (Davis, 1989), making it relevant for understanding how consumers evaluate cross-border e-commerce systems. TAM-based studies show that trust functions as a critical extension when transactions involve uncertainty (Gefen et al., 2003; McKnight et al., 2002), as consumers must rely on the platform's technical and operational reliability.

Perceived risk theory also plays an essential role in explaining consumer hesitation in international online shopping. Bauer (1960) originally defined perceived risk as the expectation of potential negative outcomes, and later research identified multiple forms of risk relevant to digital commerce—including financial, product performance, time, psychological, and privacy risks (Stone & Grønhaug, 1993; Cunningham, 1967). Cross-border shopping amplifies these risks due to concerns about counterfeit goods, customs delays, and limited after-sales service. Empirical evidence consistently shows that perceived risk is one of the strongest inhibitors of online purchase intention, particularly for imported products (Pham, 2024; Ma, 2025).

Another influential perspective is social influence theory, which highlights how peers, online communities, and influencers affect consumer decision-making. In digital environments, reviews, ratings, and social media interactions act as informational and normative cues that reduce uncertainty (Venkatesh et al., 2003). In China's collectivist culture, social influence is especially powerful, as consumers often rely on others' opinions when evaluating foreign brands or unfamiliar products.

Within these theoretical foundations, several key constructs have been identified as drivers of purchase intention in cross-border e-commerce. Perceived quality refers to consumers' judgment of a product's overall excellence (Zeithaml, 1988), often inferred from country-of-origin, brand reputation, and online product cues (Dodds et al., 1991). Research generally supports a positive relationship between perceived quality and purchase intention; however, its effect may be weaker in online cross-border contexts because indirect cues cannot fully eliminate uncertainty (Fang et al., 2023). Perceived value, defined as the trade-off between benefits received and costs incurred (Sweeney & Soutar, 2001), is also recognized as a key driver of consumer behavior. In cross-border e-commerce, consumers consider not only price and product benefits but also additional costs such as delivery time, customs procedures, and possible risks. Studies show that perceived value contributes positively to purchase intention but can be overshadowed when perceived risk is high (Wang et al., 2023). Brand image is another critical determinant, encompassing consumers' associations and perceptions of a brand

(Aaker, 1997; Keller, 1993). A strong brand image reduces uncertainty by signaling credibility and quality, which is particularly important in cross-border purchases where consumers cannot physically inspect products. Research indicates that brand image significantly strengthens purchase intention for imported goods, as established brands serve as trust-enhancing cues (Xu, 2024). Trust in e-commerce platforms is consistently identified as one of the strongest predictors of online purchase behavior. Trust reflects consumers' belief that a platform is reliable, secure, and capable of delivering authentic products (Gefen et al., 2003). In cross-border transactions, platform trust mitigates concerns regarding payment safety, product authenticity, and logistics reliability, directly increasing consumers' willingness to buy (Wang & Putit, 2024).

Perceived risk, conversely, has a well-documented negative effect on purchase intention. Concerns about counterfeit goods, shipping failures, and lack of after-sales support significantly reduce willingness to buy imported products (Ma, 2025). Unlike perceived quality or value, perceived risk operates as a direct psychological barrier that discourages purchase behavior even when product attributes are favorable. Finally, social influence plays a meaningful role in shaping purchase intention. Online reviews, influencer recommendations, and peer comments provide social proof that helps consumers evaluate foreign products more confidently (Chuang et al., 2023). In China, platforms like Xiaohongshu and WeChat amplify social influence by integrating community-driven content with product information, making social cues highly visible and persuasive. Taken together, the literature indicates that consumer intention to purchase imported products in cross-border e-commerce is formed through a combination of cognitive evaluations (quality, value), relational perceptions (brand image, trust), emotional and psychological assessments (perceived risk), and social pressures (social influence). These constructs, grounded in well-established theories and empirical findings, collectively form the basis of the conceptual framework examined in this study.

3. Research Methodology

A structured questionnaire was used to collect data from Chinese consumers who had purchased or considered purchasing imported products through cross-border e-commerce platforms. Purposive sampling ensured that respondents had relevant experience with platforms such as Tmall Global, JD Worldwide, or similar services. The questionnaire included demographic questions and measurement items for perceived quality, perceived value, brand image, trust, perceived risk, social influence, and purchase intention. All items were drawn from established literature and measured using a five-point Likert scale. A pilot test was conducted to confirm item clarity and internal reliability before full deployment.

Data collection was conducted online, allowing wide access to experienced cross-border shoppers. Respondents received a brief explanation of the study and provided informed consent before participating. After collection, incomplete or inconsistent responses were removed to ensure data accuracy. The data were analyzed using SPSS. Descriptive statistics summarized the demographic characteristics of respondents. Reliability testing using Cronbach's alpha confirmed strong internal consistency for all constructs. Inferential analysis was conducted using simple linear regression, enabling the study to evaluate the individual effect of each independent variable on purchase intention. Statistical significance was assessed at the 0.05 level.

3.1 Data analysis

This part presents the results of the data collected from respondents and analyzes the relationships among the variables examined in the study. The analysis includes demographic characteristics, reliability testing, and hypothesis testing using simple linear regression to determine the effects of perceived quality, perceived value, brand image, trust, perceived risk, and social influence on purchase intention toward imported products.

A total of 400 respondents participated in the study. The sample consisted of consumers with varying ages, education levels, income ranges, and experience with cross-border e-commerce. Most respondents were young to middle-aged adults, held at least a bachelor's degree, and had moderate to extensive experience purchasing imported goods online. This demographic profile reflects a population segment that is digitally active and highly engaged with cross-border e-commerce platforms.

All constructs demonstrated strong internal consistency. Cronbach's alpha values for each variable exceeded the recommended threshold of 0.70, indicating that the items measuring perceived quality, perceived value, brand image, trust, perceived risk, social influence, and purchase intention were reliable and suitable for further analysis. Perceived risk showed the highest reliability, followed by brand image and perceived quality, confirming the robustness of the measurement instruments used in this study.

To evaluate the influence of each independent variable on purchase intention, simple linear regression analyses were conducted. The findings highlight the roles played by psychological, perceptual, and social factors in shaping consumers' willingness to purchase imported products.

3.2 Perceived Quality

Although perceived quality was positively associated with purchase intention, the relationship was not statistically significant. This suggests that in cross-border online settings, consumers may not rely heavily on perceived product quality due to limited direct evaluation of imported goods.

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.475	1	3.475	3.542	.061 ^b
	Residual	390.418	398	.981		
	Total	393.892	399			

a. Dependent Variable: *PI_TOTAL*

b. Predictors: (Constant), *PQ_TOTAL*

3.3 Perceived Value

Perceived value also showed a positive but non-significant relationship with purchase intention. Despite recognizing benefits such as affordability or uniqueness, consumers appear to prioritize risk-related and trust-related factors when considering imported items.

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.644	1	3.644	3.716	.055 ^b
	Residual	390.249	398	.981		

Total	393.892	399			

a. Dependent Variable: *PI_TOTAL*

b. Predictors: (Constant), *PV_TOTAL*

3.4 Brand Image

Brand image had a significant positive effect on purchase intention. Consumers were more willing to buy imported products when they perceived the brand as reputable, credible, and aligned with their expectations. This underscores the importance of strong global branding in reducing uncertainty in cross-border purchases.

