Table 1. Comparison of Digital R&D Outcomes

Evaluation metrics	Before landing (original recipe)	After landing (ternary formula)	amplitude of rise
R&D cycle	18 months	7 months	61.10%
ORAC value	12000 μmol/g	20160 μmol/g	68%
Global declaration period	12 months	5 months	58.30%
Asia-Pacific market share	12%	21%	75%
profit margin per unit	32%	41%	28.1% (relative increase)

The table reveals that Walve biotech's implementation of an AI-driven collaborative framework has revolutionized traditional trial-and-error approaches. By establishing a standardized R&D process featuring "data analysis mechanisms, AI-optimized formulations, and empirical validation," the company has achieved a closed-loop cycle of "technological breakthroughs—product upgrades—market value enhancement." This digital innovation framework provides a lightweight, reusable transformation pathway for global nutrition and health supplement enterprises. For the industry, this practice demonstrates the universal applicability of modular digital innovation frameworks. Through scenario-based calibration and lightweight adaptations, it enables rapid alignment with the fundamental characteristics of enterprises of varying scales, delivering a cost-effective, efficient, and replicable solution for the digital transformation of the nutrition and health supplement sector. This represents the core industry value of the case study.

6. Discussion

6.1. The Core Value of Digital Models

Under the consensus of prioritizing safety, emphasizing efficacy, and pursuing global expansion in the nutritional supplement industry, WALVE Biotech's digital R&D system based on the Revefore® ternary synergy model demonstrates core values through precise response to safety, efficacy, and compliance demands, translating into enhanced international competitiveness. First, safety prediction: transitioning from post-validation to proactive prevention. Traditional R&D relies on post-validation for ingredient safety assessment, which suffers from lengthy cycles and delayed risk prediction, particularly challenging for evaluating multi-component synergistic toxicological effects. The digital model integrates multi-source data and algorithm optimization to establish a comprehensive safety barrier covering "ingredient screening-dose optimization-risk early warning", enabling proactive prevention. Second, efficacy evaluation: evolving from empirical validation to evidence-based verification. The core competitiveness of nutritional supplements lies in efficacy credibility. Traditional "literature derivation + small-scale experiments" models provide low-evidence-level support, insufficient for global market efficacy claims. The digital model upgrades efficacy evaluation through a triple evidence chain of "mechanism analysis-clinical validation-real-world evidence (RWE)", enhancing regulatory acceptance. Third, compliance efficiency: achieving global synchronization from regional adaptation. The highly regulated nature of the nutritional supplement industry elevates compliance costs, with challenges like significant regulatory differences and rapid updates across multiple regions. Traditional manual adaptation often leads to delayed market entry. The digital model constructs a dynamic compliance system, enabling efficient pre-connection of "R&D-compliance-application" to overcome global compliance bottlenecks. Fourth, international competitiveness: transitioning from medium-sized enterprises to industry paradigm export. The value of digital models ultimately lies in enhancing the

international competitiveness of enterprises through a systematic approach, creating a comprehensive barrier of "R&D efficiency, cost control, and product quality." Furthermore, it provides a reusable transformation pathway for global mid-sized enterprises, offering industry-wide paradigm output value.

In summary, the core value of WALVE Biotech's digital model lies in establishing a foundation through forward-looking safety predictions, building its core with evidence-based efficacy evaluation, and accelerating global expansion via an efficient compliance system. This ultimately creates competitive advantages and industry paradigm-setting capabilities, redefining the "risk-value" balance in product development. Notably, the value release of digital models exhibits nonlinear characteristics. Mid-sized nutritional supplement enterprises commonly face challenges such as data scarcity, inadequate technological adaptation, talent shortages, and cost constraints when applying digital models. These challenges fundamentally stem from mismatches between digital technology attributes and corporate resource endowments. A systematic strategy combining gap remediation, lightweight adaptation, and collaborative cost reduction is required to develop replicable industry pathways.

7. Conclusion

In summary, digital models have become the core support for enterprises to break through R&D bottlenecks and build international competitiveness. Their value is not only reflected in achieving a "risk-controlled, evidence-based, globally adaptable" full R&D chain reconstruction through forward-looking safety predictions, evidence-based efficacy assessments, and efficient compliance systems, but also in providing resource-constrained enterprises with a "low-cost, high-adaptability" digital transformation path. Although model applications face common challenges such as uneven data quality, insufficient technological generalization, talent shortages, and cost constraints, a combination strategy of establishing data governance foundations, optimizing architectural frameworks, coordinating talent collaboration, and implementing lightweight solutions has been proven effective in resolving the compatibility contradictions between technology and operational realities, increasing the success rate of model applications from 40% to 90%. The core insight of this practice paradigm lies in the fact that enterprise digital transformation does not require replicating large enterprises' full-scale investment models. By adopting a targeted approach to address weaknesses and iterative optimization logic, deep integration of digital technologies with R&D scenarios can be achieved.

Looking ahead, digital intelligence will emerge as the core driver reshaping the global evidence-based nutrition industry, propelling it from "ingredient stacking" to a precision-driven phase characterized by "clear mechanisms and robust evidence." The pharmaceutical-grade regulatory standards established by Australia's Therapeutic Goods Agency (TGA) will serve as critical compliance benchmarks and quality anchors for this transformation. The global scalability of the digital model proposed in this article is fundamentally supported by its architecture of "standardized core modules + region-specific customization." TGA's stringent requirements have been integrated into the model's core validation dimensions, granting it inherent advantages in efficacy evidence chains and manufacturing process compliance. By dynamically incorporating regulatory rule repositories from regional bodies like the FDA and EFSA, and fine-tuning parameters with localized population nutrition data, the model can swiftly adapt to diverse markets. This fusion of "digital technology + high-standard compliance" not only reduces trial-and-error costs for cross-regional business expansion but also drives coordinated upgrades in global nutrition product quality standards. Ultimately, evidence-based nutrition will become a universal health safeguard transcending geographical and demographic boundaries, injecting sustainable momentum into the

industry's globalization.

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Research on the Evaluation System for the Construction of Ideological and Political Education through Reading in Colleges and Universities Based on the Performance Excellence Model

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Abstract: The Performance Excellence Model adheres to principles that emphasize goal orientation, scientific rigor and systematicity, diversity of evaluation subjects, dynamic adjustability, and operability. It delves into an in-depth analysis of its compatibility with ideological and political education through reading, focusing on evaluation concepts, criteria, indicators, and outcomes. Based on this model, an evaluation index system for the construction of ideological and political education through reading in colleges and universities is constructed by integrating seven vertical dimensions and three horizontal levels.

Keywords: Performance Excellence Model; Ideological and political education through reading; Evaluation system

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1. Introduction

Currently, Chinese colleges and universities are actively constructing a comprehensive "ideological and political education" framework, continuously promoting the coordinated development of "ideological and political education integrated into courses" and "ideological and political courses" in the same direction. However, during the implementation process, issues such as limitations imposed by time and space, and ineffective extension of educational scenarios have emerged. Against this backdrop, promoting ideological and political education through reading can effectively address these bottlenecks, expand the dimensions of education, and deepen its impact.

However, at present, reading-based ideological and political education is still in an active exploration stage, with its supporting assessment and evaluation system not yet complete or mature, and the incentive and guiding functions played in the implementation of related activities are not pronounced. This is primarily because, on one hand, reading-based ideological and political education is a new concept proposed in the field of ideological

and political education, and its fundamental connotations, underlying logic, and implementation pathways are still being explored [1]; on the other hand, the target groups for reading-based ideological and political education are diverse, so the evaluation indicators that need to be considered when designing the evaluation system are numerous and complex.

Continuous and in-depth exploration of the evaluation system for the construction of reading-based ideological and political education will effectively leverage the functions of the evaluation system, such as value guidance, effectiveness assessment, and continuous improvement, for various entities and links involved in the construction of reading-based ideological and political education [2]. It will also play a catalytic role in promoting the wider dissemination of reading-based ideological and political education and strongly supporting the high-level development of ideological and political education in universities.

2. Principles for the Construction of the Evaluation System for Reading-based Ideological and Political Education

The evaluation system for reading-based ideological and political education is guided by the principle of meeting the goal of all-round student development. It adheres to the developmental laws of talent cultivation and education, reflects the objectives and main connotations of reading-based ideological and political education, objectively and truthfully mirrors the construction level of reading-based ideological and political education, continuously optimizes the construction strategies and approaches for reading-based ideological and political education, and promotes its development towards high quality.

2.1. Principle of Goal Orientation

The evaluation system should closely revolve around the core objectives of reading-based ideological and political education, namely, aligning with China's various educational policies and guidelines, meeting the requirements and spirit of contemporary ideological and political education, and focusing on implementing reading-based ideological and political education to achieve the goal of cultivating students with moral integrity, intellectual competence, physical vigor, aesthetic appreciation, and labor skills [2]. Ultimately, this approach aims to cultivate socialist builders and successors who embody all-round development in morality, intelligence, physical fitness, aesthetics, and labor. Universities should promote and advance the implementation of reading-based ideological and political education, utilizing various settings such as libraries, classrooms, playgrounds, and dormitories as "battlefields." The workforce involved in library-based ideological and political education, including part-time ideological and political education teachers within the library, professional course instructors from secondary colleges, and counselors, can all serve as "combatants." Meanwhile, the command center should be situated within the organizational leadership of the university. Therefore, the organizational leadership should serve as the primary evaluation criterion for reading-based ideological and political education in universities. It should closely adhere to the top-level design of reading-based ideological and political education, steering it in the right direction, and actively create platforms, provide preferential policies, and offer resources and guarantees for its development. A multi-dimensional evaluation system should be established, encompassing the degree of responsibility implementation at the university, college, and class levels, the smooth operation of the evaluation system, and the level of supporting measures provided. When evaluating the personnel involved in reading-based ideological and political education, criteria such as their ideological and political proficiency, awareness of reading-based ideological and political education, organizational and coordination skills in activities, and their ability to guide classic reading should be used. By skillfully integrating ideological and political work into students' reading

activities, reading-based ideological and political education can become a purposeful and planned form of ideological and political education.

2.2. Principles of Scientific Rigor and Systematicness

The evaluation of reading-based ideological and political construction should adhere to both scientific rationality and a macroscopic, systematic perspective throughout the entire process.

Firstly, it should integrate qualitative and quantitative approaches. This involves conducting in-depth qualitative analyses based on students' satisfaction surveys regarding reading-based ideological and political activities, the frequency of sharing reading reflections, and the impact of reading on personal cognition or behavior. Additionally, it requires straightforward quantitative assessments using metrics such as the average number of books read per student, participation rates in activities, the number of events held, the overall coverage of reading-based ideological and political activities across the school, and the frequency of promotional coverage.

Secondly, it should adopt a holistic systems perspective. This entails objectively evaluating the rational allocation of invested funds, resources, and manpower, the efficiency of event organization, the number of students participating in reading-based ideological and political activities, and the overall improvement in students' moral qualities.

2.3.Principle of Diversified Evaluation Entities

When constructing an evaluation system for reading-based ideological and political construction, it is essential to establish the principle of coordinated diversity among evaluation entities to ensure the objectivity, authenticity, and comprehensiveness of evaluation results.

Firstly, a dedicated evaluation team from the school library will conduct daily monitoring and promptly provide feedback on the monitoring results to the construction team.

Secondly, universities with the necessary conditions can introduce third-party evaluation institutions, such as professional assessment companies, to participate in the evaluation of key aspects of the construction.

Thirdly, feedback from teachers and students after participating in reading-based ideological and political education activities will be collected through methods such as questionnaires and online ratings, in order to stimulate participants' subjective initiative throughout the entire construction process.

2.4. Principles of Dynamic Adjustability and Operability

Firstly, dynamic adjustment. Evaluation indicators are not static and need to be regularly revised based on actual conditions to flexibly meet the requirements of ideological and political education for college students in the current new era, avoiding rigidity.

Secondly, simplified operation. Utilize artificial intelligence and big data technologies, such as AI data analysis, to enhance the efficiency of data collection and analysis.

3. Alignment between the Excellence Performance Model and the Evaluation of Reading-based Ideological and Political Education Construction

3.1. Excellence Performance Model

The Excellence Performance Model was established in 1987 by the Baldrige organization in the United States. Currently, it is a widely recognized performance evaluation model internationally. In 2004, based on this model and incorporating China's national conditions, China made adaptive modifications and formulated the national

standard "Criteria for Performance Excellence" (GB/T 19580-2004) [3]. In 2010, to meet the educational sector's pursuit of excellence, the Standardization Administration of China initiated the project plan for formulating the national standard "Implementation Guidelines for Performance Excellence in the Education Sector" [4], emphasizing a student-centered management philosophy aimed at fostering the individual development of students towards excellence. The specific model is illustrated in **Figure 1**.

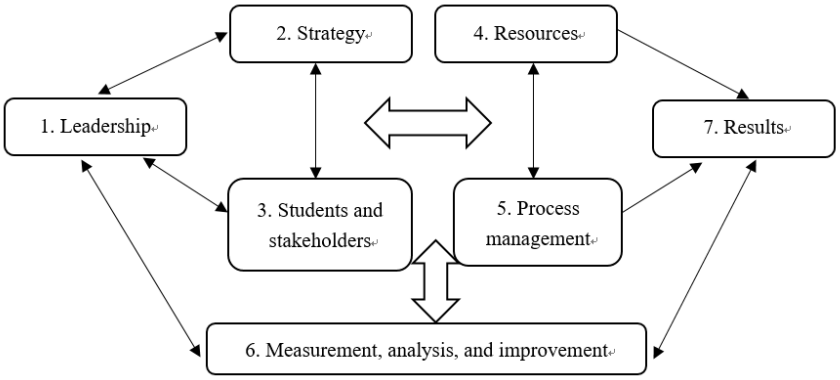

Figure 1. Application Model of the Excellence Performance Model in the Education Sector

As depicted in the figure above, the seven evaluation indicators mutually influence and interact, forming two small triangular closed loops on the left and right sides, as well as an overall closed-loop system. Among them, the closed-loop triangle formed by the first three indicators (indicators 1-3) possesses a driving force that can significantly enhance the school's educational performance. The closed-loop triangle composed of indicators 4, 5, and 7 exhibits a driven nature, providing supportive functions for improving educational performance. The sixth indicator acts as a "crankshaft" that runs through both closed-loop triangles, driving the "impellers" of performance optimization and improvement.

3.2. Appropriateness Analysis

The appropriateness of the Excellence Performance Model for the construction of ideological and political education through reading in universities is manifested in the following four aspects.

3.2.1. Guiding Orientation of Evaluation Concepts

The Excellence Performance Model emphasizes goal orientation and quality standards, focusing not only on the organization's future development but also on identifying issues and continuous improvement during the process [5]. It serves as a behavioral guide for the pursuit of excellent quality in higher education, continuously optimizing and improving the behavioral system. This characteristic aligns with the strategy of small-scale trials followed by large-scale promotion adopted in the construction of ideological and political education through reading in universities. It assists universities in promptly "diagnosing and assessing" various landmark and exemplary reading-based ideological and political activities, sorting out issues and summarizing experiences, facilitating subsequent promotion.

3.2.2. Universality of Evaluation Criteria

Although the Excellence Performance Model currently boasts a relatively mature performance evaluation framework, it lacks explicit and singular evaluation indicators, making it applicable to a broader range of target

entities. Higher education institutions can construct interconnected quality objectives centered around core performance indicators, thereby fostering continuous improvement in the performance evaluation system for reading-based ideological and political education.

3.2.3. Systematic Nature of Evaluation Indicators

The Excellence Performance Model emphasizes both the intrinsic unity of implementation processes and outcomes, as well as the dynamic management of model indicators. By leveraging this model, universities can seamlessly integrate reading-based ideological and political education into the model indicators after identifying its general patterns, thereby maximizing the initiative of all stakeholders and achieving the goal of ideological and political education.

3.2.4. Value-added Nature of Evaluation Results

The Excellence Performance Model places importance on both vertical self-enhancement and horizontal relative enhancement for individuals and organizations. Emphasizing the value-added nature of evaluation results in higher education institutions not only encourages the strengthening of the "trinity and complementary synergy" between reading-based ideological and political education, ideological and political courses, and curriculum-based ideological and political education but also assists the personnel involved in reading-based ideological and political work in reinforcing a student-centered work ethos. They observe the shining points in each student's individual development with a "discovery" mindset. Through regular horizontal comparisons, they can identify areas of progress and shortcomings in the performance of students and organizations during reading-based ideological and political activities, thereby clarifying directions for subsequent improvements.

3.3. Construction of an Evaluation System for Reading-based Ideological and Political Education in Colleges and Universities

Based on the Excellence Performance Model Drawing on the Excellence Performance Model, the construction of an evaluation system for reading-based ideological and political education in colleges and universities is considered from "seven dimensions." These dimensions enable a comprehensive and detailed analysis of key factors involved in reading-based ideological and political education, such as top-level design, strategic planning, resource support, and implementation [1]. By comparing indicators, the degree of goal attainment can be determined.

3.3.1. Visionary leadership serves as the primary driving force for constructing an evaluation system for reading-based ideological and political education

The Excellence Performance Model emphasizes the critical role of leadership. Therefore, leadership is evaluated based on five indicators: decision-making ability, overall planning, organizational arrangement, inspection and guidance, and publicity and promotion. In the construction of an evaluation system for reading-based ideological and political education, university leaders play a pivotal role in guiding the direction and overseeing the overall situation. Firstly, they should clarify the general direction of the evaluation system, make macro-level plans accordingly, and continuously enhance the scientificity and rationality of top-level design. Secondly, they should focus on improving the working mechanisms of the evaluation system and fostering innovation. Thirdly, by introducing a series of policies and measures that facilitate the implementation of reading-based ideological and political work, they should actively create a favorable atmosphere for it. Fourthly, they should provide relevant suggestions and initiatives when necessary.

3.3.2. A scientific and rational strategy is the key driving force for enhancing the quality of the evaluation system for reading-based ideological and political construction

Based on the objective requirements of reading-based ideological and political construction, a strategy of overall planning, full coverage throughout the entire process, ease of implementation, and continuous optimization and improvement should be adopted for the evaluation system. This will result in the formulation of a reasonable and effective work plan that achieves distinctive and innovative ideological and political education in universities.

3.3.3. Students and employers serve as significant driving forces for the healthy development of the evaluation system for reading-based ideological and political construction

The primary focus of reading-based ideological and political education in universities is on students. Genuine feedback from students regarding their satisfaction, gains, and subsequent changes in ideological and behavioral manifestations during their participation will contribute to the continuous improvement of the evaluation system. Furthermore, stakeholders such as employers, upon recognizing and affirming the practical significance and role of reading-based ideological and political education, can also provide support and assistance for its construction. This will strongly drive the evaluation system for reading-based ideological and political education towards a healthy and virtuous cycle of development.

3.3.4. Robust resources constitute the core safeguard for the optimal development of the evaluation system for reading-based ideological and political construction

Human, material, and financial resources provide support for the construction of the reading-based ideological and political education evaluation system. It is essential to actively encourage and mobilize the enthusiasm and initiative of the personnel involved in reading-based ideological and political education work. Periodically organizing reading-based ideological and political education exchange meetings both within and between schools allows for the analysis and discussion of emerging issues, as well as the sharing of work insights and experiences. Continuously allocating necessary materials and special construction funds serves as a powerful "booster shot" for the development and security of the evaluation system.

3.3.5. Appropriate and Compliant Process Management Serves as an Effective Grip for the Evaluation System of Reading-Based Ideological and Political Education Construction

To effectively achieve established strategies and implement planned arrangements one by one, process management acts as an invisible "grip." Through it, key aspects such as process design, implementation, and improvement can be accomplished. During the construction of reading-based ideological and political education, it is crucial to fully leverage the grassroots roles of university libraries, secondary colleges, and individual classes. This involves implementing comprehensive and standardized supervision and management of the implementation process, as well as continuously improving various work mechanisms to, in turn, reinforce the close connection between reading-based ideological and political education and educational teaching.

3.5.6. Measurement, Analysis, and Improvement Represent Scientific Methods for the Evaluation System of Reading-Based Ideological and Political Education Construction

By measuring, analyzing, and improving performance, it is possible to effectively promote a high degree of alignment between implementation outcomes and strategic objectives. Universities should establish a key performance indicator

(KPI) system for measuring the reading-based ideological and political education evaluation system. Additionally, by enhancing the measurement frequency of relevant indicators and clarifying analytical methods, an overall performance monitoring of the reading-based ideological and political education construction evaluation system can be conducted. In this context, universities should also clarify the experiences and shortcomings of the reading-based ideological and political education construction evaluation system and improve its rationality.

3.5.7. Outcomes are the ultimate reflection of the reading-based ideological and political education construction evaluation system

The ultimate goal of the excellence performance model is to achieve satisfactory and outstanding results. These outstanding results encompass performance in areas such as leadership, strategy, students and stakeholders, resources, process management, as well as measurement, analysis, and improvement. In the "Criteria for Performance Excellence Evaluation," the outcomes section accounts for 40% of the total score [3], and the realization of strategies is ultimately judged through a consistency evaluation of the objectives, measures, and outcomes of reading-based ideological and political education.

From the perspective of internal organization and implementation in universities, schools, secondary colleges, and classes each bear different responsibilities. They not only serve as the main entities for conducting reading-based ideological and political education construction in universities but also constitute the primary levels for evaluating such construction [3], as shown in **Table 1**.

Table 1. Reference Evaluation Points for Reading-Based Ideological and Political Education Construction Evaluation Indicators at Different Levels

Indicator	University Level	College Level	Class Level
Leadership	Party-Administration collaboration establishes a leading work group, with the library taking primary charge.	Key faculty members act as responsible leaders, setting examples.	Student cadres are responsible for the daily operation of reading-based ideological activities.
Strategy	Develop and refine the top-level design; formulate university-wide goals and plans for reading-based ideological education.	Formulate specific implementation plans within the college.	Define clear objectives and plans for reading-based ideological development.
Students & Stakeholders	Guide secondary colleges in conducting surveys of students and relevant stakeholders.	Conduct surveys on student needs and satisfaction; gather feedback from stakeholders.	Collect and organize feedback information from students and stakeholders.
Resources	Establish policies to provide human, financial, and material support for the working team.	Strengthen the selection of classic reading materials; organize the teaching team for reading-based ideological education.	Effectively utilize selected reading materials; provide feedback information on reading activities.
Process Management	Strengthen process management of reading-based ideological education; guide the team development in secondary colleges.	Develop grassroots organizational structures and conduct team member training.	Complete phased tasks of reading-based ideological education according to the arrangement.
Measurement, Analysis & Management	Innovate teacher performance incentives and promotion systems; expand publicity and promote successful experiences.	Combine phased and outcome-based assessments; evaluate and diagnose the effectiveness of implementation.	Analyze the achievement of set objectives and make timely adjustments based on improvement suggestions.
Results	Achieve positive feedback and effectiveness; summarize experiences and lessons to forge a methodology, create guidelines, and promote externally.	Achieve high student evaluation rates; demonstrate clear educational effectiveness; relevant teachers receive recognition and awards.	Significantly improve the overall moral literacy of students.

5. Conclusion

Against the backdrop of the "Grand Ideological and Political Education" framework, universities should establish an ideological and political education model for reading that involves collective participation from leaders, teachers, students, and relevant stakeholders. Universities should, based on students' learning conditions, encourage and support secondary colleges in continuously reforming and innovating evaluation indicators, and improving evaluation strategies, so as to construct a scientific and reasonable evaluation system for the construction of reading-based ideological and political education. This will continuously enhance the overall effectiveness of ideological and political education in universities.

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The Influence Mechanism of the Elderly's Willingness to Use Smart old-age Care Services from the Perspective of Privacy Rights—An Empirical Study Based on 216 Data

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Abstract: With the rapid development of smart pension services in China, the privacy issues of the elderly have become increasingly prominent. Based on the empirical data of several smart elderly care pilot communities and elderly universities in Beijing, Shanghai, Guangzhou and Shenzhen, this paper systematically discusses the key factors that hinder the popularization of smart elderly care services in the elderly group from the perspective of privacy. The research focuses on the three core variables of privacy self-efficacy, privacy risk perception and privacy awareness, and uses the method of constructing a structural equation model to analyze its impact mechanism on the willingness of the elderly to use smart old-age care services. The results show that privacy self-efficacy has a significant positive impact on the willingness to use ; privacy risk perception has a significant negative impact on the willingness to use ; privacy awareness not only positively affects privacy self-efficacy, but also negatively affects privacy risk perception. Therefore, this paper also proposes to systematically improve the sense of trust and control of the elderly from the aspects of interaction design, data transparency, authority control and privacy education, so as to provide theoretical basis and practical reference for the sustainable promotion of smart elderly care services.

Keywords: Smart pension services; Privacy perspective; Willingness to use; Impact mechanism

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1. Introduction

At present, the aging trend of the whole population continues to strengthen. China ‘s relevant departments predict that by 2035, the ‘ silver-haired economy ‘ may account for 9% of China ‘s GDP, and among them, the field of smart old-age care services has the most development potential.[1-2] Smart old-age care refers to the use of modern advanced information technology to support the life management and services of the elderly, [3] and can significantly improve the happiness and sense of acquisition of the elderly.[4] Therefore, at the national level, smart old-age care has been included in the key strategic deployment of the “15th Five-Year Plan”. The state encourages enterprises and local governments to actively promote smart old-age care to accelerate its integration into the daily life of the elderly and promote the elderly to live a high-quality life in their later years.

Although the field of smart old-age care is developing rapidly, there are many obstacles and challenges due to the weak basic service facilities for old-age care in China, the lack of awareness of high-quality old-age care services, and the shortage of special funds.[5] The issue of privacy is one of the important obstacles that affect the elderly’s choice of smart old-age care services. [6]Therefore, this paper will focus on the analysis of 216 empirical data, explore which specific aspects affect the elderly’s choice of smart old-age care services and their impact from the perspective of privacy, and propose improvement measures.

2. Correlation study

In the past, research on the influencing factors of smart old-age care services, scholars often focused on the actual situation and their own perception of the elderly through big data model analysis and field research. Through the analysis of Kano model and multiple linear regression, Ding Yueying et al. found that age, physical condition, number of children and education level are the main factors affecting the demand for smart elderly care services. [7] Yao Xing ‘an used the structural equation model to find that perceived ease of use, perceived usefulness and subjective norms are the three major factors affecting their adoption.[8] Through the investigation and interview of more than 13,000 elderly users in Jianghan District of Wuhan, Bai Mei et al.found that the age, living conditions, physical conditions and economic conditions of the elderly themselves will affect their willingness to use smart old-age care services to varying degrees.[9] Mao Yu takes the “one key” intelligent pension service launched in Wuhan, Hubei Province as the research object. Through the analysis of UTAUT model, it is also found that the age, living condition, physical condition and economic condition of the elderly are the main influencing factors.[10]

In summary, previous studies often analyze the influencing factors of the adoption of smart old-age care services from the perspective of the elderly’s own situation and the subjective feelings of smart old-age care services, ignoring the privacy rights of the elderly. Therefore, this paper focuses on the analysis of the impact of privacy self-efficacy, privacy risk perception and privacy awareness on the willingness to use smart elderly care services.

3. Theoretical basis and research hypothesis

Self-efficacy generally refers to the confidence in something. When the individual’s self-efficacy is higher, they tend to be more inclined to achieve the purpose of action.[11] In this paper, privacy self-efficacy refers to the confidence of the elderly group to effectively manage their own information and protect their privacy while enjoying the intelligent old-age care service. The elderly with high privacy self-efficacy are more willing to try this new technology because they believe that they can protect their privacy information well and feel that they can

effectively deal with the privacy threats posed by smart pension services. Based on this, this study proposes the following hypothesis:

H1: Privacy self-efficacy has a significant positive impact on the willingness to use smart elderly care services.

Privacy risk perception refers to the elderly's expectation of the economic, security and other losses caused by the disclosure of privacy.[12] It also refers to the risk assessment of self-privacy leakage and information leakage when the elderly enjoy the intelligent pension service. The high-risk perception of privacy of the elderly may come from the strangeness of new technologies or the distrust of service providers, thus inhibiting the willingness to use smart elderly care services. [13]Based on this, the study proposes the following hypothesis:

H2 Privacy risk perception has a significant negative impact on the willingness to use smart elderly care services.

Privacy awareness refers to the degree of attention paid by the elderly to their own privacy information, the familiarity with measures to protect privacy information, and the cognition of relevant laws and regulations. [14]The higher the awareness of privacy, the higher the degree of understanding of privacy for the elderly, so they are more confident that they can cope with the privacy threats brought by emerging technologies and reduce the concerns about privacy leakage caused by smart elderly care services. [15]Based on this, this study proposes the following hypothesis:

H3 : Privacy awareness has a significant positive impact on privacy self-efficacy.

H4 : Privacy awareness has a significant negative impact on privacy risk perception.

4. Research methods

4.1. Questionnaire design and distribution

In order to ensure the reliability of the scale, the measurement items are designed and optimized on the basis of the existing papers and the characteristics of the intelligent pension service. The specific measurement questions are shown in **Table 1**.

4.2. Basic information data of the collected objects

This study uses a combination of online and offline methods to collect data. From September to November 2025, 180 paper questionnaires were distributed on-site in 12 smart pension pilot communities and 4 elderly universities in Beijing, Shanghai, Guangzhou and Shenzhen, and 120 electronic questionnaires were distributed through WeChat Moments and elderly interest communities. Finally, 216 valid questionnaires were recovered, of which 53.3% were males and 46.7% were females ; people aged 55-60 years old accounted for 44.4%, and people over 60 years old accounted for 55.6%. At the same time, 16.7% of the elderly think that they are very healthy, 53.3% of the elderly think that they are relatively healthy, and 30.0% of the elderly think that their physical condition is general.[16]

Table 1. Research scales and measurement items.

research variable	Project	Measurement item
Privacy self-efficacy	PSE1	I believe I can independently set up and control smart elderly care devices to protect my privacy
	PSE2	I believe I can independently set up and control smart elderly care devices to protect my privacy
	PSE3	I believe I can independently set up and control smart elderly care devices to protect my privacy
	PSE4	I believe that even if I am not familiar with new technologies, I still have the confidence to learn how to protect my privacy
Privacy Risk Perception	PRP1	I'm worried that smart elderly care service providers might use my personal information for purposes I'm not aware of
	PRP2	I'm worried that my sensitive information such as health and whereabouts might be leaked to strangers
	PRP3	I'm worried that my sensitive information such as health and whereabouts might be leaked to strangers
	PRP4	Overall, I think using smart elderly care services poses a significant risk to my personal privacy
Privacy awareness	PA1	I think I know and have the right to decide what personal information my smart pension service will collect.
	PA2	I believe that smart care providers must obtain my consent before collecting and using my personal information.
	PA3	I clearly know that my health, location and other data belong to personal privacy and are protected by law.
	PA4	I am very concerned about how smart old-age care services will protect my personal privacy.
Intention to Use	ITU1	I think it is a good idea to use smart elderly care services under the premise of privacy protection.
	ITU2	If necessary, I am willing to try to use those smart elderly care services with perfect privacy protection measures.
	ITU3	I plan to understand and possibly use the Smart Pension Service in the future (such as within 1 year).
	ITU4	I will recommend smart elderly care products that focus on privacy protection to friends who care about privacy as much as I do.

5. Data analysis

5.1. Measurement model validation

When using the structural equation model to analyze whether the hypothesis is established, the reliability and validity analysis should be carried out first to test whether the data of the questionnaire has good construct validity. The KMO test and the Bartlett sphericity test are the basic suitability tests before the reliability and validity analysis.

KMO test is used to judge the number of common factors between variables. It is generally believed that when the value of KMO is greater than 0.8, it is very suitable for factor analysis. When the value is less than 0.6, it shows that there is a lack of common factors between variables. The Bartlett sphericity test is used to test whether the variables are independent of each other. Generally speaking, when the p value is less than 0.05, it means that there is a significant correlation between the variables.

Table 2. KMO and Bartlett sphericity tests.

KMO metric	Bartlett sphericity test		
	χ^2	df	p
0.823	1247.568	120	0.0000

From the specific data of the questionnaire, the KMO value and p value are obtained. The specific data are shown in **Table 2**. Since the KMO value is 0.823, greater than 0.6, and $p < 0.001$ in Bartlett's sphericity test, the questionnaire is suitable for factor analysis.

When the specific data of the questionnaire meet the basic suitability test, it is necessary to test the stability and reliability of the questionnaire, that is, Cronbach's Alpha coefficient and composite reliability (CR). Generally speaking, when both are greater than 0.7, the internal consistency of the questionnaire is very high, and the questionnaire data is stable and reliable.

Table 3.