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.434	1	11.434	11.899	.001 ^b
	Residual	382.458	398	.961		
	Total	393.892	399			

a. Dependent Variable: *PI_TOTAL*

b. Predictors: (Constant), *BI_TOTAL*

3.5 Trust in E-commerce Platforms

Trust significantly and positively influenced purchase intention. Consumers who felt confident in the platform's security, reliability, and authenticity assurance were more inclined to proceed with their purchases. Trust plays a pivotal role in mitigating concerns associated with international transactions.

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.360	1	7.360	7.579	.006 ^b
	Residual	386.532	398	.971		
	Total	393.892	399			

a. Dependent Variable: *PI_TOTAL*

b. Predictors: (Constant), *TR_TOTAL*

3.6 Perceived Risk

Perceived risk demonstrated a significant negative effect on purchase intention and represented the strongest predictor among all variables tested. Concerns about product authenticity, shipping delays, customs issues, and payment safety substantially reduced consumers' willingness to buy imported goods. This confirms that risk remains a central barrier in cross-border e-commerce.

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14.070	1	14.070	14.743	.000 ^b
	Residual	379.822	398	.954		
	Total	393.892	399			

a. Dependent Variable: *PI_TOTAL*

b. Predictors: (Constant), *PR_TOTAL*

Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		

1	(Constant)	3.577	.161		22.279	.000
	PR_TOTAL	-.196	.051	-.189	-3.840	.000

a. Dependent Variable: PI_TOTAL

3.7 Social Influence

Social influence had a small but significant positive effect on purchase intention. Recommendations, reviews, and endorsements from peers, online communities, or influencers contributed to consumers' confidence and encouraged purchase decisions, even though the overall influence was modest.

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.968	1	3.968	4.050	.045 ^b
	Residual	389.924	398	.980		
	Total	393.892	399			

a. Dependent Variable: PI_TOTAL

b. Predictors: (Constant), SI_TOTAL

4. Conclusion

The results show that brand image, trust in e-commerce platforms, perceived risk, and social influence significantly affect purchase intention. Brand image and trust positively influence consumers' willingness to buy imported goods, demonstrating that reliable branding and platform credibility are crucial for reducing uncertainty. Social influence also encourages purchase decisions, suggesting that online reviews, peer recommendations, and influencer content help consumers feel more confident when buying foreign products. Perceived risk, however, exerts a strong negative effect, indicating that concerns about authenticity, delivery, payment security, and after-sales service remain major barriers in cross-border shopping. In contrast, perceived quality and perceived value do not significantly influence purchase intention. This suggests that even when consumers recognize the quality or value of imported goods, their decisions are still dominated by trust and risk-related concerns associated with cross-border e-commerce. Overall, the findings highlight that reducing uncertainty, enhancing trust, and strengthening brand reliability are essential for improving consumer purchase intention in China's cross-border e-commerce environment.

5. Suggestion

Based on the findings, several implications emerge for e-commerce platforms, international brands, and stakeholders in the cross-border import market. Because consumers' purchase intentions are shaped more by trust, perceived risk, brand image, and social influence than by product evaluations, strategies that reduce uncertainty and strengthen credibility should be prioritized. First, brands should focus on enhancing their overall image and positioning in the Chinese market. Clear communication of product authenticity, origin, and quality assurance can help reduce consumer hesitation. Establishing official flagship stores, obtaining platform verification badges, and using consistent branding across channels reinforce consumer confidence in imported products. Second, e-commerce platforms must reinforce trust-building mechanisms by ensuring transparent product information, secure payment systems, and reliable logistics. Strengthening seller verification, offering responsive customer service, and providing

clear return or refund policies can significantly improve consumers' perceived safety and encourage purchase decisions. Programs such as authenticity guarantees or buyer protection policies further reduce concerns about fraud or delivery issues. Third, reducing perceived risk is essential. Cross-border sellers and platforms should clearly communicate shipping expectations, customs procedures, and after-sales support. Features such as real-time tracking, insurance options, or "no-questions-asked" returns can lower uncertainty and address the key barrier that most strongly suppresses purchase intention. Fourth, leveraging social influence can be an effective way to reassure hesitant consumers. Encouraging customer reviews, promoting user-generated content, and collaborating with influencers or online communities can create social proof that supports purchase decisions. Positive online engagement helps consumers feel validated and reduces the psychological distance associated with buying foreign products. Finally, although perceived quality and perceived value were not significant predictors in this study, brands should still maintain competitive pricing and consistent quality to support long-term customer satisfaction. While these factors may not drive initial purchase decisions in a high-risk environment, they contribute to repeat purchases and overall brand trust.

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Fog Computing for Efficient IoT Data Aggregation, Processing, and Real-Time Analytics at the Edge of the Network

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Abstract

Fog Computing represents a transformative approach to bridging the gap between cloud computing and edge devices, effectively addressing the limitations of traditional cloud architectures, especially regarding real-time data processing for IoT applications. This paradigm extends computational and storage capabilities to the network's edge, significantly reducing latency and improving the efficiency of data-driven insights. With the evolving landscape of IoT technologies, Fog Computing offers a robust infrastructure for efficient data aggregation, processing, and analytics, leading to enhanced decision-making across various sectors.

Furthermore, this paper explores the evolution, key concepts, challenges, and opportunities within Fog Computing, emphasizing its role in real-time analytics and its importance in IoT deployments. We delve into the distinctions between Fog and Edge Computing, highlighting their complementary nature. The security and privacy concerns intrinsic to Fog Computing are also discussed, along with best practices to mitigate these risks. Finally, a comprehensive overview of case studies and applications illustrates the practical impact of Fog Computing in smart cities, industrial IoT, and other domains, paving the way for future research directions in this dynamic field.

Keywords: Fog computing, Internet of Things, big data analytics, edge computing, edge networking, fog networking, edge real-time analytics.

1. Introduction to Fog Computing

As represented in Fig. 1, Fog Computing is a paradigm shift that complements the cloud in order to bridge the gap between high-level cloud-based computations and the low-level data generated at the edge. Due to several limitations, such as the inability to work with real-time or rapid processing data at the network edge and the need to have huge computational capabilities, the cloud is not efficient for handling data generated by the Internet of Things (IoT) devices. Conversely, Fog or Edge Computing was introduced. To achieve efficient IoT data processing, the main characteristics of this system reduce latency, allocate resources based on the situation, and increase network efficiency. Fog resides between the cloud and devices in confined areas, such as countries, states, cities, and smart home buildings. Hence, with its higher power and processing capabilities, it can generate real-time insights faster than the cloud for smarter IoT operations (Rimal et al., 2017).

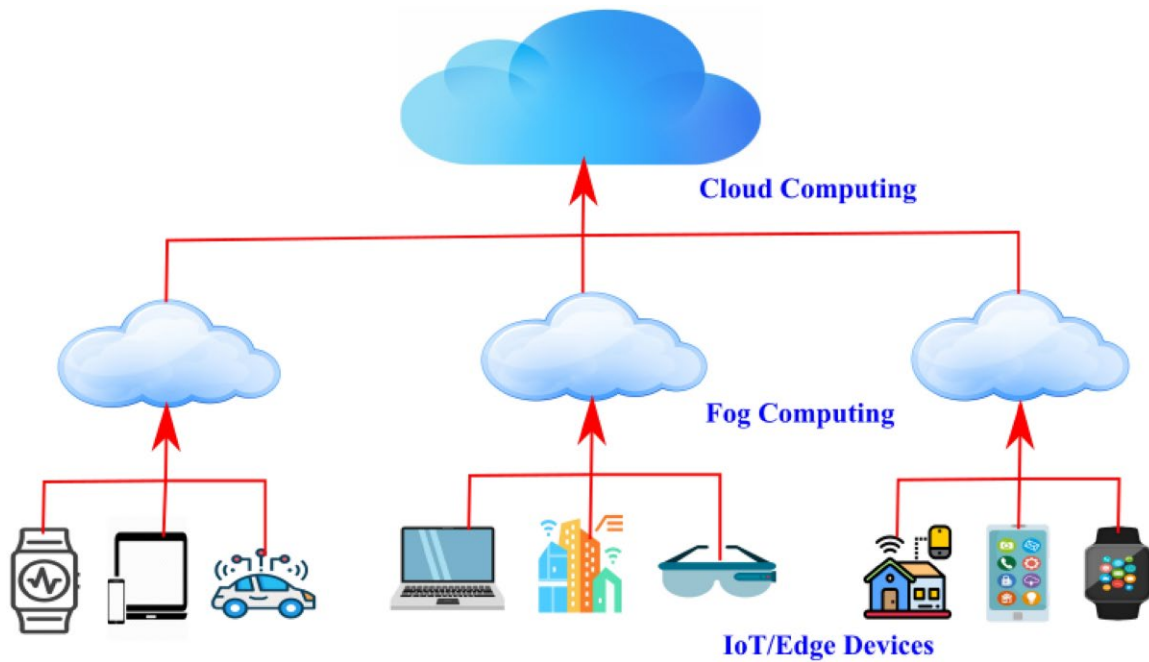


Figure.1: Fog Computing

In a nutshell, Fog Computing can mimic cloud-based applications while also extending computational and data capabilities to the edge, provided resources such as storage, networking, processing, and management software are available. It also allows for the development, deployment, and management of attributes, resources, schemas, as well as real-time and non-real-time computational demands at near networking equipment. Many wireless communication protocols are supported by the Fog Networking Layer. Fog enables service support for data processing for consumers, industry verticals, and other market-regulating networks, and provides real-time IoT operating systems. It also allows for the successful transition of sensory and device data, operations, and computational and storage requirements to consumer services at the near network edge (Saleem et al., 2021).

1.1. Definition and Evolution of Fog Computing

The rise of Internet of Things technologies has enabled a wave of new applications combining different IoT data sources, services, and platforms. These IoT applications and services can now rely on the traditional computing infrastructure, which has been redesigned at the edge of the network and close to the end users. This new computing infrastructure for big data processing and real-time data analytics can not only provide low-latency processing of big data but also reduce the backhaul traffic and the communication overhead between the globally distributed data centers. This overview discusses how the fog computing paradigm has been integrated with an IoT-enabled infrastructure to provide more efficient and real-time big data analytics and how IoT applications have taken advantage of the fog computing paradigm to increase their agility and performance (Abdel-Basset et al., 2018).

In the past few years, the concepts of fog computing have been widely accepted and deployed, especially for big data processing and real-time data analytics in large-scale IoT applications,

thanks to the requests for migrating the data processing from the core of the network to the edge of the network. This work provides a comprehensive review of the latest research and development in fog computing and IoT-related technologies, and then mainly uncovers how the fog computing concepts can efficiently reduce the latencies between large-scale IoT applications and the complicated configurable cloud data centers. This discussion particularly emphasizes the integration between intra-fog networking and fog-cloud networking, which are critical to developing various classic and emerging large-scale IoT applications (Abdelwahab et al., 2016).

Fog computing was introduced as an extension of cloud computing by extending its architecture to the edge of the network for efficient, scalable, and real-time IoT data aggregation, event processing, and data analytics. This section first provides the definition of fog computing and then focuses on the evolution of fog computing. Fog computing is a conceptual model for the operation of computing, storage, and networking at the edge of the network (Sergii Datsenko and Tarasenko (2024)). Fog computing provides a distributed computing infrastructure located at the edge of the network. Fog nodes now support many of the functions and applications supported by cloud data centers, but because they are closer to the end devices, they are capable of monitoring and controlling the environments. Fog refers to an adjunct system connected to cloud data centers with the power and ability to process data at the device-equipped network edge, instead of the cloud or a remote data center (Al-Fuqaha et al., 2015).

Traditional cloud architectures were designed more than a decade ago as a general-purpose computing and storage infrastructure to aggregate data from remote sensors and end devices and store them for subsequent processing. These cloud data processing and analytics services were supported through numerous cloud data centers interconnected with the backbone network. The hierarchical network-centric model provides a pure cloud computing platform for various industries and was extensively discussed at that time (Shahzad et al., 2019). The cloud computing paradigm eliminates the requirements of dedicated low-latency networking intermediaries and exploits the standard core network, which makes it very cost-effective to support global applications. After more than ten years of development, it is now necessary to evolve towards more application-oriented architectures and technologies that can meet the growing needs of modern networking such as high-quality data collection, data management, data analytics, event processing, and real-time control using edge computing at the network. Fog computing is gaining more importance with time because it was estimated that by 2022 the number of IoT devices will reach around 43 billion (Alwakeel, 2021). On one hand, traditional data centers are valuable resources for big data analytics, transaction processing, and content hosting; on the other hand, IoT services and applications can benefit from cloud data centers' power for efficient coordination, machine learning, and decisions in many dimensions. With fog computing, there would be more opportunities for data analytics considering billions of IoT devices that have been deployed till now. Selected analytics of interest can go to the edge of the network for real-time decisions. In another way, fog nodes can control and monitor IoT devices and streamline raw data, processing data in either a centralized or distributed way before their final aggregation and further analytics in a cloud data center. In this way, fog

computing can be used as a filtering layer that screens out interesting data points or raw data for transmission of analyses to the cloud data center (Botta et al., 2016).

1.2. Key Concepts and Characteristics

Fog computing is a computing paradigm that extends the cloud computing capabilities to the edge of the network by providing compute, storage, and application services to end users. Fog computing provides high bandwidth, flexibility, power, location awareness, mobility, and low latency features at the edge of a network. Characteristics observed in fog cloud environments include virtualization, network integration, location awareness, low latency, diverse resource localization, support of heterogeneous device interconnectivity, geographic distribution, real-time processing, and real-time analytics (Breitbach et al., 2019).