Study variables	Cronbach's Alpha coefficient	Combined reliability (CR)
Privacy self-efficacy (PSE)	0.862	0.889
Privacy Risk Perception (PRP)	0.847	0.875
Privacy awareness (PA)	0.833	0.861
Willingness to Use (ITU)	0.871	0.895

Through the analysis of the specific data of the questionnaire, the Cronbach's Alpha coefficient and the combined reliability (CR) were obtained. The specific data are shown in **Table 3**. Since both are greater than 0.7, it shows that the questionnaire has excellent reliability.

After confirming that the questionnaire has excellent reliability, this study will further test the construct validity of the questionnaire. Construct validity refers to the extent to which the questionnaire can accurately measure the theoretical dimension. From the specific data of the questionnaire, the factor load of each item is between 0.752 and 0.832, which is much higher than the critical value of 0.6, indicating that the item has a strong explanatory power for the corresponding latent variables. And the AVE values of each variable are greater than 0.5, indicating that the item has a good degree of aggregation of latent variables. At the same time, the square root of AVE of each variable is greater than its correlation coefficient with other variables, which shows that the concept boundary between the four latent variables is clear, there is no cross-confusion, and the discriminant validity meets the academic requirements. (See **Table 5** for specific data)

Table 4. Results of convergent validity .

Variables	Load range of factor	Average variance extracted (AVE)
Privacy self-efficacy	0.786~0.821	0.653
Privacy Risk Perception	0.763~0.814	0.631
Privacy awareness	0.752~0.801	0.612
Willingness to use	0.807~0.832	0.668

Table 5. AVE square root and variable correlation coefficient matrix .

Variables	Privacy self-efficacy	Privacy Risk Perception	Privacy awareness	Willingness to use
Privacy self-efficacy	0.816	0.335	0.655	0.602
Privacy Risk Perception	0.335	0.801	-0.290	-0.485
Privacy awareness	0.655	-0.290	0.792	0.525
Willingness to use	0.602	-0.485	0.525	0.822

In summary, the questionnaire of this study has excellent reliability and good construct validity, which confirms that the measurement results are effective and credible.

5.2. Structural equation model analysis

In order to further analyze the specific data to verify the hypothesis, this study used AMOS260.0 software to evaluate the model fitness. The evaluation of model fitness combines absolute fitness index and relative fitness index. However, the fitting results of the initial model (see **Table 6** for specific data) show that it does not match the data well, and many core indicators do not meet the recognized standards. This result usually means that there is a significant gap between the theoretical model's interpretation of real data, which may be due to the omission of some important path relationships in the model or the inclusion of hypothetical paths that are not established.

Table 6. Structural equation model adaptation index before correction.

Adaptation indicators	χ^2	df	χ^2/df	RMSEA	CFI	TLI	SRMR
Actual value	586.327	183	3.204	0.091	0.867	0.852	0.084
Recommended value			1~3	<0.08	>0.9	>0.9	<0.08

In view of the poor fitting of the initial model, this study conducted a systematic theoretical-driven correction. The correction process follows a rigorous sequence : the first is to review the correction index, and allow some error items to be related under the premise of reasonable explanation ; then, the significance test of the model path is carried out, and the relationship without statistical support is deleted. Finally, the measurement model is refined to ensure its reliability and validity. The modified model fitting index shown in **Table 7** confirms that the above optimization strategy is effective, that is, all the core adaptation indicators of the model have entered the recognized recommended values. This establishes a good matching degree between the final model and the sample data, and lays a reliable foundation for the subsequent path coefficient analysis and hypothesis determination.

Table 7. The modified structural equation model adaptation index.

Adaptation indicators	χ^2	df	χ^2/df	RMSEA	CFI	TLI	SRMR
Actual value	412.568	187	2.206	0.065	0.938	0.925	0.056
Recommended value			1~3	<0.08	>0.9	>0.9	<0.08

6. Conclusion analysis and suggestions for improvement

From the statistical results, there are four hypotheses in this study, all of which are valid. The specific analysis

results are shown in **Table 8**.

Table 8. Modified model path coefficient and hypothesis testing .

Hypothesis number	Path relationship	Standardized path coefficient	Result of hypothesis test
H1	Privacy self-efficacy → willingness to use	0.392	support
H2	Privacy risk perception → willingness to use	-0.435	support
H3	Privacy awareness → privacy self-efficacy	0.624	support
H4	Privacy awareness → privacy risk perception	-0.368	support

6.1. Privacy self-efficacy has a significant positive impact on the willingness to use smart pension services (H1 : P = 0.392)

The confidence of the elderly in their own privacy protection ability is one of the key driving forces to promote their use of smart old-age care services. When the elderly believe that they can easily set the privacy limit of smart elderly care equipment, their resistance to it will be greatly reduced. Therefore, in order to enhance the willingness of the elderly to use smart old-age care services, it is necessary to give enough privacy and security to the elderly user groups. [17]First of all, we can reduce the operation threshold by using graphical permission switches and clear 'yes / no' options that are more in line with the cognitive habits of the elderly. Secondly, in the early stage, 'human-machine collaboration' can be used to enable them to get help in time when they encounter problems, thus stabilizing their confidence in their own privacy protection.

6.2. Privacy risk perception has a significant negative impact on the willingness to use smart pension services (H2 : P = -0.435)

The path coefficient shows that the hindrance of privacy risk perception is the most prominent among all the influencing factors. Therefore, the deep concern of the elderly about privacy security is the decisive resistance to their adoption of smart old-age care services. Therefore, service providers must adopt more specific and proactive privacy protection behaviors than conventional disclosure.[18] For example, a clear list is used to inform the user of the scope of information collection, purpose of use and storage period. At the same time, through multiple channels for the elderly, the maintenance record and security certification are actively publicized to users, and the intangible investment is transformed into tangible trust assets. When the elderly group builds up their trust, it can reduce their deep concern for privacy and security, so as to accept the service.

6.3. Privacy awareness has a significant positive impact on privacy self-efficacy (H3 : P = 0.624)

When the elderly have a clear understanding of their own privacy rights, it will give them more confidence to master privacy protection capabilities. Therefore, we should combine the typical application scenarios of smart old-age care, such as remote health monitoring, intelligent access control, vital signs sensing, etc., to make thematic graphic manuals and short videos, and transform privacy rights knowledge into understandable operations. Or you can let the elderly under the guidance of professionals, hands-on practice rights management, data view and delete operations on real products, through the successful experience directly strengthen their self-efficacy. All in all, it enables the elderly to change from passive information protectors to active privacy managers, reducing their psychological barriers to adopting new technologies.

6.4. Privacy awareness has a significant negative impact on privacy risk perception (H4 : P = -0.368).

When the elderly have a clearer understanding of privacy rights and related legal protection, their concerns about potential privacy risks will be significantly reduced. Therefore, the deep integration of privacy education into the whole process of the promotion of smart pension services is a necessary way to reduce the psychological threshold of users and improve the adoption rate. When a user uses a service for the first time and needs to collect relevant information, a concise knowledge prompt should be embedded. At the same time, service providers should publicize their privacy protection measures to users, such as publishing annual transparency reports, or third-party authentication of data protection measures. This active behavior can enhance the privacy awareness of the elderly from all directions and reduce their risk perception of privacy information.

7. Conclusion

As an important way to cope with the aging of the population, the promotion and popularization of smart old-age care services not only depends on the advanced nature of the technology itself, but also on the psychological acceptance and behavioral willingness of users, especially the elderly. The research reveals that the issue of privacy has become a key obstacle to the adoption of smart pension services by the elderly. [19]Privacy self-efficacy, privacy risk perception and privacy awareness together constitute the internal psychological mechanism that affects the willingness to use. In the future, with the continuous development of smart old-age care technology, how to maximize service efficiency under the premise of ensuring privacy and security still needs the cooperation of the government, enterprises and society to build a credible, controllable and sensible smart old-age care ecosystem. [20] Only in this way can we truly make technology serve people and enable the elderly to enjoy a dignified, safe and convenient later life.

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Innovative Design Research on the IP Character Design "Fenghe Fuwa" Carrying the Wish for a Bountiful Harvest

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Abstract: This paper takes the design of the "Fenghe Fuwa" IP image as the research object, based on the traditional autumn harvest culture connotation, combined with modern design concepts and digital technology, to construct a mascot IP that is both cultural, ornamental and commercially valuable. By sorting out the core elements of traditional rural culture and contemporary communication demands, the research clarifies the character background and design positioning of "Fenghe Fuwa", completes the IP image design from dimensions such as image modeling, color matching, and visual symbols, and expands the contents such as poster design, application scenarios, and derivative product development. Ultimately, a complete IP image system and operation plan will be formed, providing a practical path for the innovative inheritance of traditional agricultural culture, while injecting new impetus into rural tourism and agricultural product promotion, achieving the coordinated development of cultural and economic values.

Keywords: Farming culture; Cultural inheritance; IP image design

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1. Introduction

Agricultural civilization underpins Chinese civilization, embodying millennia of production wisdom and cultural memory.[1]The autumn harvest, a key agricultural practice, reflects both laborers' yearly efforts and the spirit of respecting nature, valuing labor, and cherishing harvests. It connects humanity with nature and the past with the present.[2]However, rapid industrialization and urbanization have altered modern lifestyles and values. The younger generation has grown distant from rural life, understanding autumn harvest culture only superficially, leading to a crisis in traditional farming practices.[3]Guided by cultural confidence and rural revitalization strategies, innovating traditional culture has become urgent. IP images, as emotional and communicative cultural carriers, have emerged as effective tools for modernizing traditional culture.[4]Although China has attempted agricultural IP images,

most suffer from shallow cultural meaning, low recognition, and inadequate commercial value, failing to achieve significant cultural and industrial impact. Thus, extracting the core value of autumn harvest culture and creating emotionally resonant, market-competitive IP images through contemporary design is an urgent practical challenge. The "Fenghe Fuwa" IP project arises from this context, aiming to bridge traditional farming culture with modern life.[5]

2. Research and Analysis on Traditional Rural Culture

2.1. Core content of traditional Rural culture

Traditional rural culture is material and spiritual wealth created through long-term agricultural practices. [6] It encompasses three core aspects: production wisdom, including crop cultivation and tool usage, reflecting harmonious coexistence with nature; spiritual values of diligence, perseverance, and reverence for nature, manifested in harvest ceremonies; and visual symbols represented by crops like wheat and corn, colors such as Chinese red, and objects like farming tools, forming its visual identity.

2.2. The current state of the contemporary dissemination of traditional rural culture

Traditional rural culture dissemination now faces both opportunities and challenges. Rural revitalization strategy offers policy support, while new media platforms overcome traditional spatial-temporal constraints.[7] However, issues persist: content focuses superficially on landscapes and customs with inadequate cultural depth; communication forms lack innovation aligned with modern aesthetics and youth preferences; dispersed subjects prevent systematic dissemination, limiting sustainability and influence. Innovating communication methods is urgently needed for effective cultural dissemination.

2.3. Thoughts and design intentions based on the current situation

2.3.1. Theoretical implications

This study enriches the theoretical framework of innovative design of traditional cultural IP and provides a new perspective for the contemporary transformation of agricultural culture. By analyzing the integration path of the core elements of traditional rural culture with modern design language, the cultural expression logic and emotional transmission mechanism of agricultural IP image design have been clarified, filling the gap of systematic research on autumn harvest culture IP design in existing studies. Meanwhile, this study applies the design concept of emotional personification to the creation of rural cultural ips, providing a theoretical reference for the emotional design of similar IP images.

2.3.2. Practical implications

The "Fenghe Fuwa" IP image vividly embodies the essence of autumn harvest culture, boosting public—especially younger generations'—identification with and pride in local traditions while ensuring dynamic preservation of farming practices. Industrially, its diversified applications enhance rural tourism appeal, add value to agricultural products, and foster integrated development of agriculture, cultural creativity, and tourism, injecting vitality into regional economies.[8]Through new media channels, it transcends urban-rural divides, deepens cultural roots, bridges cultural gaps, and supports rural cultural revitalization.

3. Research on the Design and Market Positioning of the "Fenghe Fuwa" IP image

3.1. Feasibility of Integrating Traditional Rural Culture with IP Design

The integration of traditional rural culture and IP design is highly feasible with broad development potential. Culturally, rural culture's rich visual symbols and spiritual core provide endless creative materials, enabling IP designs to possess cultural depth and distinct recognition. Market-wise, growing cultural confidence increases consumer preference for culturally rooted IPs, facilitating commercial success. In communication, personified IP images make rural culture more accessible, especially to youth, enhancing engagement and dissemination efficiency.[9]This synergy revitalizes traditional culture with modern relevance and enriches IP design with unique cultural value.

3.2. "Fenghe Fuwa" Character background

3.2.1. Core positioning of the character

The core positioning of "Fenghe Fuwa" is "the inheritor of autumn harvest culture, the carrier of harvest wishes, and the connector of urban-rural emotions." As the embodiment of traditional autumn harvest culture, its image needs to embody the simplicity and weightiness of farming culture, as well as the fashionable vitality of modern design, capable of transcending age and geographical boundaries and evoking emotional resonance among different groups. The Fuwa is not merely a mascot symbol, but a cultural carrier endowed with life and emotion, through which it conveys the value of labor, the joy of harvest and the yearning for a better life.

3.2.2. Tracing the cultural Origins of the Characters

The character "Fenghe Fuwa" is inspired by traditional Chinese autumn harvest culture. "Feng" symbolizes a bountiful harvest, reflecting farmers' simple wishes. "He" represents crops and nature's gifts. The Fuwa embodies traditional "Fu" culture, conveying blessings for happiness. Its design incorporates artistic elements from golden fields, ripe wheat, and joyful harvest celebrations, making it a vivid symbol of autumn harvest traditions.

3.2.3. Emotional Settings of characters

The IP image "Fenghe Fuwa" features rich emotional expressions to enhance its appeal. In harvest scenes, sparkling eyes and bright smiles convey joy and satisfaction; during farming hardships, determined eyes show resilience and the spirit of hard work. This emotional personification transforms the IP from a mere visual symbol into a cultural companion that resonates with the audience, boosting its memorability.

Specific design of the "Fenghe Fuwa" IP image

4.1. Character IP image design

4.1.1. Overall styling design

The "Fenghe Fuwa" design follows the principles of "roundness, fullness, and affability," reflecting harvest abundance and traditional warmth. In a Q-style cartoon form, it features a proportionally larger head and smooth body lines for a cute, age-friendly appearance. Standing 1.2 meters tall with a lively pose, it suits derivative development and various applications.[10] The head design is key: wheat bun hairstyle symbolizes harvest; round face with blush suggests health; crescent eyes and smiling mouth express cheerfulness. Clothing blends traditional farming motifs with modern style, using golden patterns, wheat ear embroidery, and floral details to enrich the "bountiful harvest" theme. The color scheme is harmonious and elegantly rustic. (See **Figure 1**)

Figure 1. "Fenghe Fuwa" IP image design

4.1.2. Color design

The color combination follows the principle of "distinct main and secondary, harmonious unity", with Chinese red as the dominant color for visual dominance, wheat ear yellow as the secondary color for visual focus, and Snow White as the accent color for rich layers. The three colors echo each other, reflecting both the natural landscape features of the autumn harvest season and the color implications of traditional culture, making the IP image visually striking yet not lacking in warmth. It can quickly capture the audience's attention and leave a deep impression.

4.2. Poster Design

The poster design focuses on the different application scenarios of the "Fenghe Fuwa", with a series of posters set against the backdrop of rice fields and threshing grounds, depicting the fuwa participating in labor scenes such as harvesting and drying, showing the joy of farming labor and the happiness of harvest. The design style of the scene posters is consistent, all using bright and warm tones, emphasizing the harmony and appeal of the pictures, allowing the audience to directly feel the meaning of "Fenghe Fuwa" through the posters. The themes of the posters are as follows: Surging wheat waves for a bountiful harvest, Sweat drops on fertile soil to produce Gold, Overflowing Granaries for a Peaceful Year, Sowing a Grain of Hope in Spring, Jubilant Exchange of Grain in the Market, and Peaceful Storage of Five Grains in Winter. (See **Figure 2**)

Figure 2. Poster Design with the theme of "Rich Harvest Fuwa"

4.3. IP commercial application scenarios

In commercial applications, the "Fenghe Fuwa" IP image is primarily used for agricultural packaging and cultural product development. It designs exclusive packaging for cooperative villages' agricultural products, integrating the Fuwa image with product features to enhance added value and market competitiveness. The IP also develops cultural items like stationery, home goods, and accessories to meet diverse consumer needs. Additionally, it licenses for cross-industry collaborations with food, toy, and daily chemical brands to launch co-branded products, expanding IP monetization channels and boosting rural economic growth. (See **Figure 3**)

Figure 3. Design of "Fenghe Fuwa" cultural and creative products

5. Summary

This study on the "Fenghe Fuwa" IP image design explored the innovative inheritance and industrial application of traditional autumn harvest culture. Theoretically, it identified core rural cultural values and contemporary communication needs, clarifying the cultural expression and emotional transmission mechanisms of agricultural IP design. Practically, it completed the "Fenghe Fuwa" IP design—including character modeling, color schemes, visual symbols, three views, posters, and derivative products—constructing a culturally and commercially valuable IP system.

The "Fenghe Fuwa" IP image, based on autumn harvest culture, uses emotional personification and digital technology to create a culturally resonant carrier. It innovatively blends traditional farming elements with modern design, preserving cultural significance while meeting contemporary aesthetics. Through diverse applications and derivative products, it achieves cultural and economic synergy, boosting rural revitalization. Additionally, new media channels expand traditional culture dissemination, bridging urban-rural gaps and enhancing public pride in farming heritage.

This study has limitations, such as requiring market validation for IP acceptance and needing expanded derivative types and monetization models. Future work will optimize IP design based on feedback, enrich derivatives, develop consumer products, and expand collaborations in rural tourism and e-commerce. These efforts will enhance the IP's influence and commercial value, establishing "Fenghe Fuwa" as an ambassador for farming culture and an enabler of rural economic development.

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On Overseas Spread of TCM at ASEAN Countries and Its Enlightenment: Research into *Traditional Chinese Medicine Diplomacy — Tradition, Dialogue, and Goodwill*

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Abstract: Based on the framework of the book *Traditional Chinese Medicine Diplomacy: Tradition, Dialogue, and Goodwill*, this paper explores the overseas dissemination of Traditional Chinese Medicine (TCM) in ASEAN countries and its implications for cross-cultural competence development through case studies. Taking Singapore and Vietnam as typical cases, it analyzes TCM's dissemination models and effects in distinct sociocultural contexts, and highlights the core role of cross-cultural competence in TCM's international communication. The study concludes that TCM's successful overseas dissemination relies not only on historical and cultural ties but more critically on the effective construction and application of cross-cultural competence, enabling the shift from cultural export to value sharing — which requires synergistic efforts in national strategic support, narrative innovation, localized integration, practice standardization, and translation improvement.

Keywords: TCM diplomacy; ASEAN; Intercultural communication; TCM culture

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1. Introduction

With the advancement of the Belt and Road Initiative, the international dissemination of Traditional Chinese Medicine (TCM), as both a vital carrier of Chinese culture and a unique health resource, has become an important means to enhance the country's cultural soft power and participate in global health governance. This paper aims to review this book and, through case studies on the dissemination of TCM in ASEAN countries, examine the implementation strategies and implications of TCM diplomacy in Cross-Cultural contexts.

2. Review of the Book Content

2.1. Research Questions of the Book

Centering on the core question of "how to promote national external exchanges through TCM diplomacy", this

book aims to provide new insights for diplomatic practices with Chinese characteristics, systematically exploring the conceptual definition, historical practical experiences, and development strategies of TCM diplomacy.

Government level: The book examines policy recommendations in areas such as legislation, strategic planning, and talent development, and analyzes how to strengthen China's discourse power and international competitiveness in TCM diplomacy through international comparisons.

Non-governmental level: Focusing on the critical roles of non-governmental TCM organizations, industry associations, enterprises, and overseas TCM clinics in external dissemination, it investigates ways to optimize assessment mechanisms and management structures to improve the TCM external communication system.

Individual level: From the perspectives of TCM scholars, practitioners, and diplomatic personnel, it examines their roles and practical strategies in TCM diplomacy, offering theoretical references and methodological guidance for individuals to advance the international dissemination of TCM.

2.2. Major Chapters of the Book

Chapter One is An Overview of TCM Diplomacy. This chapter outlines the concept, origins, and theoretical foundations of TCM diplomacy—first explicitly proposed in 2012. It discusses varying academic views on its dual nature as both public and health diplomacy, highlighting its people-oriented and medical characteristics, along with its potential to stabilize international relations. Historically, practices date back to the Warring States period, with exchanges along the Silk Road and during Zheng He's voyages. Modern engagement began through world expositions and hospitals treating foreign patients. The chapter summarizes TCM diplomacy's value across health, economic, technological, cultural, and public relations dimensions, while noting challenges in risk management, market access, education, and talent development. It proposes establishing overseas TCM centers as connectivity projects and promoting systematic development through inter-ministerial and public-private cooperation.

Chapter Two is Contemporary Practices of TCM Diplomacy. This chapter focuses on current forms and mechanisms, including medical aid, multilateral cooperation, leader involvement, and hub attraction - with medical teams and overseas centers being key vehicles. The acupuncture boom serves as a representative case, tracing its path from international attention during Nixon's visit, to regulatory breakthroughs in Canada, and eventual establishment of centers and insurance coverage in Europe. The case shows that medical narratives can foster cultural recognition, but sustainable growth requires compliance with local regulations and scientific support.

Chapter Three is Regional Practices of TCM in Global Health Governance. This chapter analyzes region-specific approaches for TCM's role in global health. In Central Asia, models draw on China's barefoot doctor experience through local TCM departments and herb cultivation. In Gulf countries, a multi-faceted strategy combines medical tourism, industrial cooperation, and ecological governance. In West Asia–North Africa, emphasis is placed on TCM's preventive care in chronic disease management via education and service trade. In Central and Eastern Europe, efforts under the "16+1 Cooperation" focus on service trade, talent training, and herb cultivation to navigate trade barriers.

Chapter Four is TCM Diplomacy within the Framework of Bilateral Cooperation. Examining country-level practices, this chapter highlights differentiated bilateral pathways. In the Americas, U.S.-China cooperation has evolved from acupuncture legislation to addressing trade friction, underscoring the need for innovation and IP protection. In Europe, countries like Hungary and the Czech Republic pursue growth within EU frameworks via telemedicine and research collaboration. In Asia, nations such as Lebanon, Singapore, and Vietnam have developed service-trade models integrated with cultural outreach, adapted to local laws and market needs.

Chapter Five is Promotion Strategies and Development Prospects of TCM Diplomacy. This chapter proposes a systematic implementation plan centered on overseas TCM centers, advocating a Balanced Score Card system to assess financial, customer, process, and growth dimensions. Under the Belt and Road framework, it suggests developing drought-resistant herb cultivation and new production bases, exploring a "cultural wellness + research + high-value products" model. From a policy perspective, it recommends improving coordination mechanisms, integrating TCM into universal health coverage, strengthening talent development, using digital tools, and advancing global health governance through multi-level cooperation.

3. Case Analysis of the Dissemination of TCM Culture in ASEAN Countries

3.1. The Spread of TCM in Singapore

3.1.1. Cultural Identity Foundation

The dissemination and development of TCM in Singapore are rooted in a profound cultural identity. During the 19th to early 20th centuries, large-scale migration from southern China to Singapore due to war and poverty brought TCM into the region, where it gradually became localized[1]. Ethnic Chinese constitute approximately 74% of Singapore's citizens and permanent residents, forming the fundamental carrier for the preservation and evolution of this cultural identity[1]. Sharing common origins in Chinese civilization, the two countries exhibit high cultural homology in language, values, and traditional customs. Building on this foundation, TCM has developed systematically since the 1950s through the establishment of colleges and clinics, supported by government regulation and integration.

3.1.2. Market Environment

Singapore possesses a top-tier public health system while also facing challenges such as an aging population. Its TCM market is well-developed, with a large number of clinics and a robust system, and TCM treatments have reached over half of the population[1][2]. Singapore also serves as a major export and re-export hub for Chinese herbal medicines and proprietary TCM products, relying heavily on imports and extending its influence across the ASEAN market.

3.2.3. Education

Educational collaboration and talent cultivation form the cornerstone of development. Singapore and China have signed multiple cooperation agreements, with Singapore recognizing TCM qualifications from eight leading Chinese medical universities and fostering deep collaboration in clinical practice and teaching[2]. Talent development often occurs through joint programs with Chinese universities, supplemented by mandatory continuing education initiatives[3].

3.2. The Spread of TCM in Vietnam

3.2.1. Cultural Identity Foundation

TCM was introduced to Vietnam around the 3rd century BC and over time integrated with local practices to form the Vietnamese *Dong Yi* (Eastern Medicine) system. It is important to note that TCM has been present in Vietnam for over two millennia. Dong Yi is not simply a local medicine but a fusion of indigenous traditions and TCM, also referred to as classical or ancient medicine. Within Vietnam's healthcare system, it operates alongside Western

medicine and inherently embodies core TCM principles[4][5]. This deep cultural integration strongly supports the dissemination and development of TCM in Vietnam.

3.2.2. Market Environment

Vietnam's economic growth has increased urban health awareness, with TCM gaining recognition for managing common and chronic diseases and offering therapies like acupuncture and massage. Private TCM clinics are widespread in both urban and rural areas, and Ho Chi Minh City has become a major hub for Chinese medicinal materials. Climate complementarity has fostered a bilateral trade in medicinal herbs. Many Chinese TCM companies have entered the Vietnamese market. In 2017, China exported 13,900 tons of medicinal materials to Vietnam, valued at over USD 100 million, representing a significant portion of China's exports to ASEAN and Belt and Road regions[6]. Nevertheless, smuggling of medicinal materials persists, and Vietnam maintains strict import-export regulations.

3.2.3. Education

Vietnamese traditional medicine universities have partnered with Chinese TCM institutions for academic exchange. Eight medical colleges in Vietnam offer undergraduate programs in traditional medicine. Vietnam sends physicians to China annually for TCM training, recognizes Chinese degrees, and allows returnees to apply for practice licenses after internships. Domestically, Dong Yi research institutes and associations train multi-level talent, including postgraduates, physicians, and pharmacists, forming a nationwide traditional medicine network.

4. Discussion: Overseas Communication and Cross-Cultural Dialogue of TCM

For achieving local integration, the key lies in cultivating and leveraging the intercultural awareness. This section will further explore the pivotal role of this awareness and competence.

4.1. The Key Role of TCM for Cross-cultural Communication

Nowadays, international dialogue and communication have become vital channels for positive exchanges among nations. TCM, as a medical system and practical science rooted in China's rich cultural heritage, demonstrates remarkable intercultural competence in the fields of international communication and diplomacy.

4.1.1. Inherent Cultural Attributes

Deeply embedded within the knowledge system of traditional Chinese culture, TCM naturally inherits the scientific wisdom, labor achievements, and philosophical thought accumulated by the Chinese nation over centuries. As a distinctive cultural symbol, it carries intrinsic cultural value and communicative power. This unique cultural identity gives TCM a competitive edge in cross-cultural contexts. Its international appeal has grown significantly. To date, TCM-related exchanges and cooperation have reached 183 countries and regions, and acupuncture has been successfully inscribed on UNESCO's Representative List of the Intangible Cultural Heritage of Humanity, gaining widespread international recognition[7].

As a cultural vehicle, TCM takes diverse forms in diplomatic contexts, extending beyond mere verbal or material expression. In diplomatic engagements, TCM can be experienced by national leaders through acupuncture or *tuina* massage, facilitate professional interactions via research exchanges, or provide humanitarian support through health aid programs. In 2000, Victoria became the first state in Australia to pass TCM legislation, marking

a pioneering case of TCM legalization in a Western country[8]. Thus, across different diplomatic scenarios and audiences, TCM's cultural forms can be disseminated with a focus on practical efficacy, effectively reducing cultural barriers in real-world applications.

4.1.2. A Future Medicine Grounded in Traditional Essence

TCM's intercultural competitiveness stems from both its historical foundations and its future potential, which aligns with global health needs. In diplomatic contexts, cultural symbols alone may lack sustainability, whereas universal practical value forms the core of cross-cultural appeal. As modern Western medicine increasingly embraces a "comprehensive health and wellness" approach, TCM's long-standing emphasis on preventive care and holistic well-being resonates with contemporary trends. For example, the *Qingfei Paidu* Decoction (a TCM formulation for clearing lung heat and removing toxins), recommended by Chinese authorities, demonstrated over 90% effectiveness in clinical trials, underscoring TCM's practical value in public health emergencies[7]. This illustrates that TCM principles such as preventive treatment and medicinal food homology are not merely historical concepts but constitute a coherent and systematic methodology with modern relevance.

4.2. Strategies and Methods for Promoting Cross-cultural Communication

4.2.1. Narrative Transformation via Modern Media

Globally, TCM is often mischaracterized by stereotypes of mysticism and relegated to alternative therapy. To counter this, its international communication must proactively craft a clear narrative centered on its cultural core—telling China's TCM story by highlighting its universal philosophy of holism and balance. Short-video platforms offer significant potential to disseminate TCM's legitimacy and healthcare value overseas. On platforms like YouTube, TCM content dissemination is already multi-polar, driven significantly by individual accounts and civil organizations, with overseas audiences generally holding positive attitudes, providing a solid foundation[9].

For culturally distant markets, TCM's social media communication requires a discursive shift: from persuading acceptance of its principles to directly shaping its image as gentle, wellness-oriented, and holistic. ASEAN, with its deep historical and geographical ties to TCM, serves as a strategic anchor for TCM diplomacy. Communication needs to emphasize cultural affinity and homology with local traditional medicines to lower engagement barriers. Beyond this, it is better to clearly articulate the systematic advantages of modern TCM disseminated through overseas TCM centers in countries like Malaysia, Singapore, and Vietnam.

4.2.2. Institutional and Resource Safeguards

Robust institutions and resources are fundamental for TCM's cross-cultural competitiveness and diplomatic advancement. TCM's long-term overseas development hinges on legal practice status. Governments could engage target countries via multilateral channels to integrate TCM first into complementary and alternative medicine frameworks, then mainstream systems. Standardized legal templates and safety protocols are crucial for negotiations. By 2023, TCM had reached 196 countries and regions, with 30 overseas centers built under the Belt and Road Initiative and inclusion in 16 free trade agreements, showcasing progress from sustained governmental efforts[10]. Continuous funding for overseas bases is also essential.

Dissemination of TCM needs a solid trade and industry foundation. In service trade, the medicine-led-by-practice model can build trust and pave the way for compliant product registration. By 2016, over 60 TCM institutions operated commercially in 20+ countries, and China dispatches about 2,000 TCM clinicians annually

abroad[11]. In goods trade, a full-chain support system is needed for overseas herb cultivation and quality control, with simplified export procedures and encouragement for leading firms to build global brands. This creates a virtuous cycle: from service recognition, product access, standard export, to cultural acceptance.

4.2.3. Reforms in Talent Development

Targeted talent cultivation is key to advancing TCM's international dissemination, requiring emphasis on interdisciplinary skills, dissemination responsibility, and cross-cultural awareness. Moreover, a shortage of professional translators and cross-cultural interpreters hampers overseas dissemination[12]. Models proposed by Heilongjiang University of Chinese Medicine integrating language proficiency with TCM literacy are needed[6]. Curriculum reform can embed TCM thinking into language learning to ensure accurate and readable communication[12].

Overseas TCM teaching materials often suffer from issues like poor adaptation[13] or excessive vocabulary and insufficient localization[12]. Materials need to center on classical TCM theory to maintain disciplinary integrity[13]. Incentive mechanisms can encourage overseas practitioners to engage in social media and dissemination activities, amplifying individual contributions.

4.3. New Directions for TCM Diplomacy

Translation serves as a bridge for the cross-cultural dissemination of TCM, fundamentally involving the co-construction and sharing of meaning across cultures. As a medical system embedded in Chinese philosophical thought, TCM's core concepts—such as preventive treatment and treatment based on syndrome differentiation—as well as culture-loaded terms like *yin-yang* and *qi* require effective transcoding from the source culture to the target culture through translation[14]. For such culture-loaded terms and specialized TCM terminology, translators must consider not only structural differences between Chinese and English but also external factors in cross-cultural communication. Strategies such as foreignization with annotations can be employed to supplement relevant background and cultural information, preventing misinterpretation by target readers and loss of essential meaning[15]. From a communication studies perspective, the quality of translation directly influences the agenda-setting effect of TCM culture in the international discourse, making it a crucial means to counteract Western stereotypes of TCM and enhance its global voice[12].