The general idea of fog computing envisions dynamic real-time intelligence for edges and integration with the Internet of Things ecosystem. It enhances IoT capabilities with reduced latencies, minimal bandwidth usage, and real-time context-aware calculations and real-time analytics. Fog computing can also perform edge intelligence to aggregate data from IoT devices and sensors and filter out unnecessary or unrelated information so only necessary data are sent to centralized cloud servers (Chen et al., 2022). It has three job models: cloud-based, central management, and ad-hoc models. There are four existing architectures used for fog computing, which include centralized cloud-based, fully decentralized fog architecture, centralized cloud hybrid fog, and edge-based architecture model. Fog computing acts as an intermediate entity between IoT devices and cloud computing. This is because IoT is a vast environment consisting of a large number of connected devices generally connected to cloud computing resources and services (Chiang & Zhang, 2016). Cloud computing has limited resources that get overwhelmed with the increasing number of IoT-based devices, typically for real-time response. In contrast, fog is responsible for providing the local data center and location support (Dang et al., 2019).

2. IoT Data Aggregation at the Edge

Deploying IoT on the Internet of Things (IoT) network enables the sensing of different real-world phenomena and processes. Accordingly, there is a rapid increase in the amount of data generated by these devices and sensors. In the context of vanilla IP networking and the IoT system, it is ideal to shift the capabilities of data aggregation closer to the source of data creation or, in simpler terms, to the prior edge of the network. This concept allows huge amounts of raw but valuable sensor data to be aggregated closer to different endpoints. By doing so, we have already pre-processed data that can enhance the capabilities of the central cloud data center. This, in turn, can lead to improvements in full-fledged data analytics and better decision-making capabilities for humans or machines (Darwish et al., 2017).

Tremendous heterogeneity exists in the format, categorization, and type of reported parameters. Moreover, the amount of incoming data is huge. While the notion of 'huge' is ephemeral, we use this term to describe the incoming data in the range of several megabits to terabytes per second (Singh et al., 2024). From an algorithmic standpoint, being able to process this type of incoming data and provide real-time analytics is a complex yet active research problem. In this regard, Fog provides an ideal opportunity to better process and analyze IoT data closer to its

source. This process not only reduces latency and provides real-time results, but also makes better use of network bandwidth. As an outcome, higher aggregation ratios can be facilitated with configurable 'edge aggregation' (Deepak Gupta & Aditya Khamparia, 2020).

Data aggregation can have numerous effects, and it is imperative to select the data aggregation place in Fog carefully. Therefore, it is essential to understand the nuances related to this fact. However, the aggregation techniques that work at the cloud are not an effective choice for the Fog environment. To this end, this text presents a detailed comparison of different data aggregation techniques exclusively designed for Fog. The data aggregation places with suitable techniques directly affect the current decisions, performance, and deployment of various resource domains (Suciu et al., 2013). We discuss certain parameters to effectively analyze the behavior of different data aggregation mechanisms. Furthermore, we depict a process that includes certain important components to deploy an existing or newly proposed data aggregation solution in Fog. The deployment process also mentions the sequence of steps of the target framework of the problem specifics associated with preparing specific domains for the efficient deployment of data aggregation solutions in Fog (Díaz et al., 2016).

2.1. Challenges and Opportunities

Challenges and Opportunities: The scale of data generated by IoT will cause scalability issues if it flows over the network without any preprocessing at the edge. Moreover, it may also bring security issues if the data from IoT devices is transmitted directly into the cloud. Consequently, the data can be assembled and disassembled in various ways, including time series data and non-time series data, as well as any combination of them, creating diverse formats. It is only after aggregation that data is ready for processing for different purposes such as real-time analytics, big data processing, machine learning, and knowledge extraction (Verma et al., 2016). Considering the potential that big and small data can offer, data must be processed in real-time while moving towards the edge where information is aggregated. The information can be processed in near real-time or after a certain period of data gathering. The information gathered or aggregated can easily be different from one use case to another, as well as within the context of a given application. Thus, the diverse processing requirements also create diverse operations and systemic challenges. Though there is an option to perform data processing in the cloud as data are aggregated, such an approach may increase the latency, leading to non-real-time processing and long feedbacks (Divya Vetriveeran & R, 2025).

Opportunities in the projects are different from performing data processing in the cloud. Thus, for instance, in some applications, aggregation must be hardcoded into some advanced compression algorithms and must be performed inside data acquisition devices when data are generated. Moreover, data back call can be considered by adopting advanced network queries to intelligently gather data for specific applications when needed instead of expecting to transmit all the data from IoT base to the cloud (Wang, Xu, et al., 2018). To succeed in the deployment of IoT, efficient data aggregation and acquisition, data transformation and processing, and information and knowledge extraction from the edge and dying data must be taken into account. In order to meet these general requirements, a wide range of technologies become core enablers. These technologies span from hardware components and infrastructure

technologies to data aggregation, processing, and knowledge extraction (Dr. Khalaf Khatatneh et al., 2020).

2.2. Technologies and Protocols

The fog computing/data aggregation level should combine the existing technologies into a coherent whole. The recent advances in edge devices include MEMS accelerometers and potent microcontrollers capable of arbitrary computations. Extensive research has led to the development of protocols and devices that can transfer data wirelessly or using a wired connection. An important software framework is a stream processing software platform. Another recent development offers a ready-made fog processing and storage cluster in the form of networked and stackable devices. In addition, an important software framework for lightweight data exchange between similar embedded devices is a messaging library (Elgazzar et al., 2022).

Several lightweight protocols have been developed to cope with the low-bandwidth, high-latency nature of the fog environment, where data transmitted between the fog nodes are mainly real-time sensor data. These protocols are built directly on top of lower-level network protocols to incur as little overhead as possible. The simple sensor data usually use either a messaging protocol, a constrained application protocol, or custom connectionless datagram protocols. As each application of these protocols has its own set of requirements, we use the closest fit to the application in question. More details about these protocols follow within the subsections. Finally, embedded devices are often diverse and distinct, so protocols, interfaces, and communication standards should be designed around interoperability between devices rather than being tailored to a specific make or model of device. Standards and interoperable technology reduce friction in the network. With less friction in the network, the desired data will reach its destination more quickly and reliably. For this reason, we need both embedded and fog devices to adhere to appropriate standards where they exist. It should be noted that technology changes occur, and the most effective technologies available today may not be the most effective technologies available tomorrow. As IoT continues to evolve, so will the fog computing/data aggregation level. This subsection primes the reader for the complexity involved in aggregating IoT data at the appropriate level of the network, and the factors to consider when selecting the technology. Keep in mind that the theoretical bandwidth affects the latency any technology faces. Latency is chiefly of interest to applications that require some level of real-time functionality (Gedeon et al., 2019).

3. Edge Computing vs. Fog Computing

Edge computing is a generic paradigm aiming to solve the "cloud computing bottleneck" and enhance data processing efficiency at the network edge. It can be used to help reduce latency, optimize bandwidth usage, and enhance data management. Hence, edge computing effectively distributes network, compute, and storage availability across the data path. The essence of fog computing is to deploy and outsource cloud resources closer to the network edge in a meshed network rather than within client users' networks. The key idea of the edge computing paradigm is to perform data processing and manage data products at the

network edge where data originate. In contrast, the main idea of the fog computing paradigm is to have a meshed network consisting of various collaborating fog nodes/layers to perform data processing where data can reside at various locations across the network hierarchy (George, 2024).

When it comes to hardware, both paradigms differ in their requirements for edge/fog devices. For edge computing, the devices closest to the ones that generate data are typically smartphones, wearables, and gateways. These devices are equipped with various sensors and limited computational power and can provide local storage. Stepping up, fog nodes usually possess enhanced capabilities compared to edge devices as they can run full-fledged operating systems, have much stronger computational power than edge devices, and more importantly, have vast storage capacities. Hence, it is reasonable to equip them with additional storage for analysis and service provisions. Fog nodes are typically equipped with stronger computational capabilities short of a couple of gigabytes of RAM. Scalability is an important aspect in IoT deployments, and thus, a fog computing paradigm is more apt as the technology is inherently designed to scale both vertically and horizontally. The edge paradigm is good where dynamicity is minimal as shared communication is employed. When it comes to resource management, fog nodes in a computing framework provide a unified platform for smart management of various networking resources such as memory, storage, CPU, and cloud resources (H. & V., 2021).

Edge computing and fog computing are two peer-to-peer computing paradigms that greatly impact different aspects of the computational model, based on the application and the analytics performed at the edge. Hardware choice is an important aspect since the leverage of edge and fog computing paradigms is majorly resource-driven. The success of either approach relies on the paradigm being driven by the application and the analytics performed. Alternatively, the desired analytical results might dictate which paradigm might best suit a scenario (Wang, Yan, et al., 2018). In conclusion, both paradigms represent valuable approaches to minimize the cost and time required to analyze data and come to a specific decision. It is, in fact, an essential part of research how edge and fog computing paradigms may potentially complement each other and may even be used in conjunction to provide more efficient results. Both edge and fog computing paradigms rely heavily on the analytics being performed at various ends. However, the decision of which paradigm to use completely depends on the application (Hamdan et al., 2020).

3.1. Differences and Similarities

The first issue frequently asked is explaining the relationship between edge computing and fog computing: What are the differences? What are the similarities? Let us begin by explicating some notable similarities and disparities between edge computing and fog computing. They both have the same goal of reducing latency, delay, and delay jitter when processing real-time data generated by a massive smart object network, including IoT devices dynamically connected to the internet, sensors, and UAVs, and the delay tolerance of human-centric applications is a few milliseconds or less. Nevertheless, edge computing has a rather different approach from fog computing. Edge computing advocates performing computational operations at the best practical locality of IoT devices. The purpose of such a design is to keep

data close to the device generating it and to enable data aggregation by the so-called IoT gateways or middleware (Haun, 2023).

Data flows in a star topology architecture, centered on the IoT gateway. Cloud centers may involve one or more geo-distributed accumulator server farms. Furthermore, in edge computing, a group of IoT-based devices, located in one region, may share one or more cloud centers, but since the IoT devices have mobile users, the cloud center must also involve one or more alternative smart operation repositories in a different geographic area. In contrast to edge computing, where data is multiplied by several region-wide best IoT-based device carriers, fog computing overwhelmingly considers a distributed deployment of devices that implement the complete computational functionality to process the data with an acceptable amount of delay. When comparing application areas, edge computing and fog computing can have two exclusive architecture candidates, assuming that an IoT abstraction is available for the real-world devices: fog computing can exhibit more compelling choices than edge computing in applications such as IoT-based surveillance systems or real-time weather disaster assessment systems (Imoize et al., 2021).

4. Real-Time Analytics in Fog Computing

Timely data insights, particularly real-time analytics, are quite important for supporting decision-making processes. Depending on the requirement, the realization of real-time data and insights will vary between industries and business cases. Real-time insights will guide operations ranging from cognitive learning insights to maintaining equipment and assets in various industries. In many situations, the importance of data decreases quickly over time, so real-time data insights can provide significant operational efficiency. Timely and actionable insights shorten the time to solve a problem or increase the opportunity for positive action to be put in place. Analytics performance is governed by both the proximity and agility of the equipment and algorithmic decision-making Information Resources Management Association (2018).

Therefore, with the increasing use of IoT Fog Computing as the infrastructure for data management and operational system integration that resides at the edge of the network, the possibility of data and execution is closer. A trade-off between IoT devices and cloud is enabled by embedded resources in fog computing, further reducing network performance and evaluation delays, with potential benefits. Real-time analytics is an important aspect of Fog Computing, where the intelligence of real-time actions residing on data generated by IoT objects is an end-to-end system. Various approaches are followed for the development of real-time analytics, including machine learning approaches such as machine learning, data mining, clustering, forecasting, and anomaly detection. This study aims to provide a significant overview of real-time analytics tools and technologies at Fog and IoT. As part of IoT data management and integration with operational systems, Fog Computing is used for IoT data aggregation, data processing, and event-driven systems (Wang, Zhou, et al., 2018). The analytics capabilities within Fog Computing are referred to as Fog Analytics. Nowadays, the term Fog Analytics is used synonymously for Fog Computing. Because network edges occur, there are strict

definitions that Fog Analytics is a time-sensitive analysis using up-to-date data before data are collected in the cloud analytic framework. The absolute maximum time between data acquisition and analysis in this case must be within a maximum of seconds. Site-closest edge analytics locations that do not require data to arrive at the cloud for analysis would also fit the Fog Analytics concept. These Fog Analytics data analytics sites correspond to: "Computational, storage, and networking capabilities on endpoint data support repeated decisions, delays in cloud-based data conversion, excessive network bandwidth, or increased transaction and security risks." Imply close response requirements. "Every time there is a conclusion." Moreover, closer to the site where the data is collected (Inna Petrovska and Heorhii Kuchuk (2023)).

4.1. Importance and Benefits

Fog computing can gather data from various entities connected to the Internet of Things (IoT), beyond the limitations of an entry-level server or an edge gateway. To empower various IoT devices, real-time analytics play a pivotal role in fog computing. Real-time analytics provide insights to businesses and organizations within seconds due to immediate data aggregation and processing (Istvan Ketyko et al., 2016). A few benefits that drive the requirement for real-time analytics in fog computing are discussed below.

- Improving user experiences: Real-time data analytics empower a business to respond in real-time to dynamic circumstances or conditions.
- Rapid decision-making: Real-time analytics provide quick insights and support to management in decision-making and long-term planning.
- Innovation: New applications and advancements are possible with the capabilities and data provided by fog computing in real-time analytics, such as healthcare, transportation, and smart cities.
- Identifying and analyzing trends: Extracting insights for future trends by analyzing the data in real-time.
- Intelligent data capturing: With real-time analysis, various problems like fraud detection and predictive maintenance could be implemented, leading to improved quality through the identification of anomalies.

By integrating real-time analytics at the edge of the network, we could attain many benefits, including, but not limited to, lowering operational costs, increasing returns on operations, and improving real-time decision-making. IoT features as an enabler for real-time streaming, which has been proven capable of analyzing, detecting, and predicting numerous applications in various fields. A forecast reports that global streaming analytics will grow significantly by 2025. With the advent of IoT, real-time data can predict, analyze, and implement real-time systems across a wide variety of smart systems. As a result of scalability and capability, the systems are looking to implement a real-time stream that can provide various amenities (Yin & Deng, 2022). Several categories of the system are moving towards the integration of real-time analytics capabilities, including complex and time-consuming processes, sensor-based systems that operate in challenging environments, and systems that require scalable depth in analytics, to mention a few. Although the identification of risk behaviors, fraud detection, and alarming

techniques find their proper place, the infrastructure based on cloud computing becomes a challenge for both data and identity theft. Significant differences are reported in terms of security and privacy on a large scale, addressing these challenges by leveraging the fog computing paradigm (Savaglio et al., 2024).