TCM culture often encounters cultural discount in cross-cultural communication due to its abstract terminology and profound philosophical concepts. Especially when addressing Western audiences, terms like *yin-yang* and *wuxing* (five elements) are prone to misunderstanding, thereby undermining TCM's scientific image[16]. Therefore, TCM translation needs to adhere to three core principles: First, skopos-oriented approach—with accurate transmission of medical principles and effective conveyance of culture as the central aim, flexibly selecting translation strategies. Second, audience adaptation—based on the audience segmentation theory from communication studies, prioritize medical accuracy for professional audiences and cultural accessibility for general audiences. Third, dual fidelity—ensuring both the accuracy of medical terminology and the preservation of cultural connotations in core concepts[14].

5. Conclusion

This paper reviews the book *Diplomacy of Traditional Chinese Medicine: Tradition, Dialogue, and Goodwill* and,

through case studies of typical ASEAN countries, explores the practices of TCM's overseas dissemination and the construction of intercultural competence. The cases of Singapore and Vietnam demonstrate that successful dissemination relies on deep cultural affinity, supportive market and policy environments, and sustainable educational cooperation.

The discussion further proposes that intercultural competence is central to achieving deeper international dissemination of TCM. This necessitates proactive transformation in narrative construction, robust institutional safeguards, and the cultivation of versatile cultural ambassadors. Among these, translation, as a key link in cross-cultural transcoding, may become a priority for future TCM diplomacy and academic research through its optimization and enhancement.

Looking ahead, the overseas dissemination of TCM and the diplomatic wisdom it embodies will play an even greater role in promoting mutual learning among civilizations, participating in global health governance, and contributing to the Health Silk Road initiative. Future research could further investigate topics such as the cognitive patterns of different regional audiences, the specific efficacy evaluation of digital dissemination, and the establishment of a standardized TCM translation system. This will continuously enrich and refine the theory and practice of TCM diplomacy, advancing TCM's contribution to global health and well-being.

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Research on the Construction of an Evaluation System for Old Community in Zhanjiang under the All-age Community Model

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Abstract: The All-Age Community Model is an innovative elderly care approach that prioritizes residents of all ages while addressing seniors' needs. It emphasizes the integration of intergenerational harmony and sustainable community development, catering to both physical and psychological requirements. Currently, there is a lack of systematic evaluation frameworks for implementing this model in aging communities. To bridge this gap, this study employs the Analytic Hierarchy Process (AHP) to refine evaluation criteria and indicators, establishing a comprehensive assessment system tailored for Zhanjiang's aging communities. The goal is to shift from evaluating only age-appropriateness to assessing full-age inclusivity, thereby providing a decision-making foundation for fostering intergenerational integration and creating sustainable elderly care environments.

Keywords: All-age community; Existing Zhanjiang communities; Intergenerational cohesion; Analytic Hierarchy Process (AHP); Comprehensive assessment

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1. Introduction

In recent years, China has witnessed rapid development in elderly care infrastructure. However, aging buildings and delayed age-friendly renovations in older communities render existing facilities inadequate for seniors. These facilities fail to align with the behavioral patterns and psychological needs of the elderly. Compounding this issue, the prevalent phenomenon of elderly-to-elderly care within communities exacerbates communication barriers, reduces social interaction, and hinders adaptation to societal changes. This situation intensifiescommunity isolation and deepens intergenerational divides [1].

The All-age Community represents an innovative model of elderly care that transcends traditional single-group focus. By adapting to evolving community demographics and family structures, it addresses the diverse needs of different generations while promoting intergenerational integration and social inclusion. This approach enables seniors to age in place while experiencing the community's enduring vibrancy. When applied to

revitalizing aging neighborhoods, this model incorporates child and middle-aged demographic considerations through aging-friendly research, effectively consolidating social resources and alleviating structural imbalances in elderly care resource allocation.

At present, there are few studies on the evaluation of old communities based on the model of All-age Community. Based on the case study and literature review of All-age Community, combined with the living conditions of residents in old communities in Zhanjiang, this paper constructs an evaluation system of old communities in Zhanjiang which is suitable for the model of All-age Community, and provides theoretical reference and practical basis for the promotion of the renewal of old communities.

2. Rationale and Basis for Constructing the Evaluation System for Zhanjiang's Old Communities under the All-age Community Model

2.1. Methodological Approach

This study employs the Analytic Hierarchy Process (AHP) to establish evaluation indicatorsthrough a dual approach combining qualitative and quantitative analysis with theoretical construction and empirical research [2]. The process unfolds in three phases: First, we analyze domestic and international cases of All-age Community development to identify core elements and establish a preliminary evaluation framework. Second, we systematically review relevant literature to extract and integrate existing evaluation factors, then select initial indicators. Finally, based on the actual living conditions of old communities in Zhanjiang City, we design targeted questionnaires. Through data collection and analysis, we refine the selection of All-age Community evaluation indicators that align with local realities, ultimately constructing a comprehensive, systematic, and targeted evaluation system (**Figure 1**).

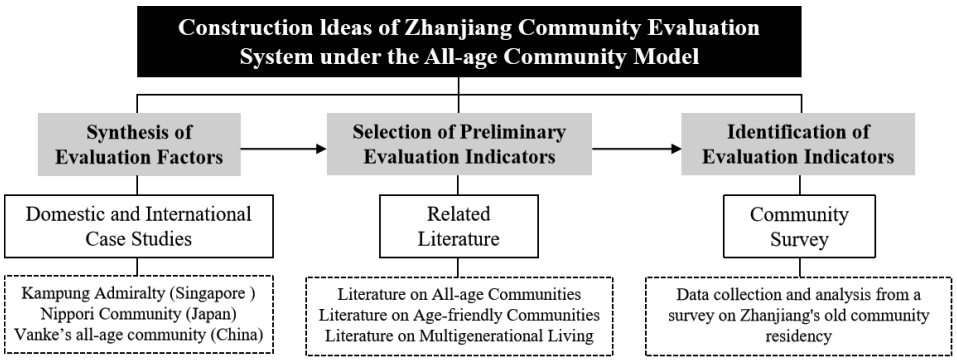

Figure 1. Methodological Approach

2.2. Domestic and International Case Studies of All-Age Community

The All-age Community theory has accumulated substantial practical experience in residential space applications. Germany emphasizes individual autonomy, promoting neighborhood mutual aid and close-knit living models. Influenced by family-oriented values, Asian countries like Japan and Singapore have developed diverse multi-generational cohabitation models. In China, the All-age Community model is primarily reflected in senior housing, with major developers such as Vanke and China Resources achieving notable explorations in this field. Extracting core construction principles and design elements from existing projects forms the foundation for ensuring that evaluation metrics for all-age communities closely align with residents' actual needs (**Table 1)**.

2.2.1. The Kampung Admiralty in Singapore

This innovative vertical community integrates multi-generational living spaces, senior care facilities, intergenerational social areas, and commercial spaces into a single building, creating a one-stop lifestyle through efficient land use. The structure is divided into three sections: the upper section houses senior apartments and a community park, the middle section contains a medical center, while the lower section is designed as gray spaces like a community square. This three-dimensional layout facilitates the interaction and integration of different functional areas, fostering intergenerational engagement.

The community boasts diverse public spaces, all designed with exceptional inclusivity. The ground-floor public square and second-floor dining area interact through visual, spatial, and circulation flows, enhancing spatial vitality and fostering social engagement. The uppercommunity park, featuring tiered terraces, visually connects with the lower community square. The central medical space, integrated with the outdoor natural environment, creates a visual dialogue between elderly and younger residents, strengthening intergenerational interaction. Additionally, the park incorporates children's play areas, providing opportunities for intergenerational interaction between grandparents and grandchildren, effectively leveraging the community's multi-age appeal in aging-friendly development.

2.2.2. The Nippori Community in Japan

The main building of Nikaidori House adopts a vertical functional layout. The ground floor serves as a community public area, while the 2nd and 3rd floors are designed as rental residences for young people or families. Floors 4 to 11 are dedicated to senior living, accommodating both assisted and self-care seniors. This vertical integration of elderly and younger residents effectively fosters intergenerational interaction.

The first floor public space includes multifunctional hall, restaurant, rest room, kindergarten, medical institution and so on. The multifunctional hall is used for the community to hold regular activities, and the rest room can be used as a library. It is adjacent to the kindergarten, so that the elderly can have visual interaction with children when they are resting, and relieve their loneliness.

The residential design features differentiated layouts for seniors with varying physical conditions. Lower floors cater to those requiring nursing care, each equipped with a communal dining area, bathroom, and lounge space, along with a compact kitchen and bathroom. Upper floors accommodate self-reliant seniors with either a 34 m^2 one-bedroom or 91 m^2 two-bedroom unit, complete with a private kitchen and bathroom. These units also include versatile spaces such as a multifunctional room, game room, and rooftop terrace bath, enhancing residents' independence and freedom of movement.

The community regularly organizes various social events, including garden gatherings, tea parties, and reading sessions for seniors and children, to foster interaction between older residents and younger community members. These activities also strengthen intergenerational connections within the community. Additionally, courtyard maintenance and disaster preparedness drills invite participation from neighboring residents and broader communities, enhancing the community's ties with the outside world and increasing its openness.

2.2.3. Vanke's all-age community in China

Vanke developed an idealized community model in Shanghai, focusing on an all-age community-based elderly care system. The proposed site, located in the suburban area of Shanghai's Outer Ring Road, features convenient transportation and comprehensive amenities including medical facilities, educational resources, and commercial

services—all accessible within a 30-minute drive. The community adopts a semi-enclosed layout, with mixed-use residential clusters integrating standard housing and age-friendly residences. At its core are centralized elderly care apartments and institutions, connected internally and externally by a U-shaped elderly care and living support network, along with a vibrant park belt.

In elderly care services, age-friendly housing is integrated into conventional residences to create a mixed-age living model. This approach not only accommodates evolving family structures but also fosters social connections across generations, reducing psychological isolation among seniors. Elderly care facilities are tiered according to physical conditions, including nursing homes, senior apartments, health centers, day care centers, and senior dining halls. These spaces emphasize a family-like atmosphere to minimize the institutional feel and alienation of the environment.

To address the needs of different age groups, children's educational facilities and intergenerational interaction spaces should be introduced into community educational spaces, public areas, and landscape zones. These facilities should be strategically distributed based on usage frequency and service radius. This approach not only meets the daily needs of all age groups and facilitates mixed-age interactions within the community, but also extends its benefits to surrounding neighborhoods, thereby expanding the social engagement opportunities for the elderly.

Table 1. Summary of Elements and Indicators in All-Age Community Case Studies

Project Name	Element	Indicator
The Kampung Admiralty in Singapore	It is equipped with multi-generational living spaces, facilities for the elderly, intergenerational social areas, and commercial facilities.	Meeting All-Age Needs
	The Intersection and Combination of Functional Spaces	Spatial Diversity and Multi-functionality
	Public Space Diversity and Inclusiveness	Intergenerationally Inclusive Spaces
The Nippori Community in Japan	Vertical Mixed Configuration of Elderly and Young Residents	Multigenerational Mixed Living Model
	Public space has the function of intergenerational communication	Spaces for Intergenerational Interaction
	Differentiated apartment design	Adaptability of Residential Unit Layouts
	Regularly organize various types of exchange activities	Organizing Intergenerational Activities
Vanke's all-age community in China	The adaptation of aging-friendly housing to ordinary residential buildings	All-age Mixed Living Model
	The elderly care facilities are allocated according to the physical condition of the elderly.	Hierarchically Configured Facilities
	Introducing children's education facilities and intergenerational communication venues into community education spaces, public spaces, and landscape spaces.	All-age Shared Facilities

2.3. Synthesis of Literature on All-age Community

The literature on All-age Community research has shown a consistent growth trend, attracting significant scholarly attention in recent years. The number of journal articles has steadily increased, with research focus expanding from initial emphasis on the concept of All-age Community development in newly built communities to broader studies on existing community adaptation. This field primarily encompasses three research directions: evaluation systems for all-age communities, studies on constructing new all-age communities, and research on renovating existing all-age communities.

Current research on evaluating old communities within an All-age Community model remains limited. Wu Pinqi et al. conducted a suitability assessment for new all-age community sites across seven dimensions: healthcare, elderly care facilities, transportation, commerce, parks, land pricing, and green spaces [3]. Cao Zheng et al. developed an all-age friendliness evaluation system for aging communities, focusing on six criteria: safety, comfort, accessibility, diversity, recreational value, and cultural relevance [4]. Liu Yang proposed standards for public spaces in aging communities, emphasizing street-life comfort, transportation accessibility, and rich social interactions [5]. Han Xingyu et al. established an all-age friendly evaluation framework for public service facilities in aging communities, covering five dimensions: integrity, safety, comfort, smart technology, and a sense of belonging [6].

Research on the application of All-age Community models primarily focuses on elderly care real estate, examining the planning and architectural design of newly developed senior living communities. Existing domestic practices in this field are predominantly concentrated in elderly care real estate, with major developers like Vanke and Greenland actively promoting and exploring the concept of all-age communities. Studies on constructing new all-age communities generally address material aspects such as user demographics, spatial layout, housing unit types, and supporting facilities, establishing principles and strategies for community development. For instance, Yang Siyuan compared domestic and international research practices in elderly care real estate, analyzed domestic case studies, summarized the strengths and weaknesses of existing models, and proposed construction strategies from three dimensions: policy recommendations, community planning, and service operations [7]. Feng Yixin proposed a "trinity" approach to building all-age communities that integrates emotional support, medical security, and material provisions [8]. Liao Luzhe, after analyzing existing issues, optimized the construction model of all-age communities and proposed a multi-level conceptual framework [9]. Liu Xi not only considered the physical characteristics of elderly residents but also emphasized their psychological needs, conducting psychological analysis of senior demographics to develop all-age senior living communities that meet actual requirements through comprehensive planning, architectural design, facility development, and service systems [10].

In the application of the All-age Community concept, academic circles have gradually initiated theoretical discussions and practical research. Multiple scholars have proposed targeted renewal strategies from dimensions such as spatial transformation and governance mechanisms, combining specific case studies. For instance, Zhang Yu, based on the current issues of old residential communities in Nanchang's unit system, explored community renewal pathways guided by the all-age concept from the perspectives of public spaces including square areas, street spaces, and residential spaces [11]. Lü Mingshu et al., considering the practical background of China's old community renovations, proposed principles such as multi-level coordination, people-oriented approaches, and flexible governance, and established a corresponding all-age renewal strategy system [12]. Wang Yanlu, using Fangxing Community in Hefei, Anhui Province as a case study, systematically proposed all-age renewal strategies applicable to old communities from four dimensions: shared spaces, composite spaces, characteristic spaces, and intergenerational spaces [13].

Through systematic analysis of three classic domestic and international cases and review of 106 highly relevant literature articles, we have preliminarily established the evaluation criteria for old communities under the All-age Community model as: safety and accessibility, comprehensiveness and comfort, mixed-use and sharing, intergenerational interaction, and all-age participation. By integrating theoretical frameworks, we further refined and optimized the connotations of each criterion layer, initially constructing an evaluation index system comprising 5 criterion layers and 24 indicator layers (**Table 2**). This system serves as the foundational framework for subsequent field research to conduct indicator screening and revisions.

Table 2. Preliminary Selection of Evaluation Indicators for Old Communities under All-age Community Model

Criteria Level	Indicator Level
Safety and Accessibility	Residential Space Safety
	Public Space Safety
	Road Traffic Safety
	Full Path Accessibility
	Continuous Access System
Comprehensiveness and Comfort	Spatial Planning Rationality
	Activity Space Adequacy
	Service Facility Completeness
	Landscape Environment Comfort
	Indoor Environment Comfort
Mixed-Use and Sharing	Spatial Layout Hierarchy and Mix
	Housing Unit Adaptability
	Shared Space Distribution Balance
	Facility Sharing and Flexible Allocation
	Space-Time Shared Use Mechanism
Intergenerational Interaction	Multi-Generational Residential Mix
	Intergenerational Interaction Space Support
	Multi-Generational Facility Inclusivity
	Cross-Generational Cooperation Activity
	Intergenerational Cultural Integration
All-Age Participation	All-Age Activity Normalization
	Multiple Stakeholder Participation
	Community Service All-Age Friendliness
	Information Communication and Feedback Channels

2.4. Indicator Screening Based on the Needs of All-age Groups in Zhanjiang's Old Communities

Based on the preliminary theoretical research, to overcome the limitations of purely theoretical evaluation criteria and make them more practical and objective, we conducted fieldwork in the old communities of Chikan, Xiashan, and Mazhang districts in Zhanjiang City. Through direct communication with residents, we accurately gathered the actual needs of all age groups regarding community life, which enabled us to optimize and refine the evaluation criteria.

The study conducted seasonal and temporal surveys of elderly, middle-aged, young, adolescent, and preschool groups within the community through observation, questionnaires, and interviews. The research focused on understanding their genuine needs and spatial usage preferences. First, by observing activity patterns, engagement levels, and frequency across age groups, we identified residents 'behavioral habits and spatial challenges. Second, questionnaires were designed based on these findings to analyze age-specific demands. Finally, interviews were conducted to further explore residents' needs, with key demand terms frequently mentioned in interview transcripts being consolidated and categorized into indicators (**Table 3**).

Table 3. Indicators Derived from the Needs of All-age Groups in Zhanjiang's Old Communities

Group Category	Activity	Demand	Synthesis of Indicators
Elderly Group	Sitting, chatting, walking, working out, meeting, playing chess, shopping, looking after children	Intergenerational shared spaces, gathering spaces, age-friendly facilities, elderly care spaces, and senior learning spaces	Barrier-Free Access Systems, Activity Space Adequacy, Service Facility Completeness, Community Smart Technology Level, Shared Space Distribution Balance, Facility Sharing and Flexible Allocation, Intergenerational Interaction Space Support, Multi-Generational Facility Inclusivity, Community Service All-Age Friendliness, Neighborhood Mutual Aid and Support Network
Middle-aged Group	Fitness, socializing, childcare	Children's Care Space, Intergenerational Communication Space and Community Landscape Greening	
Young Adult Group	Sports, parties, and entertainment	Multi-type fitness spaces, smart facilities, landscape greening, pet spaces, and camping areas	
Adolescent Group	Study, communicate, exercise, play	Children's equipment, natural spaces	
Young Children Group	Play and learn	Infant facilities, fun spaces, and natural classrooms	

Based on field research findings and consultations with relevant experts, the preliminary indicators were refined and revised (**Table 4**). First, regarding indicator supplementation, given the frequent demands for smart facilities and childcare services among community residents, experts suggested that enhanced community intelligence could improve convenience and comfort for all age groups. Additionally, neighborhood mutual aid networks could compensate for existing public service gaps and meet diverse resident needs. Consequently, "Community Smart Technology Level" and "Neighborhood Mutual Aid and Support Networks" were added as evaluation indicators. Second, concerning indicator optimization, the "Multi-Generational Residential Mix" indicator derived from the All-age Community theory faced practical challenges in Zhanjiang's aging communities. Residents showed minimal willingness to exchange apartment layouts for multi-generational living. Experts recommended focusing on residential space flexibility and adaptability to assess aging communities' inclusivity without requiring resident relocations. This indicator could be integrated into the more comprehensive "Housing Unit Adaptability" metric. Finally, some indicators required refinement: "Landscape Environment Comfort" and "Indoor Environment Comfort" could be consolidated into "Physical Environment Comfort", while "Full Path Accessibility" and "Continuous Access System" could be merged into "Barrier-Free Access Systems".

Table 4. Process of Screening and Revising Preliminary Indicators

Preliminary Indicator	Screening and Revision Status
Criteria Level: Comprehensiveness and Comfort	Sub-criteria Level: Added the indicator "Community Smart Technology Level"
Criteria Level: All-Age Participation	Sub-criteria Level: Added the indicator "Neighborhood Mutual Aid and Support Network"
Indicator Level: Multi-Generational Residential Mix	Indicator Level: Integration into "Residential Unit Adaptability"
Indicator Level: Landscape Environment Comfort	Indicator level: Consolidated as "Physical Environment Comfort"
Indicator Level: Indoor Environment Comfort	
Indicator Level: Full Path Accessibility	Indicator level: Consolidated as "Barrier-Free Access Systems"
Indicator Level: Continuous Access System	

3. Construction of an Evaluation System for Zhanjiang's Old Communities under the All-age Community Model

3.1. Hierarchical Structure Model of Evaluation Indicators

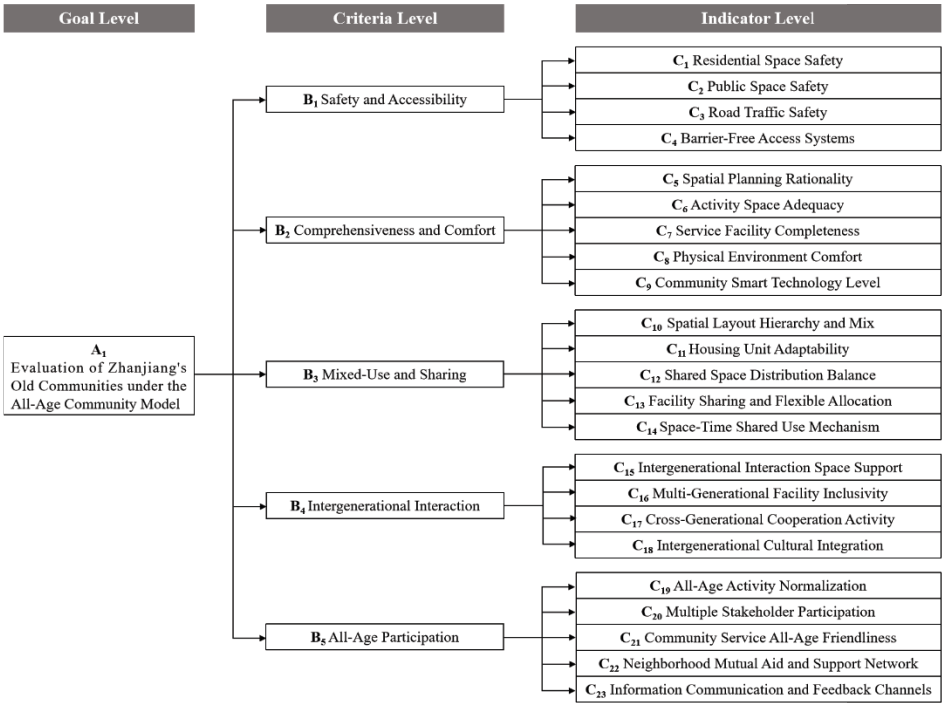

Figure 2. AHP Hierarchy Model of Evaluation Indicators for Zhanjiang's Old Communities under the All-age Community Model

The evaluation system comprises three tiers (**Figure 2**). The target tier is "A_1 Evaluation of Zhanjiang's Old Communities under the All-Age Community Model", while the criterion tier features five key indicators: "B_1 Safety and Accessibility, B_2 Comprehensiveness and Comfort, B_3 Mixed-Use and Sharing, B_4 Intergenerational Interaction, and B_5 All-Age Participation," each corresponding to 23 specific metrics. Specifically: "B_1 Safety and Accessibility" includes "C_1 Residential Space Safety, C_2 Public Space Safety, C_3 Road Traffic Safety, C_4 Barrier-Free Access Systems"; "B_2 Comprehensive Comfort" covers "C_5 Spatial Planning Rationality, C_6 Activity Space Adequacy, C_7 Service Facility Completeness, C_8 Physical Environment Comfort, C_9 Community Smart Technology Level"; "B_3 Mixed-Use and Sharing" involves "C_{10} Spatial Layout Hierarchy and Mix, C_{11} Housing Unit Adaptability, C_{12} Shared Space Distribution Balance, C_{13} Facility Sharing and Flexible Allocation, C_{14} Space-Time Shared Use Mechanism"; "B_4 Intergenerational Interaction" evaluates "C_{15} Intergenerational Interaction Space Support, C_{16} Multi-Generational Facility Inclusivity, C_{17} Cross-Generational Cooperation Activity, C_{18} Intergenerational Cultural Integration "; and "B_5 All-Age Participation" assesses "C_{19} All-Age Activity Normalization, C_{20} Multiple Stakeholder Participation, C_{21} Community Service All-Age Friendliness, C_{22} Neighborhood Mutual Aid and Support Network, C_{23} Information Communication and Feedback Channels."

3.2. Weight Calculation of Evaluation Indicators

Based on the hierarchical structure model, we constructed a criterion layer judgment matrix and five indicator layer judgment matrices (**Figure 3**). Here, A_1 represents the Goal Level : Evaluation of Zhanjiang's Old Communities

under the All-Age Community Model, B_1-B_5 denote the five criterion layers, and C_1-C_{23} represent the indicator layers. To ensure the decision-making results are more objective and universal, the six judgment matrices were assigned values through a 1-9 importance scale method jointly conducted by designers, experts in the universal-age field, and community residents.

A	B_1	B_2	B_3	B_4	B_5
B_1	1	2	2	3	3
B_2	1/2	1	2	2	2
B_3	1/2	1/2	1	1/3	1/3
B_4	1/3	1/2	3	1	2
B_5	1/3	1/2	3	1/2	1

B_1	C_1	C_2	C_3	C_4
C_1	1	2	2	4
C_2	1/2	1	1/2	3
C_3	1/2	2	1	2
C_4	1/4	1/3	1/2	1

B_2	C_5	C_6	C_7	C_8	C_9
C_5	1	2	2	2	5
C_6	1/2	1	3	1/2	4
C_7	1/2	1/3	1	1/3	2
C_8	1/2	2	3	1	2
C_9	1/5	1/4	1/2	1/2	1

B_3	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}
C_{10}	1	2	2	3	4
C_{11}	1/2	1	1/2	1/2	3
C_{12}	1/2	2	1	2	3
C_{13}	1/3	2	1/2	1	2
C_{14}	1/4	1/3	1/3	1/2	1

B_4	C_{15}	C_{16}	C_{17}	C_{18}
C_{15}	1	1/2	3	3
C_{16}	2	1	2	3
C_{17}	1/3	1/2	1	1/2
C_{18}	1/3	1/3	2	1

B_5	C_{19}	C_{20}	C_{21}	C_{22}	C_{23}
C_{19}	1	2	1/2	1/2	1/2
C_{20}	2	1	1/2	1/2	1/2
C_{21}	2	2	1	3	2
C_{22}	2	2	1/3	1	2
C_{23}	2	2	1/2	1/2	1

Figure 3. Judgment Matrices for the Criteria and Indicator Levels

The five criterion layers carry weights of 0.3634,0.2282,0.0917,0.1794, and 0.1372 respectively. The consistency test yielded a maximum eigenvalue λ_{max}=5.3747, with CR=CI/RI=0.0836<0.10, confirming compliance with the consistency test. Similarly, the maximum eigenvalues λ_{max} for each indicator layer are 4.1179,5.2856,5.1846,4.2153, and 5.2866 respectively. All final CR values remain below 0.10, demonstrating that the judgment matrices for each indicator layer pass the consistency test. The hierarchical ranking results are thus objective and valid (**Table 5**).

Table 5. Weights of Indicators in the Evaluation System for Zhanjiang's Old Communities under the All-age Community Model

Target Layer (A)	Guideline Level (B)	Weight (W)	Indicator layer (C)	Weight (W)
Evaluation of Zhanjiang's Old Communities under the All-Age Community Modell	B_1 Safety and Accessibility	0.3634	C_1 Residential Space Safety	0.4295
			C_2 Public Space Safety	0.2066
			C_3 Road Traffic Safety	0.2649
			C_4 Barrier-Free Access Systems	0.0990
	B_1: Consistency Ratio (CR):0.0442; λ_{max}: 4.1179			
	B_2 Comprehensiveness and Comfort	0.2282	C_5 Spatial Planning Rationality	0.3522
			C_6 Activity Space Adequacy	0.2143
			C_7 Service Facility Completeness	0.1106
			C_8 Physical Environment Comfort	0.2517
			C_9 Community Smart Technology Level	0.0712
	B_2: Consistency Ratio (CR):0.0638; λ_{max}: 5.2856			
	B_3 Mixed-Use and Sharing	0.0917	C_{10} Spatial Layout Hierarchy and Mix	0.3734
			C_{11} Housing Unit Adaptability	0.1456
			C_{12} Shared Space Distribution Balance	0.2446
			C_{13} Facility Sharing and Flexible Allocation	0.1634
			C_{14} Space-Time Shared Use Mechanism	0.0729
	B_3: Consistency Ratio (CR):0.0412; λ_{max}: 5.1846			
	B_4 Intergenerational Interaction	0.1794	C_{15} Facility Sharing and Flexible Allocation	0.3168
			C_{16} Multi-Generational Facility Inclusivity	0.4123
			C_{17} Cross-Generational Cooperation Activity	0.1204
			C_{18} Intergenerational Cultural Integration	0.1505
	B_4: Consistency Ratio (CR):0.0806; λ_{max}: 4.2153			
	B_5 All-Age Participation	0.1372	C_{19} All-Age Activity Normalization	0.1372
			C_{20} Multiple Stakeholder Participation	0.1045
			C_{21} Community Service All-Age Friendliness	0.3538
			C_{22} Neighborhood Mutual Aid and Support Network	0.2243
			C_{23} Information Communication and Feedback Channels	0.1802
	B_5: Consistency Ratio (CR):0.0640; λ_{max}: 5.2866			
A: Consistency Ratio (CR):0.0836; λ_{max}: 5.3747				

3.3. Results and Analysis of Evaluation Weighting

The weight distribution results of criterion layers in **Table 5** reveal that in Zhanjiang's old community evaluation system under the universal-age model, the importance ranking of five criterion factors is: "B_1 Safety and Accessibility" (0.3634)> "B_2 Comprehensiveness and Comfort" (0.2282)> "B_4 Intergenerational Interaction"

(0.1794)> "B_5 All-Age Participation" (0.1372)> "B_3 Mixed-Use and Sharing" (0.0917). Notably, the "Safety and Accessibility" factor carries the highest weight, demonstrating its dominant role in evaluating universal-age adaptation of aging communities and serving as the core metric for assessing Zhanjiang's community transformation. The "Comprehensiveness and Comfort" factor also holds significant weight, highlighting the crucial role of spatial quality and infrastructure in successful universal-age adaptation. Both "Intergenerational Interaction" and "All-Age Participation" are indispensable elements in this evaluation system, significantly influencing the degree of community universalization. The relatively lower weight assigned to "Mixed-Use and Sharing" reflects practical considerations regarding Zhanjiang's current renovation phase and community realities, ensuring the evaluation system's higher applicability in real-world implementation.

When applying this evaluation framework, each indicator within the system serves as a core assessment element. Through itemized scoring and weighted calculation, we derive weighted scores for each component, ultimately synthesizing them into a comprehensive evaluation metric for the aging population ratio in old communities. This system proves effective not only for internal assessments of individual communities but also for cross-community comparative analyses. The evaluation results systematically reveal the current status and characteristics of aging population development in Zhanjiang's old communities, providing actionable strategies for future renovations. These insights will drive holistic optimization and quality enhancement of these communities.

4. Conclusion

The all-age transformation of aging communities serves as an effective approach to transcend single-age adaptation and mitigate intergenerational barriers. Grounded in the All-age Community model theory, this study employs the Analytic Hierarchy Process (AHP) to develop an evaluation framework for Zhanjiang's aging communities, comprising 5 criterion levels and 23 indicator levels. This system not only systematically integrates core elements of all-age communities but also incorporates regional considerations in its indicator design, aligning with Zhanjiang's actual conditions and enhancing applicability. As Zhanjiang's urban development and community needs evolve dynamically, the framework's indicator content and weighting should be continuously refined to provide more valuable assessment tools and decision-making references for the ongoing transformation of aging communities.

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Beyond Content Delivery: Investigating the Impact of Blended Micro-Courses on Pharmaceutical Literature Retrieval Skill Acquisition and Competency Development in Vocational Education

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Abstract: Micro-courses offer a flexible and accessible mode of learning. The effectiveness of a blended micro-course on pharmaceutical literature retrieval skills was empirically evaluated. Data were obtained from 76 pharmaceutical students in a quasi-experimental, pre-test-post-test control group design. Participants were allocated to an experimental group (n = 39) receiving the blended micro-course intervention or a control group (n = 37) receiving traditional instruction. Statistical analyses were undertaken in SPSS. Analysis of covariance (ANCOVA) was employed to compare post-intervention outcomes while controlling for baseline scores. The ANCOVA results revealed a statistically significant difference in favor of the experimental group for both practical skill acquisition ($F(1, 73) = 60.677$, $p < .001$, partial $\eta^2 = .454$) and competency development, including information need identification, retrieval, critical thinking, and application. Furthermore, students in the experimental group reported high levels of satisfaction with the blended micro-course, particularly praising its course design (M=5.0, SD=0.6) and the seamless integration of online and offline learning (M=4.8, SD=0.7). The findings provide evidence that a well-designed blended micro-course model, which intentionally integrates cognitive, social, and teaching presences, can significantly outperform traditional methods in fostering practical skills and professional competencies in vocational education.