4.2. Algorithms and Techniques

Real-time analytics is supported at the edge of the network through a variety of algorithmic techniques. In general, a variety of algorithms widely used in cloud environments are not suitable for real-time analytics in fog environments due to their inability to adapt to rapidly changing datasets. This section discusses various algorithmic approaches that have been proposed or used to enable efficient real-time analytics in the context of fog computing (Zanella et al., 2018). These include ensemble methods in machine learning, stream processing techniques, and algorithms designed specifically for the particular aspects of edge computing. In general, the suitability of these techniques in a fog environment is determined by their ability to be efficient for low latency and reliability as data continues to flow into the system. Stream processing focuses on the efficient processing of data that is transmitted and processed in real time compared to batch processing, wherein data is processed in bulk once it is located in storage (Khan et al., 2017).

The speed at which data is produced and analytics must be reported on is one of the major issues in applying data analytics to IoT data streams. Many analytics evolve around providing more accurate results through the use of machine learning and artificial intelligence techniques. However, these computing paradigms require time to process and perform analysis. The challenge is therefore to provide a balance in their usage so that processing speed is not sacrificed in favor of result accuracy. A few examples of where machine learning or AI have been utilized in fog computing for applications involving the environment, healthcare, industrial machines, and smart buildings can be seen in the practical case studies section. One of the main benefits of fog computing as applied to the edge and in the cloud is that it allows for machine learning and AI to be made available to organizations that lack the resources to develop custom algorithms (Khan et al., 2019).

An effective real-time analytics algorithm is adaptive to dataset changes and constraints and is efficient for edge environments where changes happen rapidly. As changes happen rapidly, the scalability and adaptability in a real-time fog computing setting is key (Kraemer et al., 2017).

5. Security and Privacy in Fog Computing

Fog computing can serve as a robust architecture to address several of the distributed edge-based IoT data processing challenges. However, this opportunity comes at a significant security and privacy cost. A variety of risks compromise the safety of the fog computing architecture. For example, a hacker could try to take control of the end offloading enablement between the end device and the fog node, pollute or inject false data sources in any of the offloading buffers, compromise the data store device, exploit the edge servers to introduce Trojans in the applications, and so on. Besides, the distributed nature of fog computing may also introduce other security vulnerabilities related to data confidentiality, integrity, and

availability, such as data breaches, incorrect data processing, unreliable outputs, and unauthorized access. Essentially, fog computing is handling the information processing operations closer to the end users alongside the devices they rely on functioning in their everyday lives. Thus, the volume of the attack surface is therefore also increasing with the number of sensors, IoT devices, and other data sources (Kuchuk et al., 2023).

Hence, security measures that prevent unauthorized access to data and functions of these nodes and resources are crucial to create an additional layer that contributes to the privacy of the data of the final user. Therefore, a secure architecture of the fog computing layer is essential to both the security and integrity of the infrastructure and the privacy and confidentiality of the user data. However, security implementation also augments the computational cost associated with data processing functions. As such, a power-performance trade-off must be envisaged, taking into consideration the overall constraints of the system (Zhang et al., 2022). For these reasons, a combined security and privacy framework should be employed. But, at the same time, a balance between usability, security, and privacy should also be guaranteed. The privacy point of view of the architecture should not inconvenience both the users and the designers too much from being used. Additionally, regulatory implications should also be considered so that the functionalities of the architecture can be used in light of the extent of the regulations (Li et al., 2020).

5.1. Threats and Vulnerabilities

It is important to explore the key threats and vulnerabilities associated with fog computing. First and foremost, it is important to focus on the threat actors specifically targeting edge devices and networks. Malware presents one of the greatest concerns, as it is designed to compromise these low-powered edge and fog computing devices. Furthermore, DDoS attacks have the capacity to destroy the infrastructure of fog or the edge, the result of which could be a failure of one or more linked services. Additionally, there is an opportunity in fog computing networks to intercept and corrupt the data, laying the foundation for entirely new or different threats in comparison with cloud environments. As a result of fog computing's distributed nature, it is then more complex to manage security controls, and a chain of protagonists is involved in it (Liu et al., 2017).

One of the unique threats in the context of distributed real-time data is that the risks are executed almost immediately. Although real-time processing of the data in the normal distributed setups happens in minutes, with fog computing it is also distributed, and the responses are quicker. As a result, any particular security control that might fail can be immediately compromised when no alternative to it was built. Privacy is also an issue, as attacks due to the lack of secured sensors located on persons can result in unauthorized access, spying by discovering people's identities, finding crime patterns, or targeting certain types of clients. The assessment of vulnerabilities and how to discover them is crucial to any security program, and the consequences that they might lead to are also relevant. Cyber risk management uses strategies that are implemented to identify and assess vulnerabilities. Audit information in order to define the firm's security posture and a detailed suite of tools exists already on the market for scanning weaknesses on a regular basis. The impact of emerging technologies on safety is also positive. Cryptographic technologies provide a growing level of protection with better security

implementations, while behavioral monitoring helps improve detectability. For these reasons, it becomes essential to manage behavior with the right regulation and the right information. It also needs to be studied that cybersecurity control characteristics and processes are planned for the use of specific entities in lethal accidents or terrorist attacks (Majid et al., 2022).

5.2. Best Practices and Solutions

Based on the critical concerns identified earlier, we propose the following recommendations and solutions to address these potential security and privacy threats in the Fog Computing environment. 1. Secure Fog networks and devices at the edge (endpoints) for connections, processing, storage, and data communication. Securing end-devices with encryption, secure boot, ports, and disabling unused network services could be best practices to follow. 2. Ensure real-time streaming data processing, edge analytics, security analytics, and integrity at the edge. Design an ultra-low data aggregation, unified-core edge network/cloud architecture. Secure data communications, do not trust connections, and use encryption to protect data porting in every layer of the architecture, including the data center to edge and machine-to-machine communications. 3. Regular signature updates, software updates, and virus/malware updates are key aspects of best defense security. Regular software updates from the hardware supplier or IoT devices' manufacturer are also important best practices to follow. 4. Machine learning capabilities for every layer of the Fog architecture, including but not limited to network, cloud, and device security. 5. Comprehensive multi-tiered architecture security and use of at least three layers of protection to secure access points to applications. The best security practices solutions should consider the following best design principles: 1. Privacy by design and by default. 2. Security priorities: Always protect the security of personal data for the individual and never delegate this priority. 3. User control: Individuals should be able to easily establish the federation of their choice. 4. User awareness and training. 5. Ensure compliance with any designed and agreed upon new architecture, controls, regulations, and standards. 6. Trust and trusted systems for associations inside the systems assisting in preventing malware and attacks (Malik et al., 2021).

6. Case Studies and Applications

This section presents several case studies and applications that illustrate the effectiveness of Fog Computing through real-world use cases. The applications are selected to show a wide range of Fog Computing possibilities. We show evidence of the positive impact that can arise when leveraging Fog architectures. The cases cover different application domains and sectors ranging from industrial, smart cities, urban service, transportation, and healthcare. First, we present the smart city applications, as they have been the most reported so far (Mohammadi et al., 2018).

Several smart city applications illustrate the potential effectiveness of Fog Computing architectures in the real world. A relevant number of Fog Computing use case designs evolved around real-time analytics for enhanced urban service provision primarily targeted at city authorities. One of the indicative applications is the waste management system of a city district to demonstrate the benefits of Fog-enabled bin filling estimation as a result of street-level

monitoring technology. The waste management system integrates Fog computing principles to efficiently estimate bin fill level based on collected sensory data. An in-network aggregation engine is used to produce accurate fill level estimation in real-time, saving the costs of road-based waste collection. Another illustrative example presents a decentralized transportation analytics and management Fog/IoT framework with case studies in the Dublin Dockland area and in a smart port setup. The use cases show the value of decentralized real-time data analytics and transportation service management. In the Dockland area, nodes deployed in public street lamps and in the smart vehicle make use of standard and novel sensory input to determine real-time demand and potential supply of public services. The system distinguishes between pedestrian, cycling, and motor vehicle services, and through intelligent information fusion and service provision, a more efficient and safer transportation service can be provided Mykhailo Hunko et al. (2023).

Optimization of resources and the delivery of urban services with real-time analytics at the point of data collection is a common field of Fog Computing application. A use case of an analytical predictive maintenance system for a network of industrial assets is presented to show value for industrial companies and maintenance contractors. It showcases the potential of the system to save costs in maintenance operations, reduce the number of breakdowns, extend the operational time of the industrial assets, and save the number of hotspot network scans. In the New Town of Milton Keynes, combining transport-related and urban data sources has the potential to improve city-wide engagement and benefit both the administration and the citizens. A case study of the railway industry is presented; the integration of data enables combined data analytics to predict track roadbed settlement, leading to optimized operations and reduced infrastructure costs. A Fog Computing application in assisted living leverages user interface design to enable easy citizen interaction with smart environments in a large-scale service deployment. A case study represents a customizable system to provide advice to growers about irrigation. Quantitative and qualitative IoT analytics capabilities that unlock new business models and ways of working are realized in several industrial cases described by technology platforms. This involved performance improvement in analytics capabilities which were up to 20% more processing over standardized components as well as the development of new business models that have unlocked new revenue streams for these companies (Pérez et al., 2022).

6.1. Smart Cities

Within smart cities, pervasive urban infrastructure and services are equipped with a variety of IoT devices capable of monitoring the environment. Fog computing architectures are well suited to handle and process the large volumes of sensitive data required for such applications. Analytical models and prediction systems, used for efficiently controlling urban commodity services (such as road traffic), waste collection and disposal, and energy distribution, benefit from real-time and regular monitoring of the city by distributed objects. Smart streetlights illuminate the road only when there is some movement on the street, which is detected by motion sensors. Smart waste containers inform the trash collector when they are going to overfill. In an intelligent building, lights are alerts, so if they are lacking, backup lights

are enabled to rescue the people from getting waned. We call this a smart living system, where things show activities and trigger warnings based on behavior patterns (Petrovska et al., 2022).

The aim of storing large volumes of micro-level data at the edge is to cut down the enormous expense associated with raw data transmission to the central server for analysis. In current solutions, a sensor network is usually deployed for data gathering and onboard data processing adhering to fog computing principles. Each node in the sensor network typically has a sunk processor for processing data captured by the sensors. Beyond conventional industrial systems, there are some examples of smart city applications of this kind. The city communicates with smart waste containers through a network of sensor-equipped waste and recycling bins. Each container has a sensor that detects how full it is and then sends a signal suggesting that the trash is ready to be collected. The municipalities save money and time in a highly limited resources environment by avoiding pick-up runs on bins that are only partly full. With these analytics, significantly more progress would be achieved, which improves the quality of life. Urban-scale computing paradigms can enable entirely new classes of interconnected systems that reflect the energy and complexity of cities. However, at the heart of this potential lies the very essence of the city: its flows of people, data, goods, and services. Security and privacy in smart cities, where a wealth of delicate information tends to be used, are of utmost importance. The user and community must be embraced, and worthwhile initiatives can serve goals in which urban stakeholders have already expressed an interest. Some constituencies of such initiatives, especially human-centered applications, will allow residents to engage in meaningful feedback. Implementing challenges include scaling up beyond these early initiatives, meeting the needs of all urban communities, and ensuring that everyone has not only access but also the ability to use these new services. There must be a bridge, therefore, between the latencies, irregularities, and discontinuities inherent in technology and the many consistent flows and cycles that make up the urban process, that occur between milliseconds and hours (Pierleoni et al., 2020).

6.2. Industrial IoT

The use of Fog Computing in industrial IoT looks to improve operational efficiency and promote decisions driven by data. Accordingly, a real-world application is in the fast-food industry for tracking refrigeration system equipment. In this use case, the provision of high performance was seen in expensive servers running the cloud; however, the first cost in this solution architecture prevented scalability. As a more cost-effective solution, a Fog Computing architecture was implemented. Similarly, the price faces downtime to process large volumes of data. In predictive maintenance use cases, we review literature that determines an average 30% cost savings when fluid forcing computation is conducted in the field rather than the cloud (Posey, 2021).

In general, the work presented focuses on joint data aggregation and processing towards real-time analytics at the edge of the IoT network. This approach is especially suitable for industrial applications and mission-critical systems that have to work independently (or are at least strongly coupled) with legacy systems. This can be considered an important question in the industry: a majority of manufacturing firms need to integrate production technologies that are deeply rooted and supported by a tremendous amount of embedded intellectual property and expertise with Industry 4.0 sharp-edge, state-of-the-art technologies. This graceful coexistence

path is another unique feature in which our proposed Fog essence complements and is better than massive cloud. Moreover, in the turbulent and competitive industry vertical, necessitating extensive re-establishment, this close integration is achieved through the development of custom augmented equipment controllers by third-party firms, resulting in increased costs and time. Nevertheless, our Fog's MEC Tier 2 offering enterprise is always synchronized with plug-and-play updates. Fog-related scalability and sustainability are important for every evolving digital industry requirement (Puliafito et al., 2017).

7. Future Trends and Research Directions

Fog Computing (FC) and Internet of Things (IoT) applications: In the future, data and applications are expected to proliferate everywhere and be increasingly interconnected, leading to increasingly important requirements to support FC processing and analytics for the connected devices at the edge of the network with minimum latency. The IoT evolution and FC will increasingly be strongly impacted by rapidly emerging and advancing technologies, such as:

- (a) large-scale data analytics tools, including AI, ML, and tools that can handle not only structured but also a high degree of unstructured data;
- (b) technologies for scalable, dynamic networking and orchestration, including software-defined networking, network functions virtualization, as well as future networking technologies, such as 5G;
- (c) energy-efficient, hierarchical systems that can increasingly manage a trillion IoT devices.

We anticipate several key developments in future FC and IoT research:

Data explosion and beyond: Investigating the most effective resource-, data-, and event-driven management strategies, including data I/O processing to address the next orders of magnitude in the number of small low-power devices and their associated data rates. Efficient IoT data management is becoming increasingly difficult as the number of devices and data generated per second grows exponentially. Traditional data management systems based on cloud-centric models that may have been previously adequate for ad-hoc analysis of structured datasets are increasingly ill-suited.