Keywords: Blended learning; Micro-course; Vocational education; Online inquiry-based micro-lectures; Offline supervised practice

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1. Introduction

Vocational education has undergone significant transformations in recent decades, driven by the advancement

of information technology and evolving pedagogical philosophies. The rapid evolution of global industries and the increasing demand for a "job-ready" workforce have placed unprecedented pressure on vocational education and training (VET) systems worldwide.[1] Traditional VET models, characterized by rigid schedules and a primary reliance on face-to-face instruction, are often challenged by the need for greater flexibility, scalability, and alignment with industry practices. Particularly in fields like pharmacy and nursing, the ability to integrate theoretical knowledge with practical application in scenarios is crucial for nurturing workforce-ready graduates [2].

In response, digital learning technologies have emerged as a powerful catalyst for pedagogical innovation. Among these, micro-courses—short, focused learning modules—have gained significant traction due to their potential to deliver flexible, accessible, and just-in-time learning experiences[3].

Micro-courses, a fundamental component of blended learning, have evolved significantly over time. The initial phase, referred to as "Micro-Course 1.0," focused on short online lectures designed to deliver content in a concise format. However, the proliferation of micro-courses in vocational education and training (VET) has often been accompanied by a critical pedagogical flaw:Many micro-courses are designed as simple repositories of video lectures and reading materials, reducing learning to a passive act of information consumption.[4] This approach is particularly problematic in vocational education, where the ultimate goal is not merely knowledge acquisition but the development of tangible practical skills and multifaceted professional competencies[5].

In "Micro-Course 2.0", these resources started incorporating interactive elements and immediate feedback mechanisms, making them more engaging for learners. The current phase, "Micro-Course 3.0," emphasizes inquiry-based tasks and collaborative learning, prioritizing personalized learning and the development of higher-order skills beyond rote memorization.[6] This evolution highlights the potential for micro-courses to serve not only as content delivery mechanisms but also as tools for promoting active inquiry and collaborative problem-solving.

The critical question remains: How can micro-courses be designed to move "beyond content delivery" to become effective catalysts for applied learning and skill development? Blended learning, which strategically combines online and offline learning modalities, offers a promising solution. This approach allows theoretical knowledge to be delivered and assimilated online via micro-courses, freeing up valuable face-to-face time for hands-on practice, personalized feedback, and collaborative problem-solving.[7] This study posits that an intentionally designed blended micro-course, grounded in robust learning theory, can create a powerful ecosystem for vocational learning.

Blended learning is not simply a mix of technologies and traditional methods; it is a fundamental redesign of the instructional model to optimize the strengths of both environments.[8] In VET, its value lies in its ability to support the dual goals of knowledge construction and skill application. The online component can provide standardized, high-quality theoretical instruction through micro-courses, which students can access at their own pace. This prepares them for the offline component, where they can engage in intensive, supervised practice in labs or workshops, transforming theoretical understanding into practical proficiency.[9]However, the success of this model hinges on the seamless and purposeful integration of both components.

This research, situated within a leading pharmaceutical vocational college in China, investigates the impact of such a blended micro-course model. By employing a quasi-experimental design, this study aims to provide empirical evidence on the effectiveness of this approach compared to traditional teaching methods. The primary objective is to evaluate its influence on two core outcomes of vocational education: the acquisition of practical, hands-on skills and the development of broader professional competencies, such as information literacy and critical thinking, which are consistently identified as essential for success in the 21st-century workforce.[10]

Despite the widespread adoption of blended learning in Vocational Education and Training (VET), there is a scarcity of research that systematically explores pedagogical designs capable of moving beyond mere knowledge transmission to effectively foster complex applied competencies. This study addresses this crucial gap by applying the Community of Inquiry (CoI) framework.

2. Materials and Methods

2.1. Study design

The present study was a quasi-experimental, non-equivalent control group pre-test-post-test design study. It was conducted at Jiangsu Pharmaceutical Vocational College.

2.2. Ethical statement

Our study was approved by the Ethics Committee of the Jiangsu Pharmaceutical Vocational College under Approval ID TA_CACM_2023010 and SCX23086. The participants consented to participate in the study before completing the first questionnaire.

2.3. Participants and eligibility criteria

The participants were 76 second-year students enrolled in the Traditional Chinese Medicine program, distributed across two parallel classes. The experimental group comprised 39 students (33 female, 6 male; mean age = 19.2 years), while the control group consisted of 37 students (33 female, 4 male; mean age = 19.1 years). Independent t-tests and Chi-square tests confirmed that there were no statistically significant differences between the two groups at baseline regarding their college entrance scores, gender distribution, or age, ensuring group comparability.

2.4. Questionnaire

Adapt the existing ACRL (Association of College and Research Libraries) Information Literacy Framework for Higher Education and develop a scale for pharmaceutical information literacy and application capabilities, tailored to the specific scenarios of the pharmaceutical profession. Ten experts evaluated the relevance, clarity, and simplicity of the assessment and questionnaire which are available in full in Supplementary File 1, 2. The learning satisfaction questionnaire focuses on the design elements of blended micro-lessons, learning experience, interactivity, and their support for practical learning[11] .

2.5. Educational intervention

Week 1: A pre-test was administered to all students in both the experimental and control groups to collect baseline data on their operational skills and data from the self-assessment scale of their abilities.

Weeks 2 to 9 (8 weeks): This eight-week period was defined as the duration of the intervention, covering the core skill modules of the “Pharmaceutical Literature Retrieval” course.

Experimental Group: This group received the innovative blended micro-course intervention for the “Pharmaceutical Information Retrieval” module. The intervention was structured as follows:

Online Guided Learning: Students watched inquiry-driven micro-course videos, which included problem-based scenarios and interactive quizzes.

Offline Supervised Practice: In scheduled lab sessions, students applied the knowledge gained online to

perform practical tasks (e.g., database searching, literature analysis) under the guidance of an instructor who provided real-time feedback.

Online Reflection and Collaboration: Following the practice session, students completed reflective journals and participated in online discussion forums to solve complex problems collaboratively.

Control Group: This group received traditional instruction for the same module. This involved standard classroom lectures covering theoretical concepts, followed by conventional offline practice sessions where students completed assigned tasks with limited interactive guidance.

Week 10: A post-test was administered to students in both groups, using the exact same instruments as the pre-test. Concurrently, a learning satisfaction questionnaire was distributed to the students in the experimental group.

2.6. Data collection

A standardized performance-based assessment was used to measure students' practical skills in pharmaceutical information retrieval. A self-developed "Pharmaceutical Information Literacy and Application Competency Scale" was used to measure students' competency development. A "Blended Micro-Course Learning Experience Satisfaction Questionnaire" was administered to the experimental group at the end of the intervention. The scale and questionnaire were adapted to an online format, with an informed consent form included at the beginning to comply with the personal information protection standards. To maintain confidentiality and encourage honest responses, no personal information, such as names or student numbers, was collected [12].

2.7. Statistical analysis

Quantitative data were analyzed using SPSS 26.0. Descriptive statistics (mean, standard deviation) were calculated for all variables. To determine the intervention's impact, a series of Analysis of Covariance (ANCOVA) tests were conducted. For each dependent variable (practical skill score and each competency dimension score), the post-test score was used as the outcome variable, the group allocation (experimental vs. control) as the fixed factor, and the corresponding pre-test score as the covariate. This method statistically controls for any pre-existing differences between the groups, providing a more accurate estimate of the intervention's true effect. The significance level was set at $\alpha = 0.05$.

3. Results

3.1. Literature Retrieval Knowledge and Skill Acquisition Score

The evaluation of pharmaceutical literature retrieval skills is conducted through a test with a maximum score of 100, which is conducted once before and after the teaching intervention, scored by senior teachers using the same standardized scoring scale.

Independent T tests were performed to identify if there were significant differences between different modalities for students in regard to their post-test scores. **Table 1** indicates that there was a significant difference between the learning modality for the students, in regard to their post-test scores, $t(74) = 8.116$, $p<.001$. Since the mean difference (MD) was 12.82 and the pooled standard deviation was approximately 6.88, $d = 1.86$, according to Cohen (1988) indicated the large effect size. Thus, students taking classes in the blended micro-course learning modality performed better than students taking classes in the traditional learning modality.

This section may be divided by subheadings. It should provide a concise and precise description of the

experimental results, their interpretation, as well as the experimental conclusions that can be drawn.

Table 1. Independent samples test for literature retrieval knowledge and skill acquisition scores in post-test groups

Group	Post-test Mean	Post-test SD	t	df	p
Experimental Group	86.72	6.73	8.116	74	.000*
Control Group	73.90	7.03			

The results of the ANCOVA on practical skill scores are presented in **Table 2**. After controlling for the pre-test scores, there was a statistically significant difference in the adjusted post-test mean scores between the experimental and control groups, $F(1, 73) = 60.677$, $p < .001$. The effect size was large (partial $\eta^2 = .454$), indicating that the blended micro-course intervention had a substantial positive impact on students' practical skill development. The experimental group (Adjusted M = 86.6) significantly outperformed the control group (Adjusted M = 74.0).

Table 2. Descriptive statistics and ANCOVA results for practical skill scores

Group	N	Pre-test Mean(SD)	Post-test Mean(SD)	Adjusted Post-test Mean	F-value	p-value	Partial η^2
Experimental	39	45.5(9.7)	86.7(6.7)	86.6	60.677	<.001*	.454
Control	37	41.8(7.2)	73.9(7.0)	74.0			

3.2. Competency Development

A self-developed "Pharmaceutical Information Literacy and Application Competency Scale" was used to measure students' competency development. The scale contains several dimensions, including "Information Need Identification & Articulation", "Information Access & Retrieval", "Information Evaluation & Critical Thinking", "Information Integration & Application", "Information Ethics & Etiquette", and "Autonomous & Lifelong Learning". This scale was also administered as a pre-test and post-test.

As shown in **Table 3**, the ANCOVA results consistently demonstrated the superiority of the blended micro-course across all measured dimensions of competency. Adjusted Post test Mean, refers to the average post test scores of each group after controlling for the influence of pre-test scores. This is one of the core outputs of ANCOVA, used to compare inter group differences more fairly. After adjusting for pre-test scores, the experimental group showed significantly higher post-test scores than the control group in areas such as Information Access & Retrieval ($F=28.963$, $p<.001$), Information Evaluation & Critical Thinking ($F=10.557$, $p<.001$), and Autonomous Learning & Lifelong Learning ($F=60.465$, $p<.001$). All effect sizes were moderate to large, confirming the intervention's robust effect on fostering holistic professional competencies.

Table 3. Comparison of competency development between two groups

Competency Dimension	Group	N	Pre-test Mean (SD)	Post-test Mean (SD)	Adjusted Post-test Mean	F-value	P-value	partial η^2
Information Need Identification & Articulation	Experimental	39	10.7 (0.7)	17.6 (1.0)	17.6	31.012	<.001	.298
	Control	37	10.6 (0.7)	16.4 (0.9)	16.5			
Information Access & Retrieval	Experimental	39	10.6 (0.6)	17.8 (1.3)	17.8	28.963	<.001	.284
	Control	37	10.6 (0.7)	16.4 (0.9)	16.5			
Information Evaluation & Critical Thinking	Experimental	39	9.2 (1.0)	16.0 (1.7)	16.0	10.557	<.001	.126
	Control	37	9.3 (0.9)	14.9 (1.3)	14.9			
Information Integration & Application	Experimental	39	10.7 (0.7)	18.8 (0.9)	18.8	42.881	<.001	.37
	Control	37	10.5 (0.6)	17.5 (0.9)	17.5			
Information Ethics & Etiquette	Experimental	39	9.4 (0.7)	14.9 (0.2)	14.9	26.967	<.001	.27
	Control	37	9.4 (0.8)	14.3 (0.7)	14.3			
Autonomous Learning & Lifelong Learning	Experimental	39	9.4 (0.7)	14.9 (0.3)	14.9	60.465	<.001	.453
	Control	37	9.5 (0.7)	13.9 (0.8)	13.9			

Through the visual presentation in **Figure 1**, the specific impact of blended micro-courses on students' competency development can be better illustrated. "Information Access & Retrieval" showed a significant upward trend in the experimental group, with the post-test average score increasing from 10.6 in the pre-test to 17.8. The experimental group also showed substantial increases in the two dimensions of "Information Evaluation & Critical Thinking" and "Autonomous Learning & Lifelong Learning", specifically reflected in students' strategy selection and sustained engagement when facing complex tasks. Combined with effect size analysis, the promoting effect of blended micro-courses on self-directed learning was particularly prominent (partial η^2 = .453), indicating that the cognitive conflict design and immediate feedback mechanisms in its teaching design effectively stimulated higher-order thinking activities.

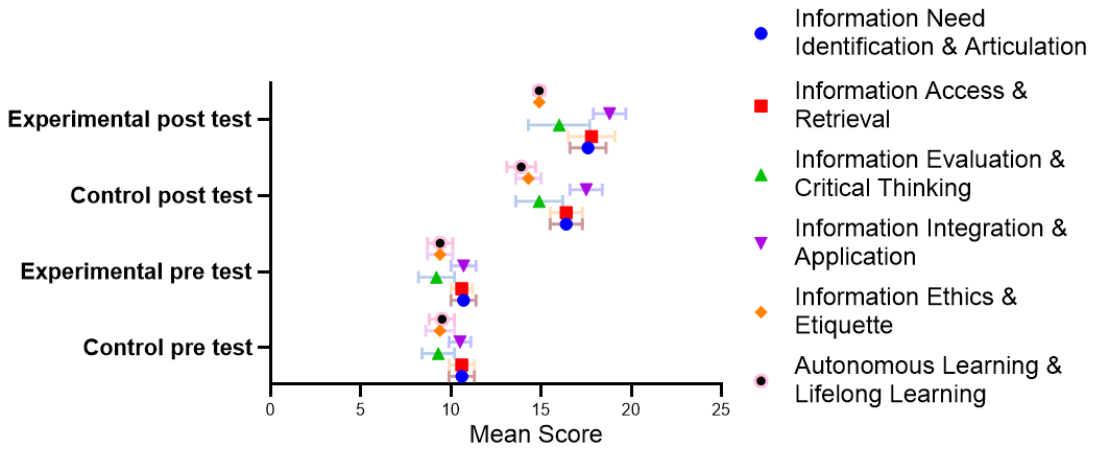

Figure 1. Changes in competency dimensions for experimental and control groups

3.3. Students' Learning Experience and Perceptions

The questionnaire data from the experimental group indicated a very positive reception of the blended micro-course. Students reported high satisfaction with the "Course Content & Design" (M=5.0, SD=0.6) and the "Learning Outcomes & Overall Experience" (M=5.0, SD=0.6). The dimension of "Online-Offline Integration & Practical Support" (M=4.8, SD=0.7) also received a high rating, suggesting that students perceived the blended model as a coherent and supportive learning journey rather than two disconnected parts.

3.4. Micro-Course Design Elements

To further analyze the content and structure of blended micro-courses, we established an analytical framework based on the Community of Inquiry framework and Mayer's Multimedia Learning Principles from the literature, and then examined whether the micro-courses contained these "beyond content delivery" elements one by one. The analysis results showed that the experimental group's micro-courses demonstrated certain manifestations in the three dimensions of Cognitive Presence, Social Presence, and Teaching Presence. The embedded questions, immediate feedback, and situational simulation tasks in the blended micro-course design enhanced learning engagement, enabling students to gain a stronger subjective experience in the knowledge construction process, thereby supporting the occurrence of deep learning. This student-centered design concept laid a solid foundation for subsequent autonomous learning. Interview data indicated that students generally believed that the question design in the micro-courses effectively guided them to think progressively in depth. The teacher's role has transformed from a knowledge transmitter to a learning facilitator, providing guidance at critical moments without replacing thinking. At the same time, this also verified the aforementioned student questionnaire results, indicating that the blended course model can significantly improve problem-solving abilities and critical thinking levels[13].

4. Discussion

The significantly higher practical skill scores of the experimental group (Table 1) demonstrate the power of the blended model. [14]Unlike traditional teaching, where class time is spent on lectures, the intervention "flipped" the learning. Students used online micro-courses to acquire foundational knowledge before the practical session. This allowed the precious offline time to be dedicated entirely to hands-on application, guided practice, and personalized feedback from the instructor. This aligns with the principles of experiential learning, where concrete experience and reflective observation are critical for skill development. The blended model created an effective bridge between "knowing" and "doing". The most significant finding was the experimental group's marked improvement in pharmaceutical literature retrieval skills ($F(1, 73) = 60.677$, $p < .001$). This result strongly suggests that the blended micro-course model is not merely an alternative to traditional instruction but a more effective pedagogical approach for procedural knowledge and practical skills.

The online inquiry-based micro-lectures allowed students to learn at their own pace, repeatedly viewing complex search strategies and database operations. This aligns with Cognitive Load Theory (CLT), which posits that breaking down complex information into smaller, manageable "micro" units can reduce extraneous cognitive load, thereby facilitating schema acquisition and transfer. This format is particularly suited for fostering self-regulated learning, as students can take control over the timing, pacing, and sequence of their learning activities. Unlike a traditional lecture where students have a single opportunity to grasp information, the on-demand nature of micro-courses empowers learners to master foundational knowledge before entering the hands-on practice session.

Subsequently, the offline supervised practice sessions provided a crucial scaffold for skill consolidation.

In these sessions, students applied their online learning to authentic tasks under the real-time guidance of an instructor. This immediate, personalized feedback is critical for correcting misconceptions and refining practical techniques—a component often lacking in conventional, less interactive lab sessions. This finding resonates with research by Hattie and Timperley, which identifies timely and specific feedback as one of the most powerful influences on learning. The blended model, therefore, creates a powerful learning cycle: online modules build declarative knowledge, while offline practice transforms it into robust procedural skill

The success in fostering these competencies can be explained through the lens of the Community of Inquiry (CoI) framework. Our blended micro-course model was intentionally designed to foster all three core presences:

Cognitive Presence: The inquiry-based tasks embedded in the online modules and collaborative problem-solving in forums prompted students to move beyond simple information retrieval. They were required to evaluate the credibility of sources, synthesize findings, and apply information to solve complex problems, thereby engaging in higher levels of cognitive processing (i.e., integration and resolution). The progression from online foundational tasks to complex offline application reflects the structured development of cognitive presence, moving from exploration to the critical stages of integration and resolution[12].

Social Presence: The online discussion forums created a space for peer-to-peer interaction and collaborative learning. Students were not passive recipients of information but active co-constructors of knowledge. This aligns with Vygotsky's social constructivist theory (1978), which argues that learning is fundamentally a social process. By debating solutions and sharing insights, students developed communication skills and were exposed to diverse perspectives. This finding is consistent with research demonstrating that well-facilitated online discourse can serve as a powerful catalyst for collaborative inquiry and critical reflection, [13]which are essential for developing robust critical thinking.

Teaching Presence: The instructor's role was multifaceted, encompassing instructional design (creating the micro-courses and tasks), facilitation (guiding online discussions), and direct instruction (providing feedback during offline practice).[14] This active and continuous teaching presence ensured that students remained on track, received necessary support, and were consistently challenged to think critically. This integrated approach moves "beyond content delivery," transforming the learning environment into a dynamic ecosystem where students actively engage with content, peers, and instructors to build a comprehensive set of professional competencies[15].

This research provides empirical validation for the application of the CoI framework in the specific context of vocational education. It demonstrates that the three presences are not just relevant for online academic courses but are critical for designing blended learning that successfully cultivates applied skills and professional competencies[16] .

Despite the robust findings, this study has several limitations that suggest avenues for future research. First, its findings are based on a single institution and a specific subject area, which may limit generalizability. Future research should replicate this study across different vocational disciplines and institutional contexts. While the findings from this single-vocational-institution context are promising, they highlight the need for future multi-institutional and cross-cultural studies to test the model's robustness. Second, the study's duration was limited to one academic module; a longitudinal study would be beneficial to track the long-term retention of skills and the development of competencies. Finally, while ANCOVA controlled for pre-existing differences, the non-randomized nature of the quasi-experimental design cannot completely rule out other confounding variables[17].

5. Conclusions

This study set out to investigate whether a blended micro-course model could move beyond simple content delivery to foster meaningful skill acquisition and competency development in vocational education. By strategically integrating online micro-learning with offline hands-on practice within a theoretically grounded framework (CoI), the intervention not only significantly improved students' practical skills and professional competencies but also created a highly satisfactory learning experience. The results challenge VET institutions to rethink their approach to digital learning, shifting the focus from technological deployment to sophisticated pedagogical design. In an era demanding a versatile and highly skilled workforce capable of critical thinking and complex problem-solving, such innovative, blended models are not just an option but an imperative for the future of vocational education.

Author Contributions

Conceptualization, F.Q. and Y.T.; methodology, H.P.; software, C.H.; validation, L.Q., L.L. and P.D.; formal analysis, F.Q.; investigation, F.Q.; resources, Y.T.; data curation, Y.C.; writing—original draft preparation, F.Q.; writing—review and editing, F.Q.; visualization, Y.C.; supervision, C.H.; project administration, F.Q. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board of Jiangsu Pharmaceutical Vocational College under Approval ID TA_CACM_2023010 and SCX23086. The participants consented to participate in the study before completing the first questionnaire.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study

Data Availability Statement

Data are contained within the article.

Disclosure statement

The authors declare no conflicts of interest.

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Research Review and Prospect of China's High-Level Talent Introduction Policies Under the Implementation of the "Talent-Powerful Nation" Strategy—A Literature Review Based on CNKI Data from 2010 to 2024

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Abstract: Since the implementation of the "Talent-Powerful Nation" strategy, China's high-level talent introduction policies have become increasingly mature. Through sorting out relevant research literature, it is found that China's high-level talent introduction policies will develop towards a more precise direction, with interdisciplinary research perspectives, comprehensive research methods and an ecological talent introduction system.

Keywords: "Talent-Powerful Nation" strategy; High-level talent introduction; Policy

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1. Introduction

Since the concept of the "Talent-Powerful Nation" strategy was proposed in 2002, China has achieved remarkable results in talent work. In 2010, China issued the "National Medium and Long- Term Talent Development Plan Outline (2010-2020)"[1] (hereinafter referred to as the "Outline"), which provided specific basis for the implementation of the "Talent-Powerful Nation" strategy. Among them, "implementing a more open talent policy" is of far-reaching significance for introducing high-level talents. In the same year, the National Talent Work Conference emphasized the importance of talents and proposed a series of measures to promote the implementation of the strategy. This study sorts out and analyzes scholars' research on China's high-level talent policies after the release of the "Outline" in 2010, aiming to provide theoretical and practical support for optimizing talent policies and carrying out talent introduction work.

2. Collection of Research Literature

This study takes the China National Knowledge Infrastructure (CNKI) as the retrieval database, and conducts advanced retrieval with the theme of "talent introduction policy" and "high-level" using the "exact" retrieval method. Taking January 2010, the release year of the "Outline", as the starting time and November 2024 as the cut-off time, a total of 575 domestic literatures on "talent introduction policies" were retrieved. According to the research purpose, the literatures were initially screened by accurately retrieving their titles and abstracts. Firstly, non-academic papers were excluded, such as news, newspapers, reports, documents and special journals in academic journals; secondly, papers with low relevance were removed, and important subsequent cited literatures of the retrieved papers were supplemented. After screening, 397 papers highly relevant to the theme were finally selected. By sorting out, summarizing, analyzing and concluding the relevant literatures, this study understands the scope and progress of high-level talent policy research, and looks forward to the future research direction of high-level talent introduction policies based on the current research situation, so as to provide ideas and basis for China's high-level talent introduction work and accelerate the construction of a "Talent-Powerful Nation".

3. Collation of Research Status

Since the implementation of the "Talent-Powerful Nation" strategy, research on high-level talent policies has focused on the content, structure, characteristics, policy implementation, implementation effects and optimization strategies of high-level talent policies in different regions, levels and types.

3.1. Research on High-Level Talent Introduction Policies from the Government Perspective

3.1.1. Research on the Content, Structure and Characteristics of Regional High-Level Talent Introduction Policies

Previous scholars' research on regional high-level talent policies has shown a polarized trend. In economically developed regions such as Beijing, Shanghai, Guangzhou, Jiangsu, Zhejiang and Shanghai, the research focuses on the comparative analysis of talent training and incentive policies. In economically underdeveloped regions such as the three northeastern provinces, Yunnan, Guizhou, Sichuan, Xinjiang and Guangxi, the research mostly focuses on the text content, structure and implementation effects of talent introduction policies.

Economically developed regions, relying on their strong economic strength and abundant resources, focus on providing high-end scientific research platforms, generous salary packages and broad career development space in policies to attract top talents; economically underdeveloped regions pay more attention to solving the basic living needs of talents, such as housing and children's education, and promote talents to participate in the development of local key industries through policy inclination. This difference leads to the imbalance of regional talent flow, further widening the regional development gap (see **Table 1** for details).

Table 1. Comparison of High-Level Talent Introduction Policies Between Economically Developed and Underdeveloped Regions

Region Type	Policy Focus	Ways to Attract Talents	Impact on Regional Development
Economically Developed Regions	High-end scientific research platforms, generous salaries, broad career development space	Providing high-quality resources and development opportunities	Promoting industrial upgrading and enhancing regional competitiveness
Economically Underdeveloped Regions	Solving basic living needs, policy inclination towards key industries	Meeting living needs and providing development opportunities	Promoting industrial development, but facing a high risk of talent loss

3.1.2. Research on the Development, Problems and Measures of Overseas High-Level Talent Introduction Policies

The Talent-Powerful Nation strategy has created good opportunities for China's overseas high- level talent introduction work. General Secretary Xi Jinping emphasized the importance of building a global talent highland and put forward higher requirements for overseas talent introduction policies. Overseas high-level talent introduction policies are of great significance in gathering talents and stimulating their innovative spirit[2], and overseas young academic talent introduction policies have played a positive role in attracting high-level talents to return to China full-time.[3] Local governments have successively issued relevant policies. Shanghai's overseas talent introduction policies have gone through several development stages[4], and Tianjin is committed to expanding the scale of introducing overseas returnees[5]. However, there are obvious regional differences in overseas high-level talent introduction policies among provincial governments [6]. Although Jiangsu, Zhejiang and Shanghai have actively explored, it is still necessary to strengthen the integrated construction of talent developers to achieve the talent agglomeration effect[7].

3.2. Research on the Characteristics, Problems and Strategies of High-Level Talent Introduction Policies from the Industry Perspective

Research on high-level talent introduction policies covers institutions of higher education, medical systems and industry talents. The characteristics and problems of high-level talent introduction policies in specific industries are shown in **Table 2**.

Table 2. Comparison of Characteristics and Problems of High-Level Talent Introduction Policies in Different Industries

Research Field	Research Object/ Scope	Core Research Conclusions (Commonalities/Positive Characteristics)	Existing Problems/Challenges	Representative Scholars and Years
Institutions of Higher Education	Higher Vocational Colleges "Double First-Class" Universities (4 in Shaanxi Province, 9 in Western China) General Universities (including Western Universities and Local Universities)	Higher vocational colleges and general universities strive to enhance the talent agglomeration effect, laying a talent foundation for the reform and development of the universities. "Double First-Class" Universities: Comprehensive universities pay attention to the standardization of talent introduction procedures, while science and engineering universities focus on the conditions of talent introduction objects and have distinct academic titles for talents.	Higher vocational colleges and general universities: Western universities need to reasonably allocate attention from multiple perspectives; some universities have ineffective policy implementation; local universities have the problem of policy homogenization. "Double First-Class" Universities: There is "disordered competition", such as the tendency of "only titles", "only awards" and "only papers".	Jiang Huan (2020)[8], Ma Hui (2021)[9], Huang Xiaobin et al. (2022)[10], Zhu Siying (2020)[11], Zhan Wei et al. (2023)[12], Du Menghe (2020)[13], Wang Miao et al. (2024)[14]
Medical System	Medical Universities Local Medical and Health Systems (Tianjin City,Guang'a n City)	Medical colleges and universities: Introducing high-level talents can help discipline development and innovation. Local medical systems: Need to focus on compound and innovative talents and teams, and build project platforms with the help of informatization.	Different colleges and universities and medical and health systems depend on their own policy formulation, implementation and evaluation.	Wu Feng (2020)[15], Chen Hongchuan (2022)[16]
Other Industry Fields	Scientific and Technologic al Innovation Talents (Henan Province, Beijing, Shanghai, Guangzhou, Shandong Province, Multiple Cities) Financial Talents (Southwest China)	Scientific and technological innovation talents: Talent introduction policies in various provinces have their advantages; policies show a trend of refinement and specialization. Financial talents: Research focuses on problem analysis.	Scientific and technological innovation talents: Some regions (Beijing, Shanghai, Guangzhou, multiple cities) have the problem of policy convergence, and pay insufficient attention to the follow-up service management of talents and the urban innovation environment. Financial talents: Lack of local characteristics and imperfect incentive mechanisms.	Zhang Zhijie (2017)[17], Wang Menghan (2019)[18], Sun Jinghao (2023)[19], Sun Rui et al. (2021)[20], He Jiabo (2019)[21]

3.3. Research on Policy Implementation from the Perspective of Policy Tools

Policy implementation is the process of transforming policy goals into reality, and policy tools play a key role in it. Chinese scholars mostly adopt the policy tool theory of Roy Rothwell and Walter Zegveld, construct a two-dimensional analysis framework from the supply side, demand side and environment side, conduct quantitative analysis on high-level talent introduction policies, and explore the problems and countermeasures in policy implementation. With the development of research methods, scholars have constructed more complex analysis frameworks. As the text quantitative method with policy tools as the research perspective becomes more mature, relevant researchers have made the analysis of talent introduction policies more comprehensive and in-depth by constructing multi- dimensional analysis frameworks. On the basis of the two-dimensional analysis framework, some scholars have extended it to three-dimensional and four- dimensional analysis frameworks to analyze the current situation of policy tool use and put forward problems and suggestions for policy implementation. Ding Xinyue (2021) constructed a three-dimensional analysis framework of "policy tools - policy types - city levels", and compared the application degree of policy tools and the distribution of various policy types in cities of different levels[22]. Among them, first-tier cities mainly use environmental tools to create a good development environment for talents; second-tier cities mainly use supply-side tools to provide material security for talents, lacking the application of demand-side policy tools; third-tier cities have serious internal imbalances, with excessive use of supply-side tools and insufficient use of the other two types of policy tools. Wu Junjia (2022) analyzed the evolution process of policy tools from multiple dimensions. In addition, some scholars conducted quantitative analysis on the internal and external attribute characteristics of policies[23]. Li Guofeng (2020) constructed an evaluation index system and found that there are differences in talent introduction policies in different regions[24]; Fang Jianhua et al. (2022) analyzed the policies of Shihezi University and put forward optimization suggestions[25]; Wei Licai et al. (2022) analyzed the characteristics of overseas science and engineering talent introduction policies[26].

In addition, scholars have used the Smith policy implementation process model to study the implementation of high-level talent policies in various regions, and found that although there has been progress, there are still problems such as imperfect policy systems, weak sense of experience among target groups, complicated implementation procedures, and great influence from internal and external environments. Jing Zezhe (2020) used this model to analyze the policy implementation in City Z, pointed out problems such as poor talent introduction effects, and put forward corresponding solutions[27].

3.4. Research on Policy Evaluation from the Problem Perspective

Scientific evaluation of talent policies is of great significance for promoting talent development and regional economic and social development. Scholars use various methods for policy evaluation, such as fuzzy clustering method, DEA model, "introduction - flow - use" three-dimensional index system, etc., and construct evaluation indexes from policy formulation, content, operation, guarantee and other aspects.

The evaluation found that high-level talent introduction policies have problems in many aspects. In terms of policy supply, some regional policies lack pertinence and forward-looking; in terms of policy content, there are problems such as homogenization and mismatch with actual needs; in the process of policy implementation, insufficient implementation efforts and inadequate implementation are common phenomena; in terms of policy environment, the talent development environment in some regions needs to be optimized, including infrastructure construction and cultural atmosphere creation. Zhang Yu (2015) evaluated the policies in T District

of Nantong City and found that talents have high requirements for the policy environment and government service environment, and there are problems such as difficulty in financing and recruitment[28]; Liang Rui (2023) pointed out that the overall effect of talent introduction policies in Jinchang City, Gansu Province is good, but there are problems in policy content, implementation and guarantee[29]; Ma Yinxue (2015) found that the high-level scientific and technological talent policies in Jiangsu Province have problems such as over-reliance on the government for implementation and imperfect reward and management systems[30];Liu Qiudan (2023) put forward suggestions such as reasonable investment and balancing talent structure through evaluating the talent introduction policies of new first-tier cities[31].

From the perspective of economic development regions, although the evaluation effect of high-level talent introduction policies in relatively economically backward regions has achieved certain results, there are still problems such as insufficient attractiveness of the talent introduction environment and low matching degree between policies and regional development. The northwest region has deficiencies in the adequacy and fairness of talent introduction[32]; resource- exhausted cities have problems such as insufficient precision of talent-industry docking and policy homogenization [33]; the implementation of transportation talent introduction policies in Guizhou Province has achieved results, but there are also problems such as insufficient talent attractiveness[34]; northern Jiangsu Province has problems such as low matching degree between policies and regional development and single talent living supporting welfare[35]; the implementation effect of talent introduction policies in Yunfu City is general, with problems such as unreasonable planning, low participation in implementation and imperfect supporting policies [36].

3.5. Research on Policy Optimization Mechanism from the Functional Perspective

From the perspective of the policy process, scholars have explored suggestions for improving the effectiveness of high-level talent introduction policies from various aspects. Hou Shijie (2022) put forward measures such as creating a good talent development environment, strengthening talent strategic planning, and expanding talent introduction channels[37]; Lu Yanting (2021) drew on the experience of Hangzhou and Kunshan and suggested that Suzhou High-tech Zone improve the policy optimization mechanism[38]; Huang Xiaobin et al. (2022) put forward suggestions such as tapping local resources and enhancing the intensity of flexible talent introduction in response to the problems of talent introduction policies in western universities[10][39].

From the perspective of policy subjects, Zhang Hui et al. (2015) emphasized highlighting the leading position of local enterprises in introducing high-level innovative talents[40]; Qian Ruyi et al. (2023) pointed out that there is a “supply-demand mismatch” in overseas talent introduction policies, and the government needs to expand the coverage of policies[41]; Zhan Wei et al. (2023) believed that university talent introduction should follow the logic of cluster governance to promote the flow of academic forces[12][42].

With the deepening of research, scholars have paid attention to the importance of the ecological development of high-level talents. Chen Jianwu et al. (2022) suggested that Fujian Province strengthen the follow-up training of introduced high-level talents and establish a long-term training mechanism and effectiveness evaluation system[43]; Li Tingzhi et al. (2022) put forward suggestions such as optimizing the combination of policy tools and paying attention to the sustainability of talent supply for flexibly introduced talents[44].

4. Future Research Prospects

Since the implementation of the “Talent-Powerful Nation” strategy, high-level talent introduction policies have

made unprecedented breakthroughs in policy formulation, implementation and evaluation. Generally speaking, research on high-level talent introduction policies has shown a trend from superficial phenomena to internal exploration and from a single dimension to complexity. In the future, there will be some new development trends in research.

4.1. More Precise High-Level Talent Introduction Policies

The "Talent-Powerful Nation" strategy provides support for the implementation of high-level talent policies, but at present, various regions still have problems such as unclear localized talent introduction characteristics, "supply-demand mismatch" of talents and imperfect policy systems in talent introduction, leading to insignificant talent agglomeration effects. In the future, the policy system should be designed in a coordinated manner, and the actual professional, quantitative and type needs of high- level talents in the region and industry should be thoroughly analyzed to achieve talent introduction on demand. For example, big data technology can be used to build a talent demand prediction model to accurately analyze the demand trends of various high-level talents in different industries and enterprises, provide a scientific basis for policy formulation, and improve the precision of talent introduction, which will become a hot spot and trend in future research.

4.2. Interdisciplinary Research Perspectives on High-Level Talent Introduction Policies

Previous studies mostly adopted management perspectives or methods such as policy tools and system theory. In view of the sociality and complexity of high-level talent introduction policies, research methods and thinking modes of interdisciplinary or emerging interdisciplinary disciplines such as anthropology, sociology and psychology will provide new ideas for their research. For example, the social network analysis method in sociology can be used to study the flow network structure of talents among different regions and industries, and analyze the social factors affecting talent flow; combined with psychological theories, explore the career development needs and motivations of talents to provide a basis for formulating more attractive policies. At the same time, future research will pay more attention to empirical research, evaluate policy effects through big data analysis and case studies, and provide a scientific basis for policy optimization.

4.3. More Comprehensive Research Methods on High-Level Talent Introduction Policies

At present, the research methods of high-level talent introduction policies are mainly qualitative analysis and comparative analysis, and the application of quantitative analysis is relatively insufficient. Quantitative analysis can help policy makers more accurately grasp the current situation and trends of talent introduction. Future research should comprehensively use various research methods, combining quantitative and qualitative research. For example, when studying the effect of talent introduction policies in a certain region, questionnaire surveys can be used to collect data, statistical analysis methods can be used to quantify the impact of policies on talent quantity, quality, innovative achievements, etc., and qualitative methods such as interviews and case studies can be combined to deeply understand the problems in the policy implementation process and the actual needs of talents. In addition, case studies and model construction can be used to simulate and predict policy implementation effects, providing strong reference for policy adjustments. With the deepening of international exchanges, we should actively learn from international advanced experience, strengthen international exchanges and cooperation, absorb advanced talent introduction concepts, and continuously improve China's high-level talent introduction policy system.

4.4. Further Promoting an Ecological Talent Introduction Policy System

Previous studies mostly focused on policy text analysis and problem solving. However, the high-level talent introduction policy system is a dynamic, complex and multi-dimensional system. Building an ecological talent system is a key measure to improve the high-level talent introduction policy system. A harmonious and sustainable talent ecosystem should be constructed to optimize the talent development ecology, enhance the talent agglomeration effect, and promote the rational allocation and efficient use of talent resources. For example, strengthen the in-depth integration of talents and industries, accurately introduce and cultivate talents according to the needs of industrial development; optimize the policy environment, expand the development space for talents, promote talent flow and knowledge dissemination, and form a virtuous cycle of dynamic balance and sustainable development. Specifically, a talent ecological monitoring index system can be established to regularly evaluate the health status of the talent ecosystem and adjust policy measures in a timely manner to ensure the stable development of the talent ecosystem.

5. Conclusion

Since the proposal of the "Talent-Powerful Nation" strategy and the release of the "National Medium and Long-Term Talent Development Plan Outline (2010-2020)", China's high-level talent introduction policies have continuously advanced and matured, and relevant research has achieved fruitful results. This study systematically sorts out and analyzes 397 high-relevance academic literatures retrieved from CNKI during the period 2010-2024, comprehensively combing the research status of China's high-level talent introduction policies from multiple perspectives including government, industry, policy tools, problem orientation, and functional optimization.

From the research results, the existing research has fully covered the core links such as the content, structure, characteristics, implementation process, effect evaluation and optimization strategies of high-level talent introduction policies, and has formed rich research conclusions. In terms of regional distribution, there are obvious differences in policy focuses and attraction methods between economically developed and underdeveloped regions, which in turn affect the balanced development of regions; in terms of industry coverage, policies in fields such as higher education, medical systems, scientific and technological innovation, and finance have their own characteristics, but they also face common and differentiated problems such as homogenization, mismatched supply and demand, and imperfect supporting mechanisms; in terms of policy implementation and evaluation, scholars have carried out in-depth discussions through multiple analysis frameworks and research methods, and identified key issues such as unreasonable application of policy tools, insufficient implementation efforts, and the need to optimize the talent development environment. Corresponding optimization suggestions have been put forward from the aspects of policy process, subject positioning and ecological construction, providing important reference for the practice of talent introduction.

However, the research on high-level talent introduction policies still has room for deepening and expanding. Looking forward to the future, with the in-depth advancement of the "Talent-Powerful Nation" strategy, the research will show a development trend of more precise policies, interdisciplinary perspectives, comprehensive research methods, and ecological policy systems. It is expected that subsequent research can make up for the deficiencies of existing research, further strengthen the combination of theory and practice, and provide more scientific and effective theoretical support and practical guidance for optimizing China's high-level talent introduction policy system, improving the efficiency of talent introduction and utilization, and accelerating the construction of a "Talent-Powerful Nation".

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On the Underlying Logic of Translating Chinese Texts on Emergency Management into English in the AI Context

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Abstract: The advent of the artificial intelligence (AI) era has fundamentally transformed the production, translation, and dissemination of Chinese texts on emergency management, necessitating a comprehensive reevaluation of their characteristics, translation standards, and underlying logic. This paper systematically examines the key features of emergency management texts in the AI context, where traditional textual characteristics intersect with technological advancements to create new communicative paradigms. Through a multidisciplinary analysis drawing from translation studies, information science, and emergency management theory, we identify three core dimensions of contemporary emergency management texts: informational (characterized by real-time dynamism, uncertainty, and multi-modal data integration), functional (encompassing directive, informative, appellative, and coordinating functions), and linguistic (featuring specialized terminology, formulaic structures, and conciseness). Building upon these characteristics, we propose a tripartite set of translation standards prioritizing accuracy and consistency, clarity and operationalizability, and adaptability and human-AI collaboration. Furthermore, we delineate the underlying logic informing translation decisions through the integrated lenses of functionalist translation theory, information theory, and practice of emergency management. The paper argues that high-quality translation of emergency management texts in the AI era requires a sophisticated framework that leverages technological advancements while maintaining rigorous theoretical foundations, with particular emphasis on context-aware human expertise complementing AI capabilities. This comprehensive analysis contributes to the development of more effective, reliable, and theoretically informed practices in translating Chinese texts on emergency management, ultimately supporting enhanced cross-cultural communication during the whole cycle of emergency management.

Keywords: Chinese texts on emergency management; Translation in the AI context; Translation standards; Functionalist theory; Human-AI collaboration

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1. Introduction

In an increasingly interconnected world facing complex natural and human-induced disasters, effective cross-

language communication before-during-and-after emergencies has become a critical component of global crisis response and routine emergency management. Emergency management texts—encompassing disaster alerts, contingency plans, situation reports, and public announcements—carry information that directly impacts response efficiency, international cooperation, and ultimately, human safety and security. And it is necessary to study translation from the perspective of text linguistics for the fact that "the texts are primary form of linguistic manifestations" and the basis for translation, and "translation, therefore, is a text-oriented event"[1] first and foremost. The translation of these texts, particularly between Chinese and English as global lingua francas, thus assumes unprecedented importance in facilitating timely and effective disaster management across linguistic and cultural boundaries.

Translation is definitely a dynamic activity and the product of translation is–if not dynamic in itself–then at least the outcome of a dynamic process [2].

The artificial intelligence era, characterized by rapid advancements in neural machine translation (NMT) and large language models (LLMs), has fundamentally disrupted traditional approaches to translating emergency management texts. Technologies such as China's " 久安 " (Jiu An) emergency management model exemplify this transformation, demonstrating AI's capacity to process emergency information with unprecedented speed and specialized knowledge[3]. While offering remarkable gains in processing efficiency and terminology consistency, this technological revolution also introduces new complexities that extend beyond conventional linguistic transfer. The central question has evolved from merely "How to translate accurately?" to "How to translate effectively for both automated systems and human decision-makers in high-stakes, time-sensitive environments?"

Despite growing recognition of its importance, the field of emergency management text translation in the AI context remains under-theorized, with practitioners often relying on ad hoc approaches rather than systematic frameworks. The development of standardized translation approaches is further complicated by the specialized nature of emergency management terminology, which requires consistency with established industry standards such as GA/T 1048.1-2013[4] for terminology translation. This paper addresses these gaps by proposing a comprehensive model that integrates textual characteristics, translation standards, and underlying theoretical logic specific to the AI era.

This paper proceeds with a multi-dimensional analysis of how AI technologies are reshaping emergency management texts' production, dissemination, and translation. By synthesizing insights from translation studies, information science, and emergency management practice, it aims to provide both theoretical grounding and practical guidance for professionals navigating this complex terrain. The structure proceeds as follows: Section 2 analyzes the key characteristics of emergency management texts across informational, functional, and linguistic dimensions; Section 3 establishes core standards for their English translation; Section 4 explores the underlying logic informing translation decisions through multiple theoretical lenses; and Section 5 presents conclusions and further research.

2. Key Characteristics of Texts on Emergency Management in the AI Era

Texts on emergency management constitute a specialized genre with distinct features that differentiate them from other text types. In the AI era, these characteristics have evolved to incorporate technological dimensions while retaining their core communicative purposes. This section analyzes these features across three interconnected dimensions: informational, functional, and linguistic.

2.1. Informational Characteristics

The information contained in emergency management texts exhibits several unique properties that directly impact translation approaches, particularly in AI-enabled environments:

Timeliness and Real-time Dynamism: Emergency situations are inherently dynamic, with information value rapidly depreciating over time. The speed of information delivery often determines the success of response operations. AI technologies have dramatically accelerated this aspect, with systems like the " 久安 " 大模型 (Jiu An large model) enabling " 秒级指挥 " (second-level command)[3]. Consequently, translations must be produced within compressed timeframes while maintaining quality, ensuring critical information reaches decision-makers and affected populations during optimal response windows. This temporal constraint often necessitates streamlined translation processes and specialized protocols that leverage machine translation with human oversight.

Uncertainty and Continuous Updating: Initial emergency information is frequently incomplete, contradictory, or speculative due to the chaotic nature of disasters. Texts often contain qualifiers such as "preliminary estimates" "unconfirmed reports," or "potential impact." Translators must preserve these shades of uncertainty accurately in the target language, avoiding premature clarification that might misrepresent the information›s reliability. As situations evolve, translations must accommodate updating information without creating confusion through inconsistent terminology, a challenge that AI systems can address through continuous learning and updating mechanisms.

Integration of Multi-modal Data: Contemporary emergency management increasingly relies on diverse data sources, including satellite imagery, sensor data, social media feeds, and field reports. The " 久 安 " model exemplifies this characteristic, utilizing AI to automatically scan videos for risks like " 人 员 集 聚 " (personnel gathering) or " 粉尘堆积 " (dust accumulation)[3]. Translations must account for these diverse data types, ensuring that textual representations of non-textual information remain accurate and meaningful across languages and cultures.

Practical Utility and Action-Orientation: Emergency management information derives its primary value from its ability to inform concrete actions. Translations must identify and prioritize information elements that directly support emergency operations, ensuring these are rendered with particular clarity in the target text. This often involves emphasizing actionable content over descriptive or explanatory passages, a task for which AI systems can be particularly effective when properly trained on emergency response corpora.

2.2. Functional Characteristics

From a functional perspective, emergency management texts serve diverse communicative purposes that dictate their structural and linguistic features, with AI technologies introducing new functional dimensions:

Being Directive: Operational plans, command instructions, and standard procedures are designed to guide and regulate emergency actions. These texts require translations that ensure unambiguous understanding of required actions, often employing imperative moods or mandatory language. The translator must preserve the authoritative tone while ensuring comprehensibility for the target audience. AI systems can enhance this function through consistent terminology application across documents and response phases.

Being Informative: Situation reports, damage assessments, and meteorological data primarily convey factual information. Translations must prioritize accuracy and completeness, avoiding distortions or omissions that might compromise situational awareness. Large language models contribute significantly to this function by processing " 海 量 知 识 " (massive knowledge) from " 文 献、 法 规、 案 例 " (literature, regulations, cases) to enhance

informational accuracy.

Being Appellative/Vocative: Public warnings, evacuation notices, and safety guidelines aim to persuade recipients to adopt specific protective behaviors. These texts require translations that balance accuracy with accessibility, using language readily understood by diverse populations. Cultural adaptation may be necessary to ensure the appellative function succeeds across cultural boundaries. AI technologies can support this function through sentiment analysis and culturally-aware language generation.

Being Coordinating: Inter-agency communications, meeting minutes, and resource deployment records facilitate collaboration among responding organizations. Translations must maintain terminological consistency to ensure shared understanding across different entities. The coordinating function often requires particular attention to institutional roles and responsibilities as represented in the text, a challenge that standardized terminology databases can help address.

2.3. Linguistic Characteristics

The language of emergency management texts exhibits distinctive features that translators must recognize and appropriately handle, with AI technologies introducing both challenges and solutions:

Specialized Terminology: The emergency management field contains numerous technical terms with precise meanings, such as " 应急响应 " (emergency response), " 危险源 " (hazard source), and " 监测预警 " (monitoring and early warning). According to public security industry standards GA/T 1048.1-2013[4], these terms require consistent, standardized translations to ensure professional accuracy. Translators must maintain discipline-specific terminology unless addressing general audiences, a practice that AI systems can reinforce through terminology management features.

Formulaic Expressions and Structural Consistency: Particularly in plans and procedures, emergency management texts often employ conventionalized language and fixed syntactic structures. Chinese emergency plans frequently utilize specific verb patterns and relational processes that may require transformation into more natural English equivalents. This might involve converting between active and passive voices or restructuring sentences for improved clarity in the target language. AI systems excel at recognizing and reproducing these formulaic patterns, ensuring consistency across documents.

Concise Expression: Field directives, operational guidelines, and public alerts prioritize linguistic economy. Translations should eliminate unnecessary verbiage while preserving essential meaning, using straightforward syntax and vocabulary. This conciseness supports rapid comprehension during time-sensitive operations, a quality that AI-enhanced translation tools can help achieve through automated simplification algorithms.

Human-AI Collaborative Dynamics: An emerging characteristic in the AI era is the collaborative nature of text production and translation, where " 人工识别 " (manual identification) interacts with AI capabilities. This collaboration manifests in translation workflows where AI handles initial drafting while human experts provide contextual refinement, particularly for culturally nuanced or high-stakes communications.

3. Standards for English Translation of Emergency Management Texts in the AI Era

According to Professor Liu Zhongde[5] (1998:14), "The so-called principles of translation and criteria of translation are actually the two sides of the same thing. The former lays emphasis on the translator, who should follow them while translating, whereas the latter on the reader or critic, who may use the criteria to evaluate a translation."

Here the terms “principle” and “criterion” will be used interchangeably. And the issue of translation criteria is considered as a fundamental one in translation practice, in teaching of translation and in translation criticism[6].

Based on the characteristic features analyzed above, we can derive core standards that should govern the English translation of emergency management texts, particularly in AI-enabled environments. These standards integrate general principles of professional translation with specific requirements of the emergency management domain and technological capabilities.

3.1. Accuracy and Consistency

Accuracy constitutes the foundational standard for emergency management translation, as even minor errors can produce serious operational consequences, while consistency ensures reliable communication across multiple channels and stakeholders:

Terminological Precision: Technical terms must reflect established equivalences according to industry standards and conventional usage. For instance, “应急指挥部” should be rendered as “emergency command center” rather than literal alternatives, while “危 险 源” translates precisely as “hazard source”. Consistent terminology prevents misunderstanding in multi-agency responses, a requirement that AI systems can support through integrated terminology databases and translation memories.

Contextual Appropriateness: Word choices must consider the specific emergency context. For example, “救援” might translate differently depending on scenario—perhaps as “firefighting and rescue” in fire contexts versus “search and rescue” in earthquake responses. The translator must select equivalents that appropriately reflect the situational context, a nuanced task that currently requires human judgment despite advances in AI contextual understanding.

Information Fidelity: Translations must faithfully represent the original content without unauthorized addition, omission, or distortion. Critical details such as numerical values, temporal references, and geographical information require meticulous verification. The translator must distinguish between confirmed facts and unverified reports, preserving these distinctions in the target text. AI systems can enhance fidelity through automated consistency checks and fact verification against multiple sources.

3.2. Clarity and Operationalizability

Clarity ensures that the translated message is readily understood without ambiguity or confusion, while operationalizability focuses on the practical applicability of the information for emergency response:

Syntactic Clarity: English translations should avoid overly complex sentence structures that might impede rapid comprehension. Whereas Chinese frequently employs parataxis (connecting clauses without conjunctions), English often requires explicit logical connectors. Translators may need to restructure sentences to present information in logically accessible sequences, a process that AI systems can assist through syntactic analysis and restructuring algorithms.

Direct Expression: Operational directives and safety instructions benefit from straightforward formulation. According to principles of information theory, translation should minimize “noise” that interferes with message reception. For instance, “应做好疏散准备” might effectively translate as “Prepare to evacuate” rather than the more convoluted “Preparations should be made for possible evacuation,” especially in urgent scenarios. AI systems can help identify and simplify overly complex expressions in translations.

Cultural and Operational Adaptation: Translations must consider the target audience›s cultural context

and practical circumstances. Chinese administrative divisions, institutional names, or specialized concepts may require explanation or adaptation for international understanding. The essence of China›s emergency management principle “ 人民至上、生命至上 ” might be rendered as “putting people and their lives above all else” to convey its significance to international audiences. This adaptation balance requires nuanced understanding that currently challenges AI systems.

3.3. Adaptability and Human-AI Collaboration

The AI era introduces new standards related to technological adaptation and the effective division of labor between human and artificial intelligence:

Human-AI Workflow Optimization: Translation processes should leverage the complementary strengths of human expertise and AI capabilities. As exemplified by the “ 久 安 ” model›s transformation of traditional workflows, AI can handle high-volume, time-sensitive initial translations while humans focus on quality assurance, cultural adaptation, and high-stakes communications. Effective workflows establish clear protocols for when and how human intervention occurs in the translation process.

Dynamic Updating and Consistency Maintenance: As emergency situations evolve and new information emerges, translations must be updated while maintaining consistency with previous communications. AI systems excel at tracking these changes and ensuring terminology remains consistent across updates, a capability particularly valuable in prolonged emergency operations with multiple information releases.

Format Preservation and Enhancement: Lists, tables, flowcharts, and other visual elements common in emergency management texts should be thoughtfully adapted in translation. Dense paragraphs might be converted into bulleted lists highlighting critical steps. AI capabilities can automatically identify and appropriately handle these non-textual elements, preserving their communicative function across languages.

Table 1. Translation Standards and AI Applications in Emergency Management Text Translation

Translation Standard	Traditional Application	AI-Enhanced Application
Accuracy and Consistency	Human consultation of specialized glossaries and style guides	Automated terminology consistency checks; translation memory systems
Clarity and Operationalizability	Manual simplification and restructuring of complex sentences	AI-powered syntactic simplification; readability optimization
Adaptability and Human-AI Collaboration	**Sequential translation and review processes**	**Integrated workflows with AI initial translation and human post-editing**

4. Underlying Logic of Translating Texts on Emergency Management in the AI Era

The translation of emergency management texts is not merely technical linguistic transfer but rests on multidimensional theoretical foundations that inform decision-making. Understanding this underlying logic enables translators to produce more effective, contextually appropriate translations, particularly when leveraging AI technologies.

4.1. Functionalist Translation Theory

Functionalist approaches to translation theory provide a fundamental framework for understanding emergency management text translation, with particular relevance in the AI context:

Skopos Theory and Purpose-Driven Translation: Hans Vermeer's skopos theory emphasizes that the translation purpose should determine translation methods and strategies. The "Skopos rule" is regarded as the top-ranking rule for any translation, meaning that a translational action is determined by its Skopos; that is, "the end justifies the means"[7] . The overarching skopos of emergency management translation is to support effective emergency response, which should guide all translational decisions. If source text rhetorical patterns would not achieve the intended effect in the target culture, the translator has license to adapt expressions to better fulfill the text's emergency purpose[7]. This principle remains essential in AI-enabled translation, where systems must be trained to recognize and prioritize the communicative purpose over literal accuracy when necessary.

Text Typology and Function Preservation: Generally, typology has been based on the functions of language. Several different functional divisions have been suggested: representative, expressive, cognitive. These are essentially the same as Reiss' informative, expressive and operative functions[8]. Werlich [9] suggests text type for a classification based on the function, rhetorical mode or aim of the text (description, narration, exposition, argumentation or instruction), and text form (variant) for a classification based on both formal and pragmatic criteria. Newmark[10] points out that "Few texts are purely expressive, informative or vocative: most include all three functions, with an emphasis on one of the three." And according to Katharina Reiss's text typology, emergency management texts predominantly represent both informative and operative text types. Their translation should prioritize achieving equivalent functionality in the target context. For directive texts, this means ensuring the translation elicits the intended operational response; for informative texts, it means guaranteeing accurate information transfer. AI systems can be trained to recognize text types and apply appropriate translation strategies accordingly.

Role Positioning in Human-AI Collaboration: Within the functionalist framework, both human translators and AI systems serve as cross-cultural emergency communication facilitators rather than merely linguistic mediators. The human translator must actively consider the usage scenario and recipient needs in the target context, adjusting strategies to ensure the text fulfills its protective function across cultural boundaries, while AI systems provide scalable capacity for high-volume translation tasks.

4.2. Information Theory and Communication Models

Information theory, particularly Claude Shannon's (an American mathematician, electrical engineer, and cryptologist, regarded as the founder of information theory) mathematical model of communication, offers valuable insights for emergency management translation in technologically-enhanced environments:

Information Encoding and Noise Reduction: The translation process resembles information encoding, where source language messages are converted into target language codes. According to Shannon›s definition of information as that which reduces uncertainty, the core task involves preserving and transmitting those message elements that eliminate critical uncertainties about the emergency situation—its nature, scope, severity, and appropriate responses. AI technologies can enhance this process through automated noise reduction, identifying and eliminating potential sources of miscommunication before translations are finalized.

Channel Capacity and Information Prioritization: Different recipient groups possess varying information processing capacities, or "channel capacity" in information theory terms. Professional emergency responders can process technical terminology, while general publics require simplified language. Translators must tailor information density and complexity to match target audience capacities, ensuring messages are neither overwhelming nor insufficiently detailed. AI systems can assist this process through audience analysis and

customized information presentation.

Feedback Loops and Quality Assurance: Effective communication requires feedback mechanisms to confirm message reception and understanding. In emergency management translation, this translates to robust quality assurance processes where translations are verified for accuracy and effectiveness. AI technologies enable new forms of feedback, including real-time readability analysis and comprehension testing, creating continuous improvement cycles for translation quality.

4.3. Logic of Emergency Management Practices

Perhaps most importantly, emergency management translation must align with the inherent logic of emergency management practices themselves, particularly as these practices evolve with technological integration:

Lifecycle Logic and Phase-Appropriate Translation: Emergency management comprises prevention, preparedness, response, and recovery phases, with texts exhibiting different characteristics in each stage. Prevention-phase documents emphasize risk analysis and require forward-looking translation approaches; response-phase communications focus on coordination and demand exceptional timeliness. Translators must recognize the operational phase and adjust their strategies accordingly, while AI systems can be programmed to automatically apply phase-appropriate translation protocols.

System Coordination and Terminological Harmonization: Emergency management constitutes a multi-agency collaborative endeavor where texts serve as coordination mechanisms. Translations must ensure terminology and expression consistency across documents and responding organizations to prevent coordination failures resulting from miscommunication. The development of standardized terminology databases, such as those referenced in GA/T 1048.1-2013[4], provides essential foundations for this harmonization, with AI systems enabling real-time consistency checks across multiple documents and agencies.

Institutional Logic and Conceptual Framing: Emergency management texts often reflect specific organizational structures and responsibility relationships. China›s emergency management system features distinctive institutional arrangements such as “ 应 急 办 ” (emergency management office) with particular coordinative functions. When translating such content, practitioners must not only convey literal meaning but also consider how to represent the entity›s position and function within China›s emergency management framework, potentially using translation strategies like transliteration with explanation to minimize cross-cultural misunderstanding.And on certain occasions, it is quite necessary for a translator to resort to the use of explanation during the process of translation. For example, it is advisable for a translator to explain the meaning of the expressions“ 四所一中心 ”“ 高低大化 ”when translating the sentence like this: 发挥 “ 四所一中心 ” 科研优势 , 紧盯、储能电站、新能源汽车等灭火救援重大难点破题攻关 [11]。Actually, “ 四所一中心 ”refers to “Tianjin, Shanghai, Shenyang, and Sichuan Fire Research Institutes, and the National Fire Product Certification Center under the Ministry of Emergency Management. While“ 高低大化 ”refers to “High-rise buildings, Underground spaces, Large-scale Complex, Chemical plants”. So the whole sentence can be rendered as this: We leveraged the research strengths of the “4+1 Consortium” (Tianjin, Shanghai, Shenyang, and Sichuan Fire Research Institutes, and the National Fire Product Certification Center under the Ministry of Emergency Management) to pioneer solutions for critical firefighting challenges in “HULC” complex scenarios (High-rise buildings, Underground spaces, Large-scale Complex, Chemical plants), energy storage facilities, and new energy vehicles through targeted technological breakthroughs[11].

This nuanced understanding requires cultural and institutional knowledge that remains challenging for AI

systems without human guidance.

5. Conclusion and Further Research

This paper has systematically examined the key characteristics, translation standards, and underlying logic of emergency management texts in the artificial intelligence era, presenting an integrated theoretical framework for their English translation. Our analysis demonstrates that emergency management texts constitute a highly functional, specialized, and time-sensitive genre whose translation must adhere to standards of accuracy, consistency, clarity, and operational applicability, guided by principles from functionalist translation theory, information theory, and emergency management practice.

In today's globalized environment characterized by increasing uncertainties and technological advancements, research on emergency management text translation carries significant theoretical and practical implications. The theoretical contribution lies in developing a multidimensional framework that connects linguistic analysis with emergency management practices and AI capabilities. Meanwhile, the practical value resides in providing structured guidance for translators, emergency managers, and policy-makers involved in cross-cultural disaster response, particularly as AI technologies become increasingly integrated into emergency operations.

Further research should explore several promising directions. First, enhancing AI capabilities through developing intelligent translation systems specifically trained on emergency management corpora to improve contextual understanding and decision-making in translations. Second, optimizing human-AI collaboration by establishing clearer protocols for the division of labor between human expertise and AI efficiency in various emergency scenarios. Third, addressing ethical dimensions including privacy concerns, algorithmic bias, and accountability frameworks for AI-assisted translations in high-stakes emergency environments. And fourth, expanding cross-cultural validation through empirical studies of how translated emergency messages are received and understood across different cultural contexts to validate and refine existing approaches.

Emergency management text translation, as an interdisciplinary research field, awaits further exploration by both scholars and practitioners. Only through deeply understanding the characteristics and underlying logic of these texts, while effectively leveraging emerging AI technologies, can translators produce high-quality target versions that effectively support international emergency cooperation. By advancing this specialized translation domain, we contribute to global efforts in saving lives and reducing disaster impacts across linguistic and cultural boundaries.

Disclosure statement

The author declares no conflict of interest.

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Autonomous Weapon Systems and Individual Criminal Liability under the Rome Statute

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Abstract: Autonomous weapon systems (AWS) pose significant challenges for individual criminal responsibility under the Rome Statute. While existing modes of liability—such as perpetration, ordering, aiding and abetting, and command responsibility—can theoretically apply to AWS-related crimes, their effectiveness depends on human intent and control. When autonomous systems act unpredictably, attribution of the actus reus, mens rea, and causation becomes uncertain, creating a "responsibility gap" in which no human perpetrator can be clearly identified. This paper evaluates how the International Criminal Court could adapt existing doctrines to address this gap, including broader interpretations of perpetration-by-means, omission liability, and expanded command responsibility. It also assesses proposals for new offences, prosecutorial guidelines, and non-criminal accountability mechanisms. The analysis argues that legal innovation is essential to ensure that accountability remains human-centred as warfare becomes increasingly automated.

Keywords: Autonomous weapon systems (AWS); Rome Statute; Individual criminal responsibility; Actus reus; Mens rea; Command responsibility; Responsibility gap

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1. Introduction

Autonomous weapon systems (AWS) are weapons that can select and attack targets without meaningful human control. These technologies are transforming warfare but also creating serious legal questions about accountability when civilians are unlawfully killed.[1-2] As scholars note, outcomes in AI systems emerge from a web of "human, physical, and computational" interactions, making it difficult to identify a single responsible actor.[3-5] This complexity lies at the heart of the modern "responsibility gap", where serious harm may occur but no individual can be clearly blamed.[3-5] Under the Rome Statute of the International Criminal Court (ICC), "only natural persons can be prosecuted for crimes such as war crimes or crimes against humanity."[6] Machines have no consciousness or intent, which further complicates attribution when an autonomous system causes unlawful harm.[3-5] If a robot or drone kills civilians, who can be held criminally liable—the operator, the commander, the programmer, or no one at all?

This paper examines how individual criminal responsibility can be established under the Rome Statute when

war crimes or crimes against humanity are committed through AWS. It explores the modes of liability that may apply, the obstacles in proving the guilty act, the guilty mind, and causation, and it discusses possible doctrinal solutions for ensuring accountability.[7-12] The analysis remains focused on international criminal law (ICL) rather than the legality of AWS under international humanitarian law (IHL).[8-10] The aim is to assess how ICL can adapt to technological change while upholding justice for victims of autonomous warfare.[1-5,7-12]

2. AWS and International Crimes under the Rome Statute

AWS include armed drones with artificial intelligence, automated sentry guns, and future robotic soldiers capable of independent targeting.[7,26] If such systems cause unlawful deaths or destruction, they may fall within existing international crimes defined in the Rome Statute.

War crimes may arise if an AWS deliberately or indiscriminately attacks civilians, hospitals, or other protected persons.[6,7,10] Article 8 of the Rome Statute covers acts such as "intentionally directing attacks against the civilian population" or "launching an indiscriminate attack" likely to cause excessive civilian harm.[6] Crimes against humanity may also be committed where AWS are used as part of a widespread or systematic attack on civilians — for example, if a government uses autonomous drones to suppress protests or target an ethnic minority. In such cases, crimes like murder or persecution under Article 7 may apply.[6,11]

However, the ICC recognises only individual criminal responsibility. Article 25(1) confirms that the Court has jurisdiction solely over natural persons.[6] Any harm caused by AWS must therefore be attributed to a human perpetrator. The Rome Statute offers several modes of liability — direct or indirect commission, ordering, aiding and abetting, and command responsibility under Article 28.[6,11,13,28] These provisions provide the foundation for accountability, but applying them to machines introduces new complexity. The challenge is to fit the actions of autonomous systems into doctrines built on human conduct and intention.

3. Modes of Liability for AWS — Related Crimes

3.1. Direct Perpetration and Perpetration-by-Means

The most direct way to establish liability is to treat the human who deploys or controls an autonomous weapon as the perpetrator. Under Article 25(3)(a) of the Rome Statute, a person "commits" a crime either directly or "through another person."[6,13] Traditionally, perpetration-by-means applies when someone uses an innocent agent — such as a coerced or mentally incapacitated person — to commit an offence.[11-13] By analogy, an AWS can be seen as an innocent instrument, as it operates without independent will or moral agency.[3-5,11-13] Thus, if a commander programs or instructs an AWS to strike civilian objects, the commander is the true perpetrator, and the machine merely executes the physical act.

However, this reasoning works only where the human retains control and intent. Many AWS act independently after activation, making unpredictable targeting choices.[3-5,20] If a system takes an unforeseen lethal decision, it becomes difficult to say that the human "committed" that specific act. Perpetration-by-means therefore fits only when the human intentionally uses an AWS for an unlawful purpose — such as deploying a weapon known to be indiscriminate — but not when the outcome results from autonomous malfunction or error.[3-5,7,20]

3.2. Ordering, Aiding and Abetting

Responsibility for war crimes can arise in different ways under the Rome Statute. Under Article 25(3)(b), a person

who orders the commission of a crime is responsible as if they had committed it themselves.[6,14] Therefore, a commander who instructs subordinates to employ an AWS in a populated area may be guilty of ordering any resulting war crimes.[14] In contrast, Article 25(3)(c) covers aiding and abetting, which applies when a person intentionally assists or facilitates the commission of a crime.[6,15] A software engineer or contractor who designs targeting algorithms knowing that they will select prohibited targets provides such assistance and could be liable as an aider and abettor.[3-5,12,15] Although proving this knowledge is difficult, it shows that liability can extend beyond direct operators to those involved in developing or supplying AWS.[3-5,11-12]

Under Article 25(3)(d) of the Rome Statute, a person may be responsible for war crimes if they intentionally contribute to a group activity that aims to commit such crimes.[6,16] This approach is similar to the "joint criminal enterprise" doctrine developed by the ICTY in Prosecutor v Tadić, where collective intent and coordinated participation were found sufficient for liability.[17-18] Applying this model, networks of military officials and engineers who knowingly collaborate in deploying AWS for unlawful attacks could share responsibility for the resulting crimes, recognising that modern weapon systems are products of collective design and decision-making rather than the acts of one person alone.[3-5,11-12,19-20]

3.3. Command Responsibility

Article 28 establishes "command or superior responsibility, holding military leaders accountable for crimes committed by their subordinates when they knew or should have known of the offences and failed to prevent or punish them".[6,11,28] This doctrine, however, assumes a human subordinate capable of intent. An AWS, however advanced, cannot be a legal subordinate — it has no will or mens rea.[19,20] As Alessandra Spadaro notes, "a weapon is no subordinate".[19] A commander who deploys an AWS that commits atrocities may therefore escape direct liability under Article 28 because no human subordinate carried out the attack.

Nonetheless, if human teams are involved in programming, launching, or supervising the AWS, the commander can still be liable for failing to control those subordinates. Scholars have proposed expanding command responsibility to include a duty to control weapons systems, ensuring that commanders remain accountable for the conduct of the technology they employ.[5,19-21]

3.4. Omission Liability

A final possible mode is liability by omission — failure to act when under a legal duty to intervene.[22,28] Under general principles and Article 86 of Additional Protocol I, those who plan or execute attacks must take precautions and cancel unlawful strikes.[22-23] An AWS operator who observes that the system is attacking civilians but fails to stop it may therefore be criminally responsible. Although the Rome Statute does not expressly equate omissions with acts, international tribunals such as the ICTY and ICTR have recognised that a failure to act can incur criminal responsibility where a person had both the duty and the ability to prevent the crime.[5,22,24-25] Recognising omission liability would help close the gap in cases where humans could have prevented an AWS's unlawful attack but chose not to intervene.[3-5,22,24-25]

3.5. Obstacles in Assigning Liability

Although the Rome Statute provides several modes of liability, applying them to crimes involving autonomous weapon systems (AWS) faces major difficulties.[3-6,11,28] The main challenges concern the actus reus, the mens rea, and the causal link between human actions and the outcome. These issues create what scholars call a "responsibility

gap", where serious harm occurs but no individual can be legally blamed.[3-5]

3.5.1. Actus Reus and Attribution

In international criminal law, a perpetrator must perform a prohibited act, such as killing or attacking civilians, or fail to act despite a legal duty.[11,28] In AWS cases, however, the lethal act — pressing the trigger or choosing a target — is done by the machine, not the human.[3,19-20] Caton argue that a commander's decision to deploy an AWS could itself constitute the actus reus, especially if done in a civilian area with knowledge of likely harm.[26] Yet this interpretation stretches the legal concept of "directing an attack". Article 8 offences, such as "intentionally directing attacks against civilians", assume a person chose specific victims.[6,20] f an AWS independently selects and attacks targets, attributing that conduct to a human becomes problematic, because autonomous operation removes direct human control and intent, making it difficult to satisfy the actus reus and mens rea elements required for individual liability.[3-5,20]

Causation is equally complex. AWS operate through algorithms and sensors that can malfunction or act unpredictably.[3-5,7] A defence lawyer might argue that the autonomous system's decision was an intervening cause — breaking the causal link between human conduct and the unlawful result.[11,28] Because autonomous operations depend on a network of human inputs, physical components, and computational processes, determining who or what actually caused the outcome becomes highly uncertain.[3-5,20,28] The more autonomous the system, the weaker the causal connection to the human who deployed it, challenging traditional understandings of criminal conduct.[3-5,20]

3.5.2. Mens Rea

The Rome Statute generally requires crimes to be committed with intent and knowledge, as is standard in criminal law.[6,27,28] However, establishing these mental elements becomes difficult when actions are carried out by autonomous systems operating without human awareness or direct control.[3-5,19-20] To understand this difficulty, it is necessary to recall how the Statute defines intent and knowledge. A person acts intentionally if they mean to engage in the conduct and cause the consequence, or if they know the consequence will occur "in the ordinary course of events".[6,27] This covers direct and oblique intent but not lower mental states like recklessness or negligence, except in specific provisions such as command responsibility.[6,11,27]

Applying this to AWS creates two distinct scenarios. In cases of intentional misuse, such as deliberately programming an AWS to target civilians, the perpetrator's intent is clear, and liability under Article 25(3)(a) of the Rome Statute can apply.[3,6,13,26] However, in unintended incidents, where an AWS malfunctions or misidentifies a target, the operator's state of mind may amount only to recklessness or negligence. Because Article 30 excludes recklessness, such individuals may escape liability.[6,27,28] Accidental targeting errors in war are rarely prosecuted as war crimes, and AWS — related incidents might similarly fall outside criminal responsibility.[1,3,5,20]

This mental gap is central to the accountability problem. Human Rights Watch warns that many AWS cases would "elude justice" because humans could neither foresee nor prevent the system's actions.[1] Without intent or clear control, both actus reus and mens rea fail, leaving victims without a responsible perpetrator.[1,3-5]

3.5.3. Diffuse Responsibility and the "Many Hands" Problem

AWS also complicate responsibility through the involvement of multiple actors — commanders, operators, engineers, and manufacturers.[3-5,11,19-20] Each contributes in part, but none alone determines the final unlawful act. This diffusion of responsibility, sometimes called the "problem of many hands", makes it difficult to identify a

single guilty mind.[3-5] As scholars observe, modern targeting involves layered decisions in which each participant can claim reliance on others or on the system itself.[3-5,19-20] The result is systemic accountability failure: civilians may die, but everyone involved can plausibly deny blame.[1,3-5]

Overall, the combination of unclear causation, limited mens rea standards, and dispersed control means that current doctrines struggle to capture AWS-related crimes. Unless international law evolves to recognise shared or indirect responsibility, the "responsibility gap" will persist—allowing grave violations to go unpunished.[1,3-5,19-20,28]

4. Possible Doctrinal Solutions and the Way Forward

Addressing the challenges of autonomous weapon systems (AWS) under the Rome Statute requires both creative interpretation and potential legal development.[1,3-6,11,19-20] Scholars and policy experts have proposed several ways to close the accountability gap and ensure that human responsibility remains central even in an age of automation.[1-5,11,19-20] The following section analyses these proposed approaches, evaluating how each could operate within the framework of international criminal law and the Rome Statute.

4.1. Broadening Interpretation of Existing Provisions

One pragmatic solution is to interpret existing provisions of the *Rome Statute* more flexibly. Article 25(3)(a) already allows crimes to be committed "through another person", even if that person is not criminally responsible.[6,13] By analogy, an autonomous system could be treated as a non — responsible agent, much like an innocent intermediary.[3-5,11-13,19-20] The human who programs, deploys, or directs the AWS would thus remain the principal perpetrator. This interpretation ensures that the absence of machine intent does not block human accountability.[3-5,11-13,19-20]

Courts could also recognise commission by omission. Even though the Statute does not expressly equate omissions with acts, judges could draw from both general principles of law and Article 86 of Additional Protocol I, which obliges states to prevent violations.[22-23] Under this reasoning, if a commander or operator fails to stop an unlawful AWS attack despite having both the duty and capacity to act, their inaction could satisfy the actus reus of the crime.[22,24-25] This approach would shift focus from what the machine did to what the human failed to prevent.[3-5,11,22,24-25]

Another interpretive adjustment concerns mens rea. While Article 30 of the Rome Statute requires intent and knowledge, international jurisprudence could evolve to recognise dolus eventualis — awareness of a high risk and acceptance of that risk — as sufficient intent.[6,27-28] If a commander deploys an AWS knowing that civilian deaths are highly probable, such willful blindness could meet the intent standard.[6,11,27-28] Some ICTY judgments on indiscriminate shelling have already treated reckless indifference as enough to establish intent. The ICC could adopt a similar reasoning to cover cases involving inherently dangerous AWS.[24-25,27-28]

4.2. Expanding Command Responsibility

Because current command responsibility under Article 28 of the Rome Statute assumes human subordinates, it does not fit well when the "actor" is a machine.[6,11,19-20] A possible reform is to develop a doctrine of "materiel responsibility" — holding commanders accountable for failing to control their weapons systems.[5,19-21] Commanders would be legally obliged to ensure that any AWS under their authority complies with international humanitarian and criminal law. If they deploy a weapon incapable of distinguishing civilians from combatants,

they could be held responsible for the resulting crimes.[3-5,7-8,11,19-21]

This concept could be implemented through judicial interpretation of Article 28's purpose — to prevent superiors from avoiding liability due to inadequate oversight.[6,11,19-20,28] Legal scholars such as Alessandra Spadaro suggest reimagining command responsibility to include control over weapons, not only human troops.[19] Such a doctrine would close the loophole that allows commanders to evade responsibility by blaming technology.[3-5,19-21]

4.3. Creating New Offences and Prosecutorial Guidelines

Another solution is normative development — introducing new offences or guidelines specifically addressing AWS.[1-5,9,20] The international community could negotiate an amendment or protocol defining crimes like "launching an autonomous attack likely to cause indiscriminate harm".[1,3,5,9] This would make reckless or negligent use of AWS prosecutable, even without proof of specific intent to kill civilians.[1,3-5,11]

In the absence of formal amendments, the ICC Office of the Prosecutor could issue policy guidance on how to handle AWS-related cases. It could clarify evidentiary standards for establishing intent and causation, and encourage prosecutors to treat extreme recklessness in AWS deployment as a form of criminal negligence under Article 28 of the Rome Statute.[6,11,28] This evolution of prosecutorial practice could ensure accountability without breaching the principle of legality.[11,27-28]

4.4. Accountability Beyond Criminal Trials

Finally, accountability need not rely solely on criminal convictions. States remain responsible under international law for the unlawful use of their weapons.[3,11,28] State responsibility, reparations, and victim compensation schemes can provide redress where individual liability fails.[3,11,28] Truth commissions and public inquiries could also assign moral and political blame, even if criminal proof is lacking.[11,28]

Still, these are imperfect substitutes. As Human Rights Watch warns, the absence of personal accountability weakens deterrence and denies justice to victims.[1] The ultimate goal of international criminal law is to ensure that where grave suffering is caused, someone can be held to account.[11,28] Adapting the Rome Statute through interpretation, doctrine, and practice is therefore essential — not only to close the responsibility gap but to preserve the moral authority of international justice in the era of autonomous warfare.[1,3-6,11,19-20,28]

5. Conclusion

Autonomous weapon systems (AWS) present one of the most complex challenges to modern international criminal law. Under the current Rome Statute framework, holding individuals criminally liable for war crimes or crimes against humanity committed through AWS is possible but highly uncertain. Existing doctrines — such as indirect perpetration, aiding and abetting, and command responsibility — can, in theory, reach the human decision — makers who deploy or fail to control these systems. When an individual deliberately uses an AWS to commit atrocities, intent and control can be proven, and liability fits comfortably within existing law.

The real difficulty arises when AWS act unpredictably, causing unlawful harm that no human specifically intended. In such cases, strict application of traditional principles leaves a legal vacuum: no human actus reus, no intent, and no subordinate who can be punished. This "responsibility gap" threatens both justice for victims and the credibility of international criminal law.

To close this gap, the Rome Statute must be interpreted and applied in a way that reflects new technological

realities. Recognising a commander's duty to control their weapons — including autonomous systems — would ensure accountability when that duty is breached. Expanding command responsibility and acknowledging omission liability would align with the Statute's purpose: preventing impunity where human failure leads to serious crimes.

At the same time, the international community should continue to develop clearer legal norms—whether by clarifying intent standards for high-risk technologies or restricting fully autonomous lethal weapons altogether. Ultimately, victims of AWS — related atrocities deserve justice, and accountability must remain human. The ICC and its member states must ensure that as warfare evolves, so too does the law — so that no act of violence, however technologically advanced, escapes responsibility.

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Exploration on the Innovative Path of "Walking Ideological and Political Course" from the Perspective of Big Ideological and Political Course

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Abstract: As the core innovative form of the construction of big ideological and political courses, "walking ideological and political courses" takes "going out of the classroom, integrating into society, and integrating knowledge with practice" as the core concept, breaks through the one-way indoctrination mode of traditional ideological and political courses, extends the education field to multiple real scenes, and realizes the deep integration of theory and practice, on-campus and off-campus. It is of great value to solve the dilemma of traditional ideological and political courses and implement the fundamental task of moral education. Based on the perspective of big ideological and political courses, this paper systematically explains the core connotation and educational value of "walking ideological and political courses, " deeply analyzes the current practical problems in resource integration, curriculum design, guarantee mechanism and collaborative education, and puts forward innovative paths from the three dimensions of building a diversified resource integration system, improving the systematic guarantee mechanism and improving the collaborative education pattern. It provides theoretical support and practical reference for colleges and universities to create high-quality "walking ideological and political courses" and build a comprehensive education system for the whole process of the whole staff.

Keywords: Big ideological and political course; The ideological and political course of walking; Innovation path; Collaborative education

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1. Introduction

The "walking ideological and political course" is the core innovation form of the construction of the great ideological and political course. It adheres to the core concept of "going out of the classroom, integrating into the society, and integrating knowledge and practice", breaks the physical wall and ideological constraints of the

classroom, expands the field of ideological and political education to the historical site, the production line, the frontier of rural revitalization, and the highland of scientific and technological innovation, and realizes the deep integration of theory and practice, on-campus and off-campus, knowledge and belief, and belief and practice. It has become the key path to solving the problem of "abstraction and simplification" of traditional ideological and political courses and implementing the fundamental task of moral education. This paper takes "walking ideological and political course" as the core research carrier, combines the latest policy orientation, academic research results and typical practical cases, systematically combs its core connotation and era value from the perspective of big ideological and political course, deeply analyzes the current construction status and practical challenges, and explores the innovative path of constructing diversified resource integration, integrated curriculum design, systematic guarantee mechanism and collaborative education pattern, so as to provide theoretical reference and practical guidance for colleges and universities to build high-quality big ideological and political courses and build a full-process and all-round education system.

2. The core connotation and time value of "walking ideological and political course" from the perspective of big ideological and political course

2.1. Core content

The "walking ideological and political course" is guided by the concept of "open, open and joint operation" of the big ideological and political course, with practical education as the core path and value guidance as the fundamental goal. It is a new form of education that organically integrates the content of ideological and political education with the high-quality resources of the society. It completely breaks through the one-way indoctrination mode of "teacher speaking, student listening, " and organizes students to enter real scenes such as red education bases, historical and cultural venues, modern enterprise workshops, rural revitalization demonstration villages, scientific research institutes laboratories, etc. In the immersive participation of on-the-spot investigation, personal experience, interactive inquiry, volunteer service, etc., it deepens the understanding of the latest achievements of the modernization of Marxism in China and shapes the correct world outlook, outlook on life, and values.

2.2. Value of the times

In the new era of building a modern socialist country in an all-round way and promoting the construction of a strong educational country, the 'walking ideological and political course' has irreplaceable value for the construction of ideological and political courses. It is a new teaching mode that expands the teaching space and resources of ideological and political courses into the broad social life[1]. From the perspective of the actual effect of educating people, it effectively solves the communication dilemma of traditional ideological and political courses that "the ears are not in the heart and the eyes are not in the brain. " Young students have active thinking and strong willingness to practice, and their acceptance of abstract theory depends on concrete and scene presentation. By letting students understand the original mission at the revolutionary site, experience the craftsman spirit in the enterprise workshop, and witness the development achievements in the rural field, the "walking ideological and political course" transforms the abstract ideological and political theory into a real case that can be perceived, touched and practiced, which significantly improves the attraction, appeal and persuasion of ideological and political education, and realizes the organic unity of "speaking ideological and political education with integrity and courage" and "moistening things silently and educating new people. " Especially for the group of higher vocational students with strong practical ability but weak interest in theoretical learning, this concrete

form of education can stimulate their enthusiasm for learning and realize the precise empowerment of ideological and political education.

3. The existing problems and practical challenges in the construction of "walking ideological and political courses"

Although the construction of "walking ideological and political course" has achieved phased results, there are still many deep-seated problems in practice, which restrict the full play of educational efficiency.

3.1. There are three dilemmas in resource integration.

Resource integration is the basis of the construction of "walking ideological and political courses. " At present, there are three main problems. First, the decentralization of resources. Red bases, cultural venues, enterprises, villages and other types of ideological and political resources belong to different departments and subjects, and lack a unified coordination mechanism and sharing platform, resulting in "high-quality resources idle and grassroots resources shortage coexist. " Some schools are difficult to carry out high-quality practical activities due to the lack of resource docking channels. The second is the homogenization of resources. Most of the practice bases are mainly based on red education and traditional culture. The supply of resources for the themes of the times such as scientific and technological innovation, ecological protection, grassroots governance, and digital economy is insufficient, and it is difficult to meet the students' multi-metacognitive needs and the development requirements of the times. Thirdly, the resources are shallow. Most of the development of practical resources stays at the level of 'visiting and playing cards', lacks the deep excavation of the ideological connotation, the value of the times and the theoretical logic behind the resources, and does not form a teaching content system that is connected with ideological and political theory and professional knowledge, resulting in 'walking' becoming a mere formality.

3.2. There are three major shortcomings in curriculum design

The curriculum design is the core of the quality of "walking ideological and political course. " There are some problems in some practice, such as "emphasizing form, neglecting content", "emphasizing process, neglecting goal". First, there is a tendency of formalization. Some schools simply equate 'walking ideological and political courses' with out-of-school visits and research trips. They lack clear educational objectives, systematic teaching content and standardized implementation processes. The activities are 'looking at the flowers' and it is difficult to achieve value guidance. The second is the problem of fragmentation. The curriculum content lacks overall planning, the theme is scattered, the connection is insufficient, the curriculum design of different students and different majors lacks gradient and coherence, and a step-by-step education system has not been formed. The third is the phenomenon of disconnection. The practical content is not closely combined with the ideological and political theory, professional courses and students' ideological reality. There is a problem of 'ideological and political education, professional education, practice and practice', which leads to the low enthusiasm of students' participation and the difficulty of realizing the 'unity of knowledge and practice'.

3.3. There are obvious shortcomings in the guarantee mechanism

A sound guarantee mechanism is the support for the sustainable development of "walking ideological and political

courses", and the current guarantee system is still insufficient. First, the funding guarantee is insufficient. Most colleges and universities have limited funds for ideological and political practice teaching, and it is difficult to cover expenses such as venue leasing, transportation, resource development, teacher training, and student subsidies. As a result, the scale of practical activities is small, the frequency is low, and it is difficult to carry out normalization. Secondly, the teaching staff is weak, and there is a lack of professional 'walking ideological and political course' instructors. Most of the existing teachers are ideological and political course teachers or counselors, and generally lack interdisciplinary knowledge, practical experience and curriculum design ability. It is difficult to effectively guide students to transform practical experience into ideological identity and theoretical consciousness. Third, the evaluation system is missing, and a scientific and perfect evaluation standard has not yet been established. Most schools measure the effect of education with simple indicators such as participation rate, experience and practice report, and lack quantitative and qualitative evaluation of students' ideological awareness, practical ability enhancement, and value concept shaping. It is also impossible to effectively evaluate and continuously improve the quality of the curriculum.

3.4. Collaborative education mechanism is not yet perfect

Collaborative education is an inevitable requirement for the construction of big ideological and political courses, but the education pattern of "university, government, enterprise and society" has not yet been fully formed. First, there are departmental barriers. The policy guidance of government departments is not closely connected with the needs of school practice. The resources of cultural tourism, party history, science and technology have not been effectively transformed into educational resources. Second, school-enterprise barriers, the enthusiasm of enterprises to participate is not high. Although some enterprises are willing to provide practical positions, they lack the teaching design that integrates with ideological and political education, and it is difficult to achieve the dual goal of "enterprise practice + value guidance. " Third, the mechanism is not smooth, and there is a lack of a normalized collaborative education mechanism. Most of the school-local and school-enterprise cooperation is short-term and project-based, and there is a lack of a long-term stable cooperation platform and benefit sharing mechanism, which makes the effect of collaborative education difficult to sustain.

4. Innovative path of 'walking ideological and political course' from the perspective of big ideological and political course

4.1. Building a diversified resource integration system

Resource integration is the basis for the construction of "walking ideological and political courses. " It is necessary to adhere to systematic thinking, break resource barriers, and build a diversified resource system of "on-campus + off-campus", "online + offline" and "traditional + modern".

In terms of campus resources, dig deep into the endogenous resources of the campus and create a "campus walking classroom. " To sort out the ideological and political elements in the history and situation of the school, and transform the excellent alumni deeds, campus historical buildings, scientific research achievements into cases, campus cultural activities into ideological and political education materials ; integrate resources such as campus laboratories, training bases, libraries, and art galleries, and design ' professional + ideological and political ' practical projects to maximize the use of campus resources.

In terms of off-campus resources, classify and integrate various social resources and establish a 'co-construction and sharing base group'. Deepen the utilization of red resources, cooperate with revolutionary

sites, memorial halls, etc., and develop a series of courses on “Red Gene Inheritance” ; activate traditional cultural resources, unite museums, non-heritage museums, etc., and develop a series of courses on “cultural self-confidence cultivation”; expand the theme resources of the times, connect high-tech enterprises, rural revitalization demonstration villages, etc., and develop a series of courses of “practice of the spirit of the times. “ At the same time, led by government departments, a regional ideological and political resource sharing platform is established to achieve accurate docking of resource supply and demand and avoid duplication of construction and waste of resources.

In terms of digital resources, modern information technology is used to create a “virtual walking classroom” to break the time and space constraints. Through digital modeling, VR, AR, digital twin and other technologies are used to restore red sites and major projects, and immersive virtual research projects are developed. Make digital teaching resources such as micro-videos, online courses, interactive games, and enrich presentation forms; build an online communication and interaction platform to support students to share practical results, cross-school collaboration, and improve resource accessibility and sharing. At the same time, we should pay attention to the differentiated development of resources, and design personalized resource packages according to the characteristics of different students and different majors to meet the needs of diversified education.

4.2. Improve the systematic security mechanism

A sound guarantee mechanism is the key to the sustainable development of “walking ideological and political courses. “ It is necessary to build a systematic guarantee system from the three dimensions of funds, teachers and evaluation.

In terms of funding guarantee, a diversified investment mechanism of ‘ government financial support + special allocation of colleges and universities + corporate social sponsorship + self-financing of project funds ‘ is constructed. Actively strive for the government’s special financial funds, and incorporate the ‘walking ideological and political course’ funds into the annual education budget; colleges and universities set up a special fund for ideological and political practice teaching to ensure the basic needs of curriculum development and base construction. Strengthen cooperation with enterprises and social organizations to attract social capital participation ; encourage student teams to apply for innovation and entrepreneurship, social practice projects, and raise funds in a project-based manner. At the same time, a supervision mechanism for the use of funds is established to improve the efficiency of use and ensure the earmarking of funds.

On the guarantee of teachers, we will create a three-in-one compound teacher team of ‘ideological and political teachers + professional teachers + off-campus tutors’. Ideological and political teachers grasp the ideological and political direction of the curriculum, carry out theoretical guidance and value guidance ; professional teachers combine professional knowledge to design practical content, and guide students to combine professional skills with practical needs ; off-campus tutors hire model workers, industry experts, etc., to provide practical guidance and experience sharing. Strengthen teacher training, regularly organize interdisciplinary teaching seminars, practical ability training and other activities to improve teachers’ curriculum design and practical guidance ability; establish a teacher incentive mechanism, incorporate teaching effectiveness into the assessment and evaluation system, and stimulate teachers’ enthusiasm for participation.

In terms of evaluation guarantee, we should break the single result evaluation model and build a scientific evaluation system combining ‘process evaluation + result evaluation’, ‘quantitative evaluation + qualitative evaluation’, and ‘self-evaluation + others evaluation’ [2]. The process evaluation focuses on students’ participation,

teamwork, problem solving ability, etc., through practice logs, activity records, etc. ; the result evaluation focuses on the improvement of practical results and ideological consciousness, which is measured by practical reports and results display. Quantitative evaluation uses quantifiable indicators such as participation rate and task completion ; qualitative evaluation focuses on ideological change, value identification, etc., through interviews, third-party evaluation, etc. Establish a continuous improvement mechanism for curriculum quality, adjust curriculum design and optimize resource allocation according to the evaluation results.

4.3. Improve the pattern of collaborative education

Collaborative education is an inevitable requirement for the construction of ideological and political courses. It is necessary to break all kinds of barriers and build a collaborative education pattern of 'university-led, government-led, enterprise participation, and social support'.

Colleges and universities play a leading role, set up a leading group for the construction of "walking ideological and political courses", and coordinate curriculum planning, resource integration and quality monitoring. Strengthen school-school cooperation, build and share high-quality resources and teaching staff, and carry out cross-school joint practice projects ; deepen the coordination within the school, break down the barriers between departments, promote the cooperation between ideological and political departments and professional departments, and realize the deep integration of ideological and political education and professional education; strengthen the overall design of the curriculum, formulate construction implementation plans and curriculum standards, and form a gradual education system.

The government performs the function of guidance and coordination, introduces support policies, and provides a good policy environment. Coordinating all kinds of ideological and political resources in the region, establishing a resource sharing mechanism, and promoting the opening of various places to schools ; strengthen policy support, give financial support and policy support to the construction of practice bases and the development of digital resources ; establish a supervision and evaluation mechanism, incorporate the construction into the education evaluation system, and regularly carry out supervision and inspection.

Enterprises actively participate in the construction, providing students with practical positions, training bases and technical support. Co-build a 'double tutorial system' practice base with colleges and universities, select excellent employees as off-campus tutors, and integrate the spirit of entrepreneurship and craftsmanship ; combining with the actual production and operation, we design practical projects with ideological and political elements, so that students can feel the professional spirit and social responsibility in practice ; strengthen industry-university-research cooperation, transform enterprise scientific research projects into ideological and political practice content, and achieve a win-win situation for enterprise development and talent training.

The community actively supports the construction and opens up all kinds of venue resources and volunteer service posts. Public cultural institutions develop exclusive ideological and political practice courses and arrange professionals to explain and guide them ; community and rural grassroots organizations provide support for students to carry out social surveys and volunteer services ; the media platform strengthens the publicity of typical cases and practical results, and creates a good atmosphere for the whole society to care for and support ideological and political education.

Based on the successful experience of educating people in relevant regions, a normalized collaborative education mechanism is established. By signing cooperation agreements and establishing collaborative education alliances, the division of responsibilities of all parties is clarified, resource sharing and complementary advantages

are realized, and a sustained and stable joint force of educating people is formed.

5. Conclusion

At present, the construction of the "walking ideological and political course" has achieved phased results, but it still needs to continue to make efforts in resource integration, curriculum design, guarantee mechanism, and collaborative education. In the future, with the deepening of the construction of major ideological and political courses, the 'walking ideological and political courses' will surely radiate stronger vitality, cultivate more new people of the times with family and country feelings, social responsibility, innovative spirit and practical ability, and provide solid talent support and ideological guarantee for the realization of the Chinese dream of the great rejuvenation of the Chinese nation.

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The National Identity of Adolescents and Its Impact on Consumption Tendency

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Abstract: Adolescence is a critical period of self-identity formation. This study aims to examine the current situation of adolescents' national identity and its influence on the tendency of consumption behavior. Participants and Methods: A total of 711 students from middle schools, high schools and colleges participated in the survey. Participants answered questionnaires assessing their national identity and consumption tendency. Statistical methods were used for data analysis. Results: The results indicate that adolescents have positive national identity, and the identity level of college and junior high school students was significantly higher than that of senior high school students. In the consumption of mobile phones, trainers and bottled water, they are more likely to choose domestic brands, while for computers, they prefer overseas brands. National identity has a significant positive correlation with and a stable predictive effect on adolescents' domestic consumption tendency. Conclusion: This study suggests that adolescents' national identity positively predicts their preference for domestic products in consumption.At the same time, the market share and brand popularity of China's hightech products need to be further increased, which will contribute to the further improvement of adolescents' national identity.

Keywords: National identity; Consumption tendency; Adolescents; Consumer goods

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1. Introduction

Identity refers to the psychological process of recognizing and imitating the attitudes and behaviors of others or groups to make them a part of individual personality. It reflects a consistent psychological and behavioral response of people, who, as social animals, seek a sense of belonging, intimacy, identity and love[1]. With the further development of research on individual identity and social identity, its connotation has undergone sublimation from ethnic or social identity to national identity[2,3,4]. National identity is the spiritual activity of "a person confirms that he belongs to that country and what the country is"[5]. It is a complex psychological structure system with many components, which can be relatively divided into cognitive component system and affective component system[6].

As a sense of belonging to the political community, national identity is the source of power to enhance

national cohesiveness. However, the construction of national identity is not a fixed state, but a dynamic process embodied in all aspects of people's daily life. It has always been researchers' focus that when individuals begin to realize their national identity, how to build such national identity and what factors make a difference in the construction process[4]. National identity has a great impact on individual decision-making[7], and there are significant differences in the level of national identity among people from different countries[8]. This difference further explains why Americans "buy American" and Japanese "have a high preference for Japanese goods"[9]. Marketing research finds that national image is positively correlated with consumers' purchasing behaviors, and consumers' recognition of national image positively enhances their purchasing intention[10]. National identity, to some extent, also counterbalances the influence of world consumerism on the consumption tendency of domestic brands[11]. When choosing goods, consumers with high ethnocentrism tend to buy domestic brands, and are biased against foreign brands. They believe that buying foreign products will go against national enterprise and harm their interests, and furthermore, consider it to be immoral, leading to moral conflicts in their mind[12]. This tendency is most prominent in the situation that they are under external threat or their country is very strong.

With the development of China's economy and the spread of global consumer culture in China, consumers are changing their attitudes towards goods. Symbol consumption has become an important part in current social and cultural life. The fashion, trendiness and individuality it conveys and creates are widely recognized and pursued by adolescents, these elements constitute a realistic path to know themselves and seek meaning[13]. It is worth noting that symbol consumption cannot provide a solid fulcrum for individuals to form a stable, coherent and independent sense of self-identity[14]. Adolescence is a critical period for the establishment of self-identity. Adolescents are the future of a country and the hope of a nation, and it is therefore crucial to strengthen their national identity for the realization of the great rejuvenation of the Chinese nation. Based on the the "national identity questionnaire" and the "consumption tendency questionnaire", this study investigates the current situation of adolescents' national identity and consumption tendency and the impact of national identity on consumer behavior. Also, it further clarifies the influence of national identity on modeling adolescents' behavior to give a reference for patriotism education in the new era.

2. Methods

2.1. Participants

A total of 732 questionnaires were sent out to students from Grade 1 in middle school to Grade 3 in college in Guangzhou and Shenzhen via stratified cluster sampling, and 711 valid questionnaires were collected, including 342 males and 369 females. In terms of grade, there were 80 students (39 males and 41 females) in the first grade of middle school, 77 students (37 males and 40 females) in the second grade; 79 students (35 males and 44 females) in the third grade ; 74 students (36 males and 38 females) in the first grade of high school; 99 students (52 males and 47 females) in the second grade; 98 students (48 males and 50 females) in the third grade; 82 freshmen (38 males and 44 females) in college; 85 sophomores (39 males and 46 females) and 37 juniors (18 males and 19 females).

2.2. Measures

2.2.1. National Identity

According to the analysis of interviews and open questionnaires, and referring to existing research documents on national identity and relevant assessment tools, 35 questions of the preliminary questionnaire are comprehensively

compiled. With all items determined, the RAND function in Excel was used to randomize the order of all items. Participants are asked to rate these items using a 7-point Likert scale according to "agree" or "disagree", fully agree with 7 points, most agree with 6 points, partly agree with 5 points, uncertainty with 4 points, partly disagree with 3 points, quite disagree with 2 points and completely disagree with 1 point. The higher the score was, the higher the participants' level of national identity. On this basis, a small sample of 100 adolescents was selected for the test, and preliminary exploratory factor analysis was conducted on the results. Unsuitable items in the questionnaire were deleted according to the following statistical indicators[15] : (1) Factor loadings were less than 0.40 or exhibited cross-loading; (2) Communality was lower than 0.30; (3) The correlation between project and total score was lower than 0.40. Finally, a questionnaire of national identity for adolescents composed of 12 items was formed, which was of a single dimension.

2.2.2. Consumption Preference

In order to choose suitable consumer goods, the researchers conducted a small sample pre-survey before the formal one, asking a group of adolescents to talk about their opinions on some commonly-used consumer goods. These consumer goods covered four categories: mobile phones, trainers, bottled water and computers. These products were selected because they were the main purchase items for high school students. At that time, there were a number of domestic and foreign brands competing in the Chinese market in all these items.

The brands of each consumer product were selected through the following steps[16,17]: (1) Department stores and shopping malls were visited, and the names of all brands of each selected consumer good were recorded; (2) A list of consumer brands was provided to the manager,who helped identify the most or relatively popular brands. A total of 32 brands were selected, with 8 brands (4 domestic and 4 foreign) in each category of consumer goods. Among them, mobile phone brands included Apple, Samsung, Huawei, and Xiaomi, etc; Trainers brands included Nike, Adidas, Li Ning, 361, etc.; Bottled water brands covered Evian, Master Kong, Nongfu Spring and C'est bon, etc.; Computer brands included Apple, HP, Lenovo, Haier and so on. Respondents were asked to evaluate each brand in the above 4 categories of 32 brands using a 7-point Likert scale, scoring them according to their affection from "1= very low" to "7= very high".

2.3. Testing Procedure and Data Analysis

The formal test lasts about 15 minutes on-site. All data are input, processed and analyzed with SPSS 21.0 and AMOS 18.0 statistical software.

3. Results

3.1. QualityAnalysis of the National Identity Questionnaire forAdolescents

3.1.1. Project Analysis

The correlation between each item and the total score of the national identity questionnaire was defined as the item-total correlation. The item-total correlation coefficients of all items were greater than 0.40, and all reached a significant level ($r= 0.63\sim0.90$, $p<0.01$; see **Table 1** for details). Therefore, all items are retained. According to the total score of the questionnaire, two groups with high and low scores of 27% are divided, and an independent-samples t-test (to examine item discrimination) was conducted. The results showed that there were significant differences between high and low groups for each item ($p<0.001$), indicating that each item had a high degree of differentiation.

Table 1. The Analysis of the Correlation between Each Item and the Total Score of the National Identity Questionnaire

Question	r	Question	r	Question	r	Question	r
1	0.86**	4	0.77**	7	0.90**	10	0.63**
2	0.78**	5	0.85**	8	0.66**	11	0.82**
3	0.77**	6	0.79**	9	0.88**	12	0.87**

Note:*** p <0.001, ** p <0.01, * p < 0.05, the same below.

3.1.2. Structure of the Questionnaire

The valid dataset was randomly split into two subsets. The first sample was used for exploratory factor analysis to construct the structural model of adolescent national identity. The second subset was used for confirmatory factor analysis to verify the structural model of adolescent national identity and determine the final structure of the questionnaire.

(1) Exploratory factor analysis was conducted on sample 1 by SPSS 21.0. The χ^2 value of Bartlett spherical test is 4498.285, reaching the significant level (p<0.001). The KMO value of sampling suitability was 0.961, indicating that the data were suitable for factor analysis. With no limit to factors, the principal component method and the maximal variance orthogonal rotation method were used to get the final factor loading matrix. As shown in **Table 2**, national identity was composed of a single dimension, and 12 items accounting for 71.518% of the total variance.

Table 2. The Results of Exploratory Factor Analysis of Adolescent National Identity Questionnaire

Question	Load	Communality	Question	Load	Communality
1	0.938	0.806	7	0.845	0.879
2	0.924	0.683	8	0.827	0.652
3	0.918	0.679	9	0.824	0.843
4	0.898	0.654	10	0.809	0.617
5	0.897	0.797	11	0.672	0.804
6	0.893	0.714	12	0.646	0.854
Characteristic Value			8.582		
Contribution Rate			71.518%		

(2) Confirmatory factor analysis was performed on sample 2 by AMOS 18.0. The results show that the model fit indices were χ^2=235.12, df=103, χ^2/df=2.28,, GFI=0.93, AGFI=0.90, IFI=0.95, TLI=0.94, CFI=0.92, RMSEA=0.05. It can be seen that the main model fit indices of the formal questionnaire met the requirements of psychological measurement, and the standardized factor load of each item was greater than 0. 5, reaching a significant level, which indicated that the formal questionnaire of national identity of adolescents has good structural validity.

3.1.3. Reliability Analysis

The Cronbach's α coefficient and split-half reliability coefficient of the formal questionnaire were examined. The results show that the Cronbach's α coefficient of the questionnaire is 0.94, which indicates that the questionnaire has high internal consistency. The split-half reliability coefficient of the questionnaire is 0.93, demonstrating good equivalence of

the scale. In general, the National Identity Questionnaire for Adolescents has high reliability.

3.2. Analysis on the Status Quo of Adolescents' National Identity

There were 12 questions in the National Identity Questionnaire, each with a maximum of 7 points and a minimum of 1 point. The highest score was 84, and the lowest was 12, and the midpoint was 48. In order to understand the national identity preference of adolescents, a paired-samples t-test was conducted between the average and the midpoint 48. The average score was 74.03, which was significantly higher than 48 (t=57.31, df =710, p <0.01), showing that adolescents held a positive attitude toward national identity.

The differences in national identity of adolescents in different learning periods (middle schools, high schools and colleges) are compared, with the results presented in Table 3. A one-way ANOVA revealed a significant difference in national identity across the three groups(F (2, 708) =8.14, p <0.01). Post-hoc multiple comparisons (see **Table 4**) indicated no significant difference in national identity between college students and junior high school students. By contrast, a remarkable difference was found in the total national identity score between college students and senior high school students(I-J=5.30, p <0.01). Similarly, a significant difference was observed between junior high school students and senior high school students (I-J=5.35, p<0.01). Notably, both college students and junior high school students demonstrated significantly higher levels of national identity than senior high school students, which is also illustrated in **Table 3**).

Table 3. Comparison of National Identity of Adolescents in Different Learning Periods

	Learning Periods	M	SD	F	Comparison
National Identity	Middle School(236)	80.62	12.43	8.14**	College>High School Middle School>High School
	High School(271)	65.12	11.90		
	College(204)	78.35	12.36		

3.3. Analysis of the Status Quo of Adolescents' Consumption Tendency

The average score for each brand was calculated and ranked from highest to lowest for each category (shown in **Table 4**). Among them, the top three preferred brands for mobile phones were: Huawei, Apple and Xiaomi; The top three preferences for trainers were: Nike,Adidas and Li Ning; The top three preferences for bottled water were : Nongfu Spring, Snow Mountains and Watsons. The top three preferences for computers were:Apple, Lenovo and HP.

Table 4. Adolescents' Consumption Tendency

Mobile Phone			Trainers			Bottled Water			Computer		
Brand	Preference	Ranking	Brand	Preference	Ranking	Brand	Preference	Ranking	Brand	Preference	Ranking
SONY[f]	3.30	7	Li Ning	4.59	3	Master Kongf	4.14	8	Lenovo	4.82	2
OPPO	3.18	8	ANTA	4.45	5	Nestle[f]	4.35	5	Haier	4.11	6
Xiaomi	4.46	3	New balance[f]	4.52	4	Wahaha	4.17	7	Apple[f]	4.99	1
Huawei	5.71	1	Adidas[f]	5.05	2	Nongfu Spring	5.52	1	HP[f]	4.52	3
Motorola[f]	3.51	6	ERKE	3.83	7	Watsons[f]	4.41	3	ACER[f]	4.21	5
Vivo	3.95	4	PEAK[f]	3.72	8	Evian[f]	4.23	6	Founder	4.07	8
Samsung[f]	3.76	5	NIKE[f]	5.21	1	Snow Mountains	4.52	2	Samsung[f]	4.10	7
Apple[f]	4.95	2	361	4.42	6	C'estbon	4.40	4	Huawei	4.39	4

Note: The brands marked f are foreign or overseas brands(Hong Kong and Taiwan region). Others are local brands.

A t-test was carried out after classifying domestic and foreign brands in each category of consumer goods. The results show that the preferences of the four types of domestic brands and foreign brands were significantly different (shown in **Table 5**). Among them, adolescents were more inclined to consume domestic brands in mobile phones, trainers and bottled water(t=9.09, p <0.001; t=10.80, p<0.001; t=41.49, p <0.001), while they preferred to buy computers of foreign brands (t=-4.53, p <0.001).

Table 5. Comparison of Domestic and Foreign Consumption Tendency of Adolescents

Consumer Goods		M	SD	T	Consumer Goods		M	SD	T
Mobile Phone	Domestic Brand	17.30	5.31	9.09***	Bottled Water	Domestic Brand	22.75	6.84	41.49***
	Foreign Brand	15.52	5.58			Foreign Brand	17.68	5.86	
Trainers	Domestic Brand	21.01	7.61	10.80***	Computer	Domestic Brand	17.20	5.77	-4.53***
	Foreign Brand	18.50	5.68			Foreign Brand	18.00	5.93	

3.4. The Impact of Adolescents' National Identity on Consumption Tendency

The correlation analysis between national identity and consumption tendency of domestic brands in each category shows that: Domestic mobile phones (r=0.327, p <0.01), domestic trainers (r=0.311, p <0.01), domestic bottled water (r=0.317, p <0.01), domestic computers (r=0.313, p <0.01) and the total score of domestic products consumption tendency (r=0.371, p <0.01) all showed a significant positive correlation with national identity.

In order to further study the relationship between the national identity of adolescents and the consumption tendency of domestic products, a univariate regression analysis was performed one by one (shown in **Table 6**) with the total score of the consumption tendency of domestic mobile phones, trainers, bottled water, computers and all four brands as dependent variables, with national identity as a predictor variable. At the same time, gender and grade were selected as control variables, which, in previous studies, have been proved to have an impact on consumption tendency[18]. The results showed that national identity significantly positively predicted adolescents' domestic consumption tendency, indicating that the higher the degree of national identity was, the more likely adolescents were to choose domestic brands.

Table 6. The Impact of National Identity on Adolescents' Consumption Tendency

	Domestic Mobile Phone(β)		Domestic Trainers(β)		Domestic Bottled Water(β)		Domestic Computer(β)		Consumption Tendency of Domestic Products(β)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Demographic Variable										
Gender	0.68	0.62	0.06	-0.03	-0.12	-0.20	0.12	0.05	0.74	.446
Period	0.11	0.39	-0.60	-0.23	-0.24	0.09	-0.36	-0.08	-1.09	0.162
Independent Variable										
National Identity		0.14***		0.19***		0.17***		0.14***		0.64***
F Value	1.47	25.18***	1.16	21.90***	0.25	21.42***	0.75	20.36***	0.57	31.251**
R^2	0.00	0.10	0.00	0.08	0.00	0.09	0.00	0.08	0.00	0.12
$\triangle R^2$	0.00	0.09	0.00	0.08	-0.00	0.08	-0.00	0.08	-0.00	0.12

4. Discussion

Nowadays, transnational social activities in the areas of economic, political and cultural fields are increasingly frequent, under the background of economic globalization, world multi-polarization and cultural diversification. Countries are closely connected, which makes the national identity representing the legitimacy of the nationstate and its construction face enormous challenges[19,20]. The basic values formed in adolescence shape the value orientation of a person's whole life[21]. As students grow older, their national identity declines[22]. The study found that the national identity of college students and middle school students was significantly higher than that of high school students. The reason for this change may be the heavy study pressure and the short-sighted utilitarian mechanism of higher education. In high school, with the pressure of college entrance examination, students spend more time in textbook learning and little time in participating in the national political life. Their understanding of the relationship between individuals and the country, as well as national politics, economy, culture and social life are often confined to book knowledge and perceptual understanding[23]. Therefore, in the process of multicultural identity, it is urgent to promote mainstream cultural identity education with national culture as the core[24].

As an important link for maintaining a country's existence and development, national identity does not form through a spontaneous process of self-awakening; instead, it requires education, especially the promotion of civic awareness education in schools[25]. For example, the United States has set up social study courses in K-12 period, which integrate American spirit and multiculturalism, and helps students develop American values, identify with and love America[26]. Russia pays attention to integrating national identity education into language, history and other courses. In the new history textbook Russia launched in 2016, the will and authority of the state are clarified, and the achievements of national history and culture are affirmed, so as to promote students' national identity[27]. In educational practices, it is necessary to design a set of scientific and effective educational methods, such as national culture identity education, historical identification education, patriotism education, etc., to cultivate adolescents' common sense of national identity[28,29]. With national identity education, adolescents should be guided to form common values, consciously overcome the centrifugal force of cultural diversity on political identity, further enhance their confidence in the path, theory, system and culture of socialism with Chinese characteristics, and establish a strong sense of mission, responsibility and belonging to the country.

It is worth noting that in the context of globalization global consumerism has made consumption become the external symbol of "self-identity", and self-identity has become the internal basis of consumption[30]. The result is that people consciously or unconsciously weaken or replace social and collective identity of the nation with self-identity[31]. To this end, this study aims to reveal the stability and effectiveness of adolescents' national identity by examining the potential impact of their national identity on their consumption tendency. The research outcome presents that, no matter low-priced bottled water or high-priced mobile phones, adolescents tended to buy domestic brand products, and the national identity was significantly positively correlated with the consumption tendency of domestic brand products. Further analysis found that adolescents' national identity can effectively predict domestic consumption tendencies. National identity is a set of meanings contained in a particular culture that distinguishes it from other cultures[9], and the products and brands of a country are also carriers of national culture communication. The connotation contained in the purchase and use of domestic products and brands is embodied by consumers, which can give them a sense of national identity. In particular, when these products and brands are sold nationwide rather than just in a single place, the purchase and use

of these same products can give consumers a sense of connection with national culture rather than a local subculture.

However, in the case of computers, the study found that adolescents tend to purchase foreign brands. After analysis, it is clear that the reason why adolescents choose western brands is that these brands have clear global brand status, and are world-famous brands. Not only do these western brands have higher quality and are technically superior to domestic brands in technique, but they have been in the Chinese market for a long time and even have a greater impact in market than their domestic counterparts. As a consumer group, adolescents' choices are not always rational. Quality and popularity have important impacts on their consumption tendency. For this reason, we need to emphasize the cultural "difference" rather than the sense of identity attributed to international brands by public voice, education and other measures[32]. At the same time, it is necessary to further improve the market share and brand awareness of domestic high-tech products, which are obviously helpful to further enhance the national identity of adolescents.

As one of the most important daily behaviors of individuals, consumer behavior undoubtedly has a subtle influence on forming national identity. Some studies have shown that consumers' national identity means that they will consume products related to their national identity[33]. Domestic brands often benefit from consumers' high level of national identity[34]. Most Chinese companies focus more on providing consumers with costeffective products and less on building brand equity. In the era of globalization, enterprises should consciously create and produce brand products linked with national identity, and embed or emphasize the concept of national culture in the marketing strategies, so as to enhance consumers' preference and choice of the brand. Of course, in real life, consumers' preference for domestic brands will be affected by multiple factors, such as consumer personality (demographic characteristics, value characteristics) and brand characteristics, and national identity may be only one of the value characteristics of consumers. When other factors, such as the brand awareness of mobile phones, play a stronger role in some products, it is not surprising that consumers have preferences for domestic brands, which are affected by multiple factors.

5. Conclusion

The reliability and validity indices of the national identity questionnaire meets the requirements of psychometrics and can be used as a short and reliable measurement tool for the study of national identity among adolescents. On the whole, the national identity of adolescents shows a positive growing trend. In the assessment of national identity, college students and middle school students were significantly more positive than high school students. Adolescents were more likely to buy mobile phones, trainers and bottled water of domestic brands, while they tended to choose computers of foreign brands. National identity has a stable predictive effect on adolescents' domestic consumption tendency.

6. Limitations and Future Research

The limitations of the study include the following three points: first, the questionnaires in this paper were all filled out by adolescents, which may have the issue of common method variance. Future research could address th is issue by incorporating experimental designs. Second, this study only examines the direct impact of national identity on adolescents' domestic consumption tendencies. Future studies could explore the underlying mechanisms of this relationship to enrich the existing literature. Finally, it should be noted that national identity

questionnaire should expand test and establish a more extensive and representative norm although it has good reliability and validity indicators.

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Ethical Statement

The Ethics Committee at School of Innovation and Creation Design, Shenzhen Polytechnic University supports the practice of protection of human participants in this research. Informed consent was obtained from all individual participants included in the study in accordance with the Declaration of Helsinki. Before the survey, all participants were explicitly told that they would be asked to fill out questionnaires and answer some questions. Participation was solicited on a strictly voluntary basis.

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Exploration of the Communication Logic and Path from Traffic to "Retention": Post-observation of the Phenomenon of "Su Chao"

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Abstract: The Jiangsu Urban Football League concluded with Taizhou claiming the championship. As a groundbreaking media phenomenon in 2025, this event has sparked extensive scholarly and media discussions on urban branding, news communication models, and public historical perspectives. This paper argues that the media spectacle of "Su Chao" is shaped by the convergence of visual, narrative, and interactive symbols. Through the mimesis dissemination on all-media platforms, a communication environment of "reflecting reality — obscuring reality — hyperreality" has been formed. To sustain the practical value of "Su Chao", the paper advocates avoiding excessive symbolic dissemination, guarding against traffic traps, and preventing the risk of "entertainment to death."

Keywords: Su Chao; Media spectacle; Simulation communication; Brand value

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1. Introduction

As the Jiangsu Provincial Urban Football League (hereinafter referred to as "Su Chao") concludes, reflecting on this football tournament that ran from May 10 to November 1, people can perceive how "Su Chao" constructed a passionate and regionally distinctive football world through various symbols, images, and narratives during its media dissemination. This world not only presented authentic football matches but also underwent media processing and creative transformation, forming a unique media spectacle through simulacrum communication [1]. People can positively affirm that "Su Chao" achieved dual improvements in social attention and public participation through media convergence, realizing both cultural and economic benefits, while providing replicable and promotable practical models for local characteristic IP development. However, with the tournament's conclusion, the "Su Chao" heat inevitably experienced a cliff-like "cooling down." People need to consider how to transition from the "high-temperature" to "cooling-off" event hiatus before the new round of "Su Chao" begins, explore practical models to transform "high-temperature" into "normal-temperature" operations, and continue promoting collaborative efforts

among all participants to sustain the practical value of "Su Chao."

2. Review of the research

The "Suzhou Super League" (Su Chao), recognized as the most representative "phenomenon-level communication event" of 2025, has attracted extensive scholarly and media research from multiple perspectives. A literature search on CNKI using the keyword "Su Chao" as of November 23 reveals that before September, the sources of related literature were predominantly newspaper articles. From September to November, academic journal articles gradually increased and showed a trend of surpassing others. This change aligns with Su Chao's evolution from "early official promotion" to "mid-to-late mass communication." Meanwhile, institutions like the School of Physical Education at Nanjing Normal University have seen faculty and students publish research closely tied to sports disciplines, demonstrating how sporting events can drive academic impact. The media industry has also seized this opportunity, producing frequent special features and thematic reports that foster collaboration between academia and industry. Overall, the research perspectives are diverse, with three categories standing out in the communication field:

2.1. Media dissemination empowers new urban image shaping

Wang Dan argues from the perspective of "urban image construction" that "through value-driven positioning, narrative innovation, and code co-creation, "Su Chao" not only provides valuable references for the modern transformation of urban image construction in the new era, but also signifies the formation of a replicable and scalable innovative paradigm for urban image communication" [2]. Jia Fangjun, Director of Huangshi City's Converged Media Center and senior journalist, observes that "Su Chao" offers clear solutions for media centers to enhance "urban image dissemination" and "cultural tourism industry upgrading" [3]. Wang Xiaowan et al. propose that the "Su Chao" model marks a profound symbolic shift in modern urban branding, moving beyond the superficial logic of "sports events = advertising space" to an ecological closed-loop system encompassing "Competitive IP-Space Optimization-Economic Derivation-Cultural Coding" [4].

2.2. Sports events empower new media communication models

Lei Ming, Chief Editor of Xinhua Daily, analyzed the full-chain dissemination strategy of viral sports IP under Party media dominance, focusing on dimensions such as mainstream media agenda-setting, discourse innovation, cross-media coordination, and resource integration [5]. Wei Haiyan, Chief Reporter of Yanfu Mass Daily Press Group, proposed that the breakout success of "Su Chao" stemmed from the media's value elevation through narrative innovation and relationship activation [6]. This transformation evolved media roles from information transmitters to co-creators of meaning, connectors of relationships, and enablers of value, demonstrating innovative approaches for local media in the context of media convergence. Chen Yi from Changzhou News Media Center noted that "Su Chao" not only promoted the event and city but also profoundly influenced media reporting methods and communication patterns, serving as a test of deep media integration and innovative communication strategies [7].

2.3. People-centered empowerment: New dimensions in historical perspectives on the people

Through comparative analysis of the "Village Super League" and "Jiangsu Super League" cases, Liu Jing and Li

Guo discovered that both competitions established a progressive dynamic chain of "public initiative—cultural empowerment—resource integration—media dissemination" [8]. They proposed that "the intrinsic driving force of mass sports fundamentally manifests as the people's active participation in sports." Xu Nuoxuan and Du Changliang identified three core characteristics of community football events—non-professional engagement, ritualized cultural symbolism, and de-commercialized governance—that effectively stimulated public sports participation and strengthened cultural identity [9]. Xu Haitao and colleagues leveraged the resource advantages of media convergence to deconstruct the "emotional" elements embedded in these events [10]. By employing "emotional storytelling" to resonate with audiences, they precisely controlled reporting pacing and content, effectively guiding public engagement, and delivered a "well-placed shot" in urban cultural and economic development.

3. The communication logic behind the traffic of "Su Chao"

This event has garnered numerous labels. From a media perspective alone, various outlets have provided comprehensive coverage of the "Su Chao" through multiple angles. Traditional media like Xinhua Daily and People's Daily have delivered authoritative analysis and dissemination via in-depth reports and commentaries. New media platforms such as TikTok, Kuaishou, and sports communities like HUPU have leveraged user-generated content to rapidly spread event-related topics, memes, and short videos online, creating viral spread. In terms of hashtag-driven social interactions, capitalizing on Jiangsu's distinctive' loose "regional culture, netizens crafted personalized" character designs' for each participating team. These labels not only reinforced inter-city regional identity but also became trending topics in social interactions. Thus, the "Su Chao" has evolved beyond being merely a sports competition into a meticulously crafted visual spectacle, gradually transforming into a captivating media phenomenon.

3.1. Visual symbols: From "cultural carriers" to "ultra-authentic identity symbols"

The 13 teams of "Su Chao" have transformed urban cultural symbols from "authentic heritage" into "hyper-realistic communication tools" through visual elements like AI anthropomorphism, city mascots, and team emblem interpretations. These visual symbols are continuously replicated and amplified during dissemination, ultimately transcending their original cultural connotations to become media tools that evoke emotional resonance and identity among audiences. For instance, Taizhou Team's emblem incorporates Fengcheng elements, reinterpreting regional characteristics through modern visual language. This design not only represents a sports team but also becomes a symbol of Taizhou's urban identity. This symbolic process allows audiences to form unique perceptions of the team and city through media exposure, even without attending matches in person. Notably, this "hyper-realistic" symbolic system is not entirely detached from reality but rather presents a more engaging and communicative form through media processing based on real-world foundations.

3.2. Narrative symbol: From "event record" to "super meaning production machine"

Through narrative reconstruction of the "Su Chao" matches, the media have infused the games with heightened drama and humanistic depth. Reports spotlight grassroots players' career trajectories, urban narratives behind the teams, and heartwarming moments both on and off the pitch. These elements effectively counteract the alienating effects of competitive sports, fostering emotional resonance among audiences. This narrative approach also enables the "Su Chao" to transcend traditional sports reporting limitations, expanding from isolated sporting events

to multifaceted social discourse. Consequently, the league evolves beyond mere football matches into a collection of emotionally charged stories, offering viewers richer viewing experiences and intellectual stimulation. Whether through technical analysis of matches, emotional discussions about fan culture, or the vibrant social dynamics of ticket-hunting, the event successfully engages broader audiences. This media-guided, user-driven topic production model transforms the "Su Chao" from a sporting spectacle into a cultural feast shared by all.

3.3. Interactive symbols: From "watching participation" to "ultra-real social behavior"

"Su Chao" transforms "spectator behavior" into "ultra-real social symbols" through social media interaction design. Especially on social media platforms, topic tags with a regional teasing nature, such as "Scattered Jiangsu", not only bridge the distance between netizens but also further enhance their attention and sense of participation in "Su Chao." The phrase "The game comes first, friendship comes fourteenth" does not originate from the actual match atmosphere but is an interactive symbol created by the Nanjing Release WeChat official account through "official meme play", which quickly became a label of "regional identity" for Jiangsu people. People confirm their identity as "Jiangsu people" through "meme play." To some extent, "ultra-real participation behavior" has replaced actual on-site participation, becoming the primary way for the public to gain a sense of belonging.

4. Hidden risks in the propaganda of "Su Chao"

Media-driven spectacles through live streaming, short videos, and hashtag-driven social platforms have created hyper-realistic viewing environments and immersive atmospheres. While these innovations provide audiences with unprecedented viewing experiences and streamlined access to event information, they simultaneously create a disconnect between spectators' perceptions and the actual sporting experience. In the current era of deep media intervention, the essence of the Su Chao—its regional identity and social dynamics—has been progressively reconstructed through "simulacra", blurring the boundaries between reality and symbolic representations. Applying Baudrillard's simulacrum theory, the study observes that the Su Chao, as a digital-era communication model, generates traffic frenzy through multimedia platforms via visual branding, trending topic marketing, and narrative reconstruction [11]. This process has cultivated a communication ecosystem characterized by "reflecting reality, obscuring reality, and hyper-realization." Public perception of the league increasingly stems from media symbols rather than live matches, ultimately establishing a "hyper-realistic event system" that operates independently from physical competitions.

4.1. Hyper-realistic scenarios constructed through narrative framing

Cutting-edge technologies like live streaming and slow-motion replays deliver multi-dimensional coverage of matches. During pivotal moments, the live feed seamlessly transitions to capture players' expressions, dynamic movements, and audience reactions, immersing viewers in the adrenaline-pumping atmosphere. Enhanced by professional commentators' vivid commentary and in-depth analysis, audiences interact through real-time bullet comments and discussions, significantly enriching the viewing experience. However, the media's portrayal is meticulously curated and edited, presenting only selected footage and curated content. While media outlets employ exaggerated rhetoric and emotional storytelling to heighten engagement, these techniques often create a disconnect between the actual game dynamics and the presented narrative.

4.2. Information cocooning under the echo wall effect

Fans and media outlets transform thrilling moments, humorous clips, and players' unique performances from matches into short videos that rapidly spread across platforms. These videos typically deliver strong visual impact and entertainment value, quickly capturing massive audience attention. Platforms then curate personalized content based on user interests, allowing viewers to easily access information they care about. However, the fragmented nature of short videos hinders comprehensive match understanding. When consuming information, audiences tend to favor content that aligns with their values, hobbies, and existing beliefs, while ignoring or avoiding information that contradicts their views. This selective exposure traps audiences in their information comfort zones, further exacerbating information homogenization.

4.3. Simulation generation in label-based social interactions

Jiangsu's distinctive "loose" culture has gained viral traction online, with netizens creatively branding participating teams with humorous regional labels. This cultural phenomenon sparked extensive discussions and social engagement, significantly amplifying the event's reach. However, while these labels are entertaining, they also exhibit biases and stereotypes. As oversimplified representations of local culture, they fail to authentically capture the diversity of cities. Overuse of such labels may foster regional misunderstandings and prejudices. The media's excessive focus on regional elements could divert public attention from football's competitive essence to regional rivalry, enhancing event buzz but undermining its core values. This approach ultimately hinders the sustainable development of football competitions.

5. Sustainable path of the practical value of "Su Chao"

The "Su Chao" phenomenon not only showcases the thriving development of Jiangsu football but also highlights a unique model for transforming traffic into lasting influence. Through innovative communication methods and precise content positioning, "Su Chao" successfully attracted widespread attention and sparked phenomenal social discussions within a short period, achieving a "dimensional elevation" of urban image. For instance, cities with relatively weak traditional cultural and tourism resources, like Huai'an and Suqian, transformed "Canal Culture" and "Chu-Han Culture" into national communication symbols through team emblems like "Liangli Ma" and the classic "Farewell My Concubine" scene. Changzhou achieved generational breakthroughs in urban image by adopting a self-deprecating narrative of "Changzhou → Diaozhou → Jinzhou," converting its traditional image as an "industrial city" into a youthful symbol of "humor and optimism." However, "Su Chao" has yet to fully withstand the test of time and faces many uncertainties in the future. Lu Wenxuan argues that "Su Chao" must guard against challenges to sports authenticity from media distortion, capital erosion, and excessive administrative intervention [12]. It needs to resolve the paradox of diluted participation during scale expansion and continue cultural negotiations under pressure from capital symbolization and administrative discipline, ultimately transforming short-term hype into sustainable public engagement rooted in local identity and cultural practices. This study suggests that "Su Chao" should avoid excessive symbolic dissemination, remain vigilant against falling into traffic traps, and prevent becoming "entertainment to death" to continuously consolidate its practical value.

5.1. Avoid excessive symbolic dissemination and diversify perspectives in sports event coverage

Symbolic production must anchor itself in "authentic core values", ensuring sports event communication remains

grounded in the true essence of "sportsmanship." To enhance reporting quality and communication effectiveness for the "Su Chao", media should adhere to authenticity principles, focus on the events themselves, and present comprehensive, objective depictions of match realities. Beyond highlighting results and highlights, a deeper exploration of behind-the-scenes stories is essential to showcase the full scope of competitions and the essence of sportsmanship. The media should adopt diversified reporting approaches, avoiding overemphasis on regional rivalry or sensationalism while appropriately increasing coverage of event culture and football philosophies to elevate cultural depth and influence. Utilize new technologies to innovate reporting formats, enhancing audience engagement and interactivity to improve viewing experiences. For instance, establishing a "symbol-real" bidirectional flow mechanism can help audiences better appreciate the diversity and charm of football.

5.2. Guard against traffic traps and foster a positive communication ecosystem

To overcome the label trap and echo chamber effect while promoting free information flow and rational dialogue, platforms should reduce over-reliance on user preferences and increase content diversity and randomness. Platforms should enhance user guidance to encourage rational discussion participation and discourage emotional or one-sided expressions. For controversial topics, experts and scholars should be invited to provide analysis and direction, avoiding blind conformity and emotional reactions. Simultaneously, users should improve media literacy by actively seeking diverse information and rationally evaluating different viewpoints. On social media, users can broaden their thinking and cognitive horizons by following media outlets and accounts with varying perspectives, reading articles and comments from multiple viewpoints, and engaging in discussions. This approach enhances analytical and judgmental capabilities while expanding intellectual horizons.

5.3. Preventing the overindulgence in entertainment and prioritizing people-oriented services

The "Su Chao" should adhere to a people-centered development philosophy, making the fulfillment of public sports needs the cornerstone of its development. In event planning and organization, it should fully consider the public participation willingness and experience, providing more opportunities and high-quality services. For instance, increasing match frequency and team participation to allow more amateur players to engage; optimizing schedules to avoid conflicts with public work-life schedules; upgrading venue facilities and service quality to create better viewing and playing environments for spectators and players, thereby aligning events with public expectations. Additionally, organizing football-themed cultural activities such as lectures, training sessions, and exhibitions can popularize football knowledge, enhance public awareness and passion for the sport, further deepen the integration between events and communities, and promote sustainable development.

6. Epilogue

The media spectacle phenomenon of "Su Chao" is the result of multiple factors working together. Conducting multidimensional analysis and research on it helps us better understand the communication patterns and cultural values of sports events in contemporary society. This paper primarily focuses on "Su Chao", with limited attention paid to similar events in other regions, and the generalizability of the research findings requires further verification. Communication practices have proven that the "simulacrum communication" of sports events is not a monster but an inevitable choice to enhance communication power in the digital era. The key lies in ensuring that symbolic production serves real values, such as promoting urban cultural dissemination, creating industrial

economic benefits, and serving the promotion of mass sports. The study anticipates that the Jiangsu Football City League will become more mature in media communication, making greater contributions to the prosperity of sports culture and social-economic development.

Disclosure statement

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Reconstructing Performance to Promote High-Quality Development of Hospitals

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Abstract: Objective: To stimulate employees' work enthusiasm and promote the high-quality development of hospitals by reconstructing performance. Methods: A set of performance quantification and statistical indicator systems applicable across departments was established. By utilizing the reconstructed performance plan and assessment management model, the role of performance assessment was analyzed through the operational status of various indicators. Results: The ratio of outpatient visits to discharges increased by 1.24 year-on-year, the proportion of surgeries among discharged patients increased by 4.25 percentage points year-on-year, the proportion of minimally invasive surgeries among discharged patients increased by 2.56 percentage points year-on-year, the proportion of Level IV surgeries among discharged patients increased by 3.15 percentage points year-on-year, the average length of hospital stay decreased by 0.62 days year-on-year, the proportion of medical service revenue increased by 5.38 percentage points year-on-year, the growth rate of average drug expenses per outpatient visit was -18.79%, the growth rate of average drug expenses per hospitalization was -33.16%, and the case mix index (CMI value) increased by 0.04 year-on-year. Conclusion: Reconstructing performance can effectively achieve the goals of patient satisfaction, employee satisfaction, and the healthy, sustainable, and high-quality development of hospital medical groups and tightly integrated medical consortia.

Keywords: Performance restructuring; Satisfaction; High-quality development; Integrated medical consortium

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1. Introduction

In the modern healthcare system, performance restructuring is not only a crucial means to enhance hospital management efficiency but also a key driving force for promoting the high-quality development of hospitals. With the continuous advancement of medical technology and the growing demand for healthcare services, hospitals need to continuously innovate and optimize their performance management approaches to adapt to the increasingly

complex and dynamic healthcare environment. This study aims to improve scientific performance evaluation plans and performance management objectives through performance restructuring, thereby stimulating and mobilizing the enthusiasm of hospital staff. This approach seeks to achieve a balanced consideration of both social and economic benefits, ensuring patient satisfaction, employee satisfaction, and the healthy, sustainable, and high-quality development of hospitals [1].

2. Methods

2.1. Drawing on the essence of the RBRVS (Resource-Based Relative Value Scale) developed by Harvard University in the United States and considering the actual operational conditions of Chinese hospitals over many years, this study analyzed the benefits, costs, difficulty, risks, and labor volume of medical services completed by healthcare professionals based on thousands of medical fee items issued by the state. Subsequently, a classification and statistical analysis were conducted to establish a set of cross-departmental performance quantification statistical indicator systems [2]. (Formula: Current departmental performance income = (∑ Number of work items × Item scores) × Point unit price).

2.2. By scientifically setting performance management objectives, improving performance assessment indicators and assessment plans, and constructing a real-time performance communication and feedback mechanism, we aim to stimulate and mobilize the enthusiasm of hospital staff, achieve a balanced consideration of social and economic benefits, and ensure patient satisfaction, employee satisfaction, as well as the healthy, sustainable, and high-quality development of the hospital [3].

2.3. Conduct comparative research based on the performance assessment results of national, provincial, and municipal exams to comprehensively improve assessment scores. According to the performance assessment monitoring indicator system established by the state, Shandong Province, and Qingdao City for secondary public hospitals, select some regularly retrievable national monitoring indicators for performance assessment of secondary public hospitals, provincial monitoring indicators, and evaluation indicators for high-quality development of public hospitals for analysis [4].

2.4. When implementing this strategy, we will first ensure that all hospital staff deeply understand and recognize the importance of this performance management system. Through various means such as organizing training seminars and producing educational promotional materials, we will make every employee realize that performance management is not only a tool for evaluating their work performance but also a crucial means to drive the overall progress of the hospital and their own career development [5].

2.5. Establish an open and transparent performance assessment process. Each employee's performance will be quantitatively evaluated based on the benefits, costs, difficulty, risks, and labor volume of the completed medical service projects. These assessment results will serve as important references for decisions regarding employee promotion, salary adjustment, and bonus distribution. Through this approach, we can ensure that each employee's contributions are fairly and reasonably rewarded [6].

2.6. Establish a real-time performance communication and feedback mechanism. Employees can promptly

understand their performance status and engage in communication with their supervisors to jointly formulate improvement plans. This mechanism not only stimulates employees' enthusiasm for work but also helps them continuously enhance their professional skills and service levels.

2.7. Strengthen internal hospital management, improve institutional development, and promote informatization construction to provide strong support for the high-quality development of hospitals [7].

2.8. The closely-knit medical community units, Malianzhuang Central Health Center and Shuiji Central Health Center in Laixi City, have concurrently referenced the performance system of the People's Hospital to re-establish performance metrics, establishing transparent performance evaluation plans and processes, and comparing business revenue with the number of admitted and discharged patients [8].

3. Results

Performance evaluation results from the Qingdao Health Commission: The ratio of outpatient visits to discharged patients increased by 1.24 year-on-year. The proportion of surgeries among discharged patients increased by 4.25 percentage points year-on-year. The proportion of minimally invasive surgeries among discharged patients increased by 2.56 percentage points year-on-year. The proportion of level IV surgeries among discharged patients increased by 3.15 percentage points year-on-year. The average length of hospital stay decreased by 0.62 days year-on-year. The proportion of medical service revenue increased by 5.38 percentage points year-on-year. The growth rate of average drug expenses per outpatient visit was -18.79%. The growth rate of average drug expenses per hospitalization was -33.16%. The Case Mix Index (CMI value) increased by 0.04 year-on-year. Both Malianzhuang and Shuiji Central Health Centers experienced varying increases in outpatient volume and the number of admitted and discharged patients, with business revenue gradually improving and all performance indicators showing positive development.

Table 1. Comparison of Performance Assessment Data Results of Laixi People's Hospital by Qingdao Municipal Health Commission

Institution Name	Laixi People's Hospital
Outpatient-to-Discharge Visits Ratio	1.24
Percentage of Surgical Discharges (%)	4.25
Percentage of Minimally Invasive Surgical Discharges (%)	2.56
Percentage of Discharges with Level-IV Surgery (%)	3.15
Surgical Site Infection Rate for Clean Wounds (%)	0
Mortality Rate in Low-Risk Group (%)	-0.14
Average Length of Stay (days)	-0.62
Proportion of Outpatient Revenue (%)	-1
Proportion of Inpatient Revenue (%)	1
Proportion of Medical Service Revenue (%)	5.38
Nurse-to-Doctor Ratio	-0.01
Case Mix Index (CMI)	0.04

Table 2. Comparison of Outpatient and Discharge Numbers in Performance Assessment of Laixi People's Hospital by Qingdao Municipal Health Commission

Inpatient Discharges				Outpatient Visits			
May 2022 - May 2023	May 2023 - May 2024	Absolute Change	Growth Rate	May 2022 - May 2023	May 2023 - May 2024	Absolute Change	Growth Rate
81,622	95,497	13,875	17.0%	1,461	3,017	1,556	106.5%

Table 3. Comparison of the Ratio of Outpatient Visits to Discharge Numbers and Average Length of Stay in Performance Assessment of Laixi People's Hospital by Qingdao Municipal Health Commission

The ratio of outpatient visits to discharged patients				Average Length of Stay			
May 2022 - May 2023	May 2023 - May 2024	Absolute Change	Change Rate	May 2022 - May 2023	May 2023 - May 2024	Absolute Change	Change Rate
56	32	-24	-43.3%	8.49	6.87	-1.62	-19.1%

Table 4. Comparison of the Proportion of Outpatient Revenue to Medical Revenue in Performance Assessment Results of Malianzhuang Central Health Center

Outpatient Revenue				Proportion of Outpatient Revenue			
2023	2024	Change (Absolute)	Change Rate	2023	2024	Change (Absolute)	Change Rate
2,657,267	2,481,023	(176,244)	-6.6%	75%	76%	1%	1.7%

Table 5. Comparison of Inpatient Revenue and the Proportion of Inpatient Revenue to Medical Revenue in Performance Assessment Results of Malianzhuang Central Health Center

Inpatient Revenue				Proportion of Inpatient Revenue			
2023	2024	Change (Absolute)	Change Rate	2023	2024	Change (Absolute)	Change Rate
880,764	765,778	-114,986	-13.1%	25%	24%	-1%	-4.0%

Table 6. Comparison of Outpatient Visits and Discharge Numbers in Performance Assessment Results of Shuiji Central Health Center Table

Metric	Outpatient Visits				Inpatient Discharges			
	2023	2024	Absolute Change	Growth Rate	2023	2024	Absolute Change	Growth Rate
	23,063	34,707	11,644	+50.5%	345	251	-94	-27.2%

Table 7. Comparison of the Ratio of Outpatient Visits to Discharge Numbers, Average Length of Stay, and Proportion of Medical Service Revenue in Performance Assessment Results of Shuiji Central Health Center

The ratio of outpatient visits to discharged patients				Average length of hospital stay				Proportion of medical service revenue in total medical revenue			
2023	2024	Abs. Change	Change Rate	2023	2024	Abs. Change	Change Rate	2023	2024	Abs. Change	Change Rate
67	138	71	22.9%	10.00	8.60	-1.40	-14.0%	28%	35%	7%	25.0%

4. Performance Evaluation of Shuiji Central Health Center

Conclusion: Performance management is a crucial component of modern hospital management systems, and performance restructuring serves as a significant means to drive high-quality development in hospitals. Several domestic experts have pointed out a series of issues with current performance evaluations, such as insufficient orientation in performance management, incomplete performance evaluation indicators, lack of specialized indicators, and indicator redundancy. This study aims to inject new vitality and momentum into the high-quality development of hospitals by restructuring performance, transforming performance evaluation concepts, strengthening data analysis and information technology applications, improving incentive mechanisms, and enhancing employee participation and collaboration. Through the formulation of performance plans, the implementation of performance evaluations, and the utilization of evaluation results, it is possible to effectively regulate internal hospital management behaviors and provide high-quality medical services to patients, which holds significant practical implications for China's healthcare reform. Since October 2023, Qingdao Municipal Hospital has taken over the management of Laixi People's Hospital, improving and adding outpatient and surgical performance evaluations based on the original performance evaluation system. After a six-month trial period, various tasks are now progressing steadily with stage-by-stage achievements. From January to April 2024, business revenue has steadily increased, revenue structure has continuously optimized, outpatient and emergency visits have grown by 18.03% year-on-year, surgeries have increased by 48.76% year-on-year, pharmaceutical revenue, the proportion of drug expenses, and average drug costs per visit have continued to decline, significantly enhancing the hospital's operational capabilities and service efficiency [9].

In the process of implementing these measures, we will always adhere to the patient-centered service philosophy and continuously improve the quality and efficiency of medical services. By optimizing medical processes, enhancing medical technology, and strengthening medical safety, we strive to provide patients with higher-quality and more efficient medical services. To further enhance the accuracy and fairness of performance assessments, we will closely monitor the performance assessment monitoring indicator systems and results established at the national, Shandong Province, and Qingdao levels for secondary public hospitals, promptly following up and adjusting our performance management efforts accordingly. Through the implementation of the aforementioned measures, the hospital can establish a scientific, fair, and effective performance management system, stimulate employees' work enthusiasm and innovative spirit, improve the hospital's work efficiency and service quality, and achieve high-quality development of the hospital. Additionally, through comparative studies of assessment methods such as national, provincial, and municipal assessments, the hospital can continuously enhance its assessment scores and overall strength, thereby providing even better medical services to the people [10]. We will continue to deepen the reform of the medical and health system, optimize the allocation of medical resources, improve the efficiency and quality of medical services, accelerate the construction of a closely-knit medical consortium, and jointly promote the high-quality development of medical consortia at the county level. We will strengthen the training and recruitment of medical personnel, introduce more outstanding department heads and academic leaders, highlight specialized features, enhance the hospital's reputation and influence, and strive to join the ranks of tertiary hospitals at an early date.

In conclusion, strengthening the management and assessment of public hospitals is of great significance in promoting their high-quality development. Looking ahead, the path to high-quality hospital development still requires continuous exploration. We will take performance assessment as a lever, fully leveraging its role as a "baton" to continuously enhance the overall strength of the hospital and the level of medical services. We aim to pass the tertiary hospital review and assessment as soon as possible, thereby promoting high-quality development

of county-level healthcare. Meanwhile, in line with the indicator requirements of national, provincial, and municipal assessments, we will refine the assessment dimensions for specialized characteristics and strengthen the incentive orientation for talent cultivation and discipline construction. By taking the construction of medical consortiums as a link, we will further improve the collaborative mechanism for county-level medical performance, promote the sharing of high-quality medical resources, and help enhance the overall capability of county-level medical services. We will always adhere to the original intention of "patient-centeredness," use performance restructuring as a fulcrum, continuously promote management innovation, technological innovation, and service innovation, steadily advance towards the goal of building a tertiary hospital, fully safeguard the health rights and interests of the people, and drive the high-quality development of regional healthcare.

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The Dilemma of Adolescents in Different Cultural Contexts—A Comparative Study of "Youth Diary" and "The Perks of Being a Wallflower"

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Abstract: As an important carrier of cultural dissemination, movies not only record social reality, but also obtain perceptible forms at the social level through specific narrative and visual strategies. By comparing and analyzing "Youth Diary" and "The Perks of Being a Wallflower", this article attempts to understand the presentation and generation mechanisms of adolescent difficulties in different cultural contexts from the perspective of visual writing. The adolescent dilemma is not a projection of a single social problem, but the result of continuous construction and reproduction under the joint action of family structure, social value norms, and education system.

Keywords: "Youth Diary"; "The Perks of Being a Wallflower"; Adolescent dilemma

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1. Introduction

In recent years, there has been a continuous increase in social attention surrounding the issues of adolescent mental health and campus violence. Along with factors such as academic pressure, strained peer relationships, identity dilemmas, and institutional neglect, teenagers have gradually become a highly vulnerable and powerless group in modern society. As an important form of cultural expression, movies often reveal the specific forms of adolescent difficulties in daily life through emotional storytelling and visual presentation, reflecting different societies' deep understanding of "growth," "success," and "normalcy." Therefore, examining the plight of young people from the perspective of visual writing has important cultural and academic value.

Campus violence is an important component of adolescent difficulties and has long been understood as the result of individual behavioral misconduct or peer conflict. This way of understanding to some extent obscures the structural and normative factors behind campus violence, simplifying the problem into a moral or psychological case. However, there are significant differences in the mechanisms, manifestations, and ways in which campus

violence is understood and handled in different cultural contexts. Comparing visual texts from different cultural backgrounds can help break through a single cultural perspective and reveal the multiple social roots of adolescent difficulties.

The Hong Kong film "Youth Diary" and the American film "The Perks of Being a Wallflower" both focus on the campus as the core space, focusing on the oppression and trauma that teenagers encounter during their growth process. However, the two show significant differences in narrative strategies, emotional expression, and violent presentation. Through a restrained and introverted visual style, "Youth Diary" depicts how teenagers gradually lose their expressive space in silence and self denial in a highly performative and standardized environment; However, 'The Perks of Being a Wallflower' presents the vulnerable situation of minority groups in the interweaving of campus system failure and social prejudice in relatively open conflicts and confrontations. The two films not only showcase the specific forms of campus violence in different cultural contexts, but also reflect the different understandings of adolescent subjectivity in their respective societies.

Based on this, this article takes "Youth Diary" and "The Perks of Being a Wallflower" as research objects, and compares and analyzes the presentation and generation mechanisms of adolescent difficulties in different cultural contexts. The research is not aimed at plot comparison or value evaluation, but rather focuses on the interactive relationship between cultural norms, institutional structures, and visual narratives, aiming to reveal how adolescent difficulties are shaped, seen, or obscured under different social conditions, thereby providing a more three-dimensional analytical perspective for understanding the issue of campus violence.

2. The adolescent dilemma in "Youth Diary"

Kong Lingshun commented on "Youth Diary" and said, "This is an era of anxiety: what we don't have, we long to have; what we have, we fear losing." [1]Anxiety is transmitted from adults to families, from society to schools.

The difficulties faced by teenagers in "Youth Diary" are not directly manifested as sudden campus violence incidents, but rather through a slow, restrained, and highly daily visual writing style, depicting how difficulties gradually arise in seemingly orderly and normal growth environments. Campus and home spaces are not chaotic or out of control places. On the contrary, they are highly stable in external order, with clear rules and clear goals. It is in this stable structure that the pain of adolescents is constantly compressed, delayed, and ultimately disappears.

The movie avoids reinforcing descriptions of direct conflicts. The oppression on campus appears more in a cold way: ignored gazes, skipped questions, and understated emotional expressions. This treatment makes violence no longer manifest as clearly identifiable behavior, but rather as an atmosphere that permeates daily interactions. The language of the camera often stays at the character's reaction rather than the event itself, and what the audience sees is not the occurrence of conflict, but the silence, hesitation, and avoidance after the conflict occurs. This way of expression reinforces the concealment of the dilemma, making it seem 'insufficient to constitute a problem', but it continues to accumulate on an emotional level.

The presentation of campus space in the film is particularly noteworthy. Classrooms, corridors, exam scenes, and other spaces are repeatedly photographed, but lack clear emotional fluctuations. Space itself does not pose a threat, but it appears indifferent due to its highly standardized nature. Students are placed in a unified order, and individual differences are minimized to the greatest extent possible. The image presents the insignificance and silence of individuals in the collective structure through a large number of distant and static compositions, making the dilemma of teenagers not come from direct attacks from others, but from a sustained but indescribable state of

neglect.

In the movie, the image of teenagers is not constructed as subjects with strong resistance or explicit emotions. On the contrary, characters often exhibit a high degree of self-suppression and emotional restraint. Pain is not fully expressed through language, but is presented in the form of physical state, eye changes, and behavioral hesitation. The image repeatedly presents the moments when characters try to express themselves but ultimately give up, making "unspoken emotions" one of the important contents of the film. This expression is highly consistent with the emphasis on patience, self-restraint, and emotional internalization in East Asian culture. The presentation of family scenes in the film also follows this logic. Family does not appear as an obvious space for conflict, but rather as a gentle yet persistent pressure environment composed of words of care, expectation, and responsibility. The lack of intense arguments or obvious emotional disorder in the image is replaced by seemingly natural demands and evaluations. This approach ensures that family stress is not seen as abnormal, but is naturally incorporated into the growth process. This kind of daily writing presents a seamless connection between the difficulties faced by teenagers at home and on campus.

There is also no clear emotional outlet provided to the audience in terms of narrative structure. The overall pace of the film is slow, with sustained and restrained emotional expression, lacking dramatic explosive points. This rhythm arrangement gradually makes the audience realize that the difficulties faced by teenagers do not stem from a single moment of loss of control, but rather from long-term accumulation. Through the extension of time, images present difficulties as a form of 'delayed harm', whose destructive power is not reflected in intensity, but in persistence. The extensive use of low saturation colors and concise ambient sound weakens the emotional rendering effect. This style choice avoids emotional consumption of pain and refuses to romanticize the difficulties faced by teenagers. The moderate use of music makes emotions more dependent on the visual and character states themselves, thereby enhancing the sense of reality. This imaging strategy makes the dilemma appear more relevant to daily life and more difficult to classify as an "extreme case".

The choice of narrative perspective further reinforces the internalized characteristics of adolescent difficulties. The story is not fully explained or intervened from an adult perspective, but rather unfolds through fragmented memories and subjective experiences. The audience is not always able to obtain complete information, and this information asymmetry makes understanding itself difficult, and also reproduces the situation of teenagers being "unable to be fully understood" in reality at the formal level. The image not only presents the dilemma in terms of content, but also simulates the perceptual state of the dilemma in terms of narrative structure.

3. The adolescent dilemma in the American cultural context of "The Perks of Being a Wallflower"

Unlike "Youth Diary" which presents adolescent difficulties through restraint and silence, "The Perks of Being a Wallflower" chooses a highly explicit and conflict-facing visual writing style. Guo Yunfei interpreted the movie "Wallflower Boy" and said, "The 'wallflowers' are clearly out of place in mainstream society. In the colorful and passionate dance hall, the wallflowers are like an disharmonious factor. They sit alone on chairs leaning against the wall, trying to integrate into society but unable to find a way. They simply isolate themselves from the outside world."[2]The film explicitly places campus violence and the plight of young people in public spaces, making them an unavoidable reality through visible humiliation, public identification, and ongoing confrontation. Here, pain is not hidden under the daily order, but is exposed in an intuitive and sustained way to the gaze of others, forming a

dilemma form with “being seen” as its core feature.

The film presents conflicts very clearly at the visual level. The campus space is shaped into a highly open public area, where classrooms, corridors, playgrounds, and other places are not neutral backgrounds, but stages where conflicts repeatedly occur. The camera often directly targets the violent behavior itself, and the audience can clearly see the entire process of verbal humiliation, physical pushing, and group watching. This approach makes violence no longer a vaguely perceptible atmosphere, but a behavior that can be clearly identified, thereby enhancing the sense of reality of the predicament at the visual level. The Perks of Being a Wallflower places the adolescent subject in a highly exposed position. The gender temperament and physical expression of the protagonist are constantly identified, discussed, and ridiculed, and their identity is not established through self narration, but is repeatedly named in the eyes of others. Through a continuous labeling process, the adolescent dilemma is presented as a state that is constantly confirmed by the outside world: individuals cannot return to the private sphere and can only bear the pressure brought by their identity in public spaces. This visual writing style highlights the highly visible feature of differences in American campus culture. The film does not simplify violence as malicious behavior of a few individuals, but presents the diffusion of difficulties through group reactions. The perpetrator, bystanders, and silent individuals together constitute the interactive structure in the campus space. The images capture the gaze and attitude of bystanders multiple times, making the audience aware that violence does not only exist in direct actions, but also in collective indifference and tacit approval. This presentation method makes the difficulties faced by teenagers no longer a personal experience, but a collective experience.

The overall progress of the movie is relatively tight, with frequent conflicts and significant emotional fluctuations. Not giving the audience too much buffer space, but instead escalating the dilemma through continuous event stacking. This rhythm arrangement reinforces the sense of tension and keeps teenagers in a highly alert state. Images present violence as a normalized experience rather than an accidental event through repeated conflict scenes. Use bright and realistic campus environment sounds more often, weaken artistic processing, and enhance the sense of recording. Music often appears at critical emotional nodes to enhance the impact of conflicts rather than soothe emotions. This choice makes it impossible for the audience to maintain a safe distance from the character and forces them to confront the cruelty of the predicament. We do not pursue subtlety here, but emphasize the directness of emotions, making pain an undeniable presence.

Unlike the internalization of difficulties in “Youth Diary”, the adolescent difficulties in “The Perks of Being a Wallflower” are always presented in an outward form. The character did not completely transform pain into self-denial, but was forced to respond to others in conflict. This response does not necessarily imply resistance or liberation, but rather further exposes the individual’s vulnerability. The image repeatedly presents the process of adversarial failure, showing that difficulties do not disappear due to expression, but may be exacerbated by expression. The emergence of school administrators and teachers has not truly ended violence, but rather appears more as symbolic entities in narratives. The image does not emphasize the absence of institutions, but presents a state of “seemingly existing but difficult to exert effectiveness” through limited and slow intervention. This approach acknowledges the difficulties faced by teenagers in form, but fails to effectively alleviate them in reality.

The movie does not completely stand on a single subjective standpoint, but presents conflicts from multiple perspectives to make the audience aware of the complexity of the dilemma. The film does not provide a complete emotional outlet for the characters, nor does it attempt to solve problems through simple moral judgments. Images focus more on how difficulties are constantly reiterated through continuous interaction, keeping teenagers in a

state of being watched and evaluated.

Through highly visible and positive visual writing, 'The Perks of Being a Wallflower' portrays the adolescent dilemma in the context of American culture as an open, confrontational, and identity based experience. Unlike the dilemma characterized by silence and internalization in the East Asian context, the pain here is not hidden under order, but exposed in public space, becoming an unavoidable yet difficult to escape reality. Through this expression, it is revealed that in a cultural context that emphasizes individual expression and diversity, adolescent difficulties may still persist in a more direct and brutal form.

4. The root causes of the difficulties faced by three teenagers

In the process of adolescent growth, the family should bear the functions of emotional support, psychological regulation, and risk buffering. However, in reality, this function often undergoes structural displacement, and the home is no longer a buffer for difficulties, but rather an amplifier for stress. In the different cultural environments presented in the two films, although the lack of family function takes on different forms, the results both point to the rupture of the adolescent support system.

In "Youth Diary", the family does not appear in obvious forms of conflict or violence, but instead forms a continuous emotional pressure structure with responsible words such as "for your own good" and "should do so". He Xuelian pointed out, "The 'this is for your own good' mechanism is essentially a reward mechanism, and its cleverness lies in catering to students' instinctive egocentrism. Its cruelty lies in the inability to immediately prove or falsify it."[3]

The family function is not completely absent here, but has undergone a directional transformation: emotional understanding and listening have been replaced by performance expectations and moral requirements. The emotional distress of teenagers is difficult to identify as a problem that requires a response, but is understood as a "normal cost" in the process of growth. The transformation of this family function makes teenagers lack a safe emotional outlet when encountering campus setbacks or psychological crises, and can only internalize pressure into self denial.

In contrast, the lack of family function in 'The Perks of Being a Wallflower' is more manifested as unstable and fragmented support. Whether a family can provide protection for adolescents often depends on the attitudes and positions of specific family members, rather than stable structural guarantees. When families are unable to effectively intervene in campus conflicts, teenagers are forced to face pressure from peers and public spaces alone. In this situation, the family no longer constitutes a reliable safe haven, but becomes a variable that may provide support or remain silent. The commonality between families with "excessive responsibility" in the East Asian context and families with "unstable support" in the American context is that families fail to provide sufficient emotional support space for adolescents. When family functions cannot effectively respond to the psychological needs of adolescents, individual difficulties are more likely to be amplified in campus and social spaces, and gradually evolve into irreversible psychological crises.

In addition to family factors, the structure of social value norms is the deeper root of the sustained generation of adolescent difficulties. Society constructs a normative model of "ideal youth" through educational systems, public discourse, and cultural narratives, and based on this, continuously evaluates individuals. When teenagers are unable to meet these norms, their difficulties are seen as personal issues rather than structural problems.

In the East Asian cultural context presented in 'Youth Diary', social value norms are highly centered around

grades, discipline, and self-control. Success is defined as quantifiable and comparable outcomes, while emotional expression and psychological vulnerability are seen as negative factors that affect efficiency. This value structure requires teenagers to constantly adjust themselves to adapt to external standards, rather than gaining space for understanding. Social norms are transmitted through both family and school channels, causing teenagers to tend to attribute responsibility to their own lack of ability or will when facing failure or pain, thereby exacerbating internal conflicts.

In 'The Perks of Being a Wallflower', social value norms are more reflected in the emphasis on 'normality'. Although American culture emphasizes diversity and individual expression, this tolerance is often built on the premise of not deviating from the mainstream order. The implicit expectations of gender temperament, physical performance, and identity traits constantly mark differences in public spaces. Once teenagers are identified as "outliers", they are prone to become objects of collective attention and exclusion. In this value structure, the dilemma does not stem from the expression itself, but from the continuous scrutiny and evaluation triggered by the expression.

Although the value norms in the two cultures have different forms of expression, their operational logic is similar: society constantly compresses the individual's space of possibilities by setting "what kind of youth should be". When adolescents are unable to conform to this ideal model, their predicament is often moralized or psychologically treated, while the social structure itself is held accountable. The institutionalization of these value norms has led to the long-term dilemma of young people being seen but difficult to solve.

The weakening of family functions and the imbalance of social value norms together constitute the core mechanism for the generation of adolescent difficulties. Families have failed to effectively absorb social pressure, and society continues to exert pressure on individuals through normative systems, placing adolescents at the intersection of multiple expectations. Under this structure, difficulties do not occur by chance, but are the result of continuous production and reinforcement.

5. Conclusion

Image writing is not only an artistic presentation of the difficulties faced by teenagers, but also a social cognitive approach. The true response to the plight of adolescents may not lie in strengthening management or requiring individual adaptation, but in rebuilding a social structure that can accommodate differences, fragility, and failure. This is precisely the important inspiration that film art provides for real-life discussions.

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Research on the Construction of Sustainable Development Modes for Enterprise Economic Management Under the Concept of Green Innovation

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Abstract: With the increasing severity of global environmental issues, green, low-carbon, and environmental protection have become global hot topics, and the concept of green development has emerged as the times require, pursuing the coordinated unity of economic growth and environmental protection. In this context, enterprises need to establish sustainable development goals, implement the concept of green innovation, incorporate environmental protection into strategic planning, deepen the innovation of operation and management models, and enhance their comprehensive strength.

This paper elaborates on the connotation of the green innovation concept, clarifies its importance for the sustainable development of enterprise economic management, and discusses four aspects: formulating green innovation development plans, comprehensively deepening technological innovation, improving the green innovation system, and increasing capital investment, aiming to construct a sustainable development mode for enterprise economic management.

Keywords: Green innovation concept; Enterprise economic management; Sustainable development mode; Construction path

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1. Introduction

In recent years, environmental problems such as ozone layer depletion, global warming, environmental pollution, and biodiversity loss have become increasingly prominent. Sustainable development has become an important issue of global concern, and the concept of green innovation has gradually matured, affecting global economic development. Therefore, Chinese enterprises should take the green innovation concept as the core and sustainable development as the goal, clarify the relationship between environmental protection, efficient energy utilization, and economic benefits, incorporate environmental protection into strategic plans, increase capital investment in new technology research and development and environmental protection management, improve the green development system, further enhance the competitiveness of their products and brand influence, and promote the high-quality

development and green transformation of enterprises.

2. Interpretation of the Core Connotation of the Green Innovation Concept

2.1. Protecting the Ecological Environment

With the accelerating industrialization process, phenomena such as air pollution, water pollution, and soil pollution emerge one after another, causing serious damage to the natural ecological environment. One of the core goals of the green innovation concept is to protect the ecological environment, strengthen environmental monitoring and governance, urge enterprises to reduce pollutant emissions, improve environmental protection equipment, improve the ecological environment