Security, privacy, and non-repudiation: Investigating the key IoT and FC security and privacy requirements of future architectures, with integrated non-repudiation capabilities leveraging technological evolution in areas such as advanced certificate technologies, emerging blockchain and distributed ledger technologies, secure immutable logs, and audit systems; as interconnected IoT and FC systems are being designed to permit interactions, privacy and security are becoming increasingly important and challenging.

Interoperability and beyond: We anticipate a general and more comprehensive shift in FC research that extends investigations beyond isolation and the desirability of FC research towards research that focuses on enabling targeted interoperation between the FC and the cloud, as well as nodes, compute and storage offload algorithms, query optimization, machine

learning, and deep learning techniques. Building on conventional techniques, speculative execution provides a powerful tool to accelerate deep learning and other cloud computing applications.

Standardization and regulatory aspects: Anticipated research efforts in market trials, demonstrations, industrial focus, technical surveys, regulatory impacts, showcasing, and informing strategic and financial investments. Finally, for future work in FC systems, we see many challenges and opportunities related to edge-to-cloud analytics, including multi-cloud and federated cloud computing. Key directions for resolving these challenges may include interrogating the effectiveness of FC for energy efficiency, devising next-generation data methods, training algorithms and models that will provide competitive value in the fog, rather than solely in the cloud, leveraging the hierarchical and limited capabilities of fog chips.

7.1. Emerging Technologies

While fog computing placements and architectures present numerous unaddressed challenges, it is quite evident that many emerging technologies, besides research pursuits, can greatly contribute to the evolution of fog computing. First, the integration of artificial intelligence (AI) and automated decision-making processes at the edge can significantly enhance the fog computing paradigm. AI-driven fog nodes can autonomously adapt to network conditions and changing application requirements, which is an evident necessity in fog computing due to its edge placements. Improved resource management and optimized data structures are significant benefits for real-time analytics in IoT applications. Further, specialized AI rules can improve the speed and precision of fog node decision-making. The advent of 5G technology is another key technological advancement. 5G greatly increases network bandwidth and speed and therefore facilitates the massive amounts of data that IoT applications generate. The exceptionally low-latency times of 5G technologies are also relevant for Internet of Things (IoT) communication. In another context, the integration of 5G technology in mobile networks will also greatly enhance mobile edge placement and essentially expand the fog architecture into the mobile edge to create even greater coverage. The expectation for the 5G future is a connection of up to one million IoT devices per square kilometer with the capacity to connect 10 to 100 times more devices than 4G, enabling more robust, faster, and more reliable connections (R, 2021).

Finally, blockchain is emerging as a distributed structure for identity management, data integrity, and security. Blockchain and fog computing are very compatible, as they are both distributed, redundant architectures. The integration of blockchain technology can benefit fog computing in expanding data integrity and security as a decentralized architecture. Edge-based blockchains can perform tamper-proof data blocks and secure identities at the edge. Other important emerging future technologies include sustainably powering fog nodes and recharging mobile IoT devices. Equipping fog nodes with IoT charging stations will also enable many future mobile IoT devices to benefit from automatic recharging. Although existing technology already enables built-in IoT devices to last over a year with power-saving features, the available power is a problem. Moreover, innovative solutions are also proposed to make the most of novel technology paradigms, which may disrupt the way decision-makers design and select their future architecture for efficient IoT services. There is a vision to deepen the IoT

connectivity. However, the ending statement is that there should be an active push for the integration of various open research issues and the care for standardizations. Indeed, network topology adaptations and resilience in response to IoT failure, latency, and real-time big data slicing must be addressed in advance. The present work helps to inspire and encourage research leadership projects that consist of an intelligent synergy of research issues and the development of new technologies in the context of fog computing. Appropriate modeling and hybrid methodologies, selected from cost efficiency to mission-critical oriented prototypes with adaptive assessment of endpoints, should be carefully chosen and assessed by multidisciplinary approaches. Proper methodologies are needed to promote cost-slicing design and self-organization in bentos (Rafique et al., 2019).

7.2. Challenges and Opportunities

The development of new networks and IoT, which are increasingly driven by device characteristics, is leading to their distribution, which makes the Internet architecture evolve to be increasingly managed at its edges. A Fog Infrastructure will contain more and more points at which a network resides closer to the data and devices. Integration of devices will soon reach billions of points, mostly connected to their Internet service provider. Many homes and businesses use wireless devices to link, and in some cases, even set up their networks, but in many cases, devices connect to operator-managed networks. In many cases, it also interfaces with broadband networks. Although other devices will have wireline access to the backbone layer, those devices will reach a billion devices served by tier two operators and small private networks that engage with local networks (Rajkumar Buyya and Satish Narayana Srirama (2019)).

However, currently existing challenges are related to managing an increasingly distributed population, especially at the lower part of the technology stack, ensuring that the IT has the appropriate interoperability. Large data amounts are at stake. It is important, however, not only to diffuse the fog, but also to protect users at the same time. Any penetration in time creates the possibility of data violation by unauthorized entities, which is both difficult and dangerous in the analog world. Hence, two important components are security and intellectual property rights for protecting data transmitted by other devices. To achieve this, it is necessary to create a strategy that will encourage subscription to engage the whole community, particularly Fog developers, designers, and end users. As neurons disseminate culture, continuous innovation is good, aimed at attentive observation and development within the Fog field, designing new applications over time. Any system has so many potential use cases and applications (Ray et al., 2019).

8. Conclusion

In contemporary and future IoT deployments, security and privacy aside, Fog Computing has emerged as a paradigm in which large volumes of sensor-related data can be aggregated, processed, and analyzed further in real time. Fog Computing in the scope of connected healthcare devices, industry deployments, smart cities infrastructure, and smart grids is a must because these devices sense electromechanical and chemical process phenomena locally or from the environment, and may need to react in real time based on the data they sense. Thus, in addition to Fog Computing's real-time data processing and real-time analytics

capabilities, Fog can be actively used to save physical bandwidth in edge-to-cloud environments by filtering and balancing traffic that goes to a data center in the cloud. In addition to Fog Computing's balancing, offloading, augmentation, analytics, and aggregation capabilities, integrating various data from different sources can even provide useful insight when the data are combined.

For wide-area network, smart IoT environments of multiple domain-deployed connected devices can judiciously make use of resource usage optimization network services irrespective of customer/individual requirements. Given so, privacy and security directors must be considered in almost all architectures that enable real-time data aggregation and processing between IoT edge devices at the base and edge of the network. Moreover, apart from resource optimizations and quantifying the effect of various attacks that are relevant to fog architectures, this emerging paradigm of computing includes other challenges. These challenges are more specifically focused on data management, particularly in light of the dynamic nature of the IoT landscape. Identifying key use cases and conducting case studies on these use cases reveals what efficiencies can be generated when using a Fog architecture in an IoT landscape. Moreover, the data generated from these studies can add significant value to these domains. Therefore, it is imperative that scalability and robustness are built in to Fog architectures as future trends and research continue. Any such solutions, including edge-to-cloud computing, will need to be rapidly adaptive to avoid the need for frequent updates.

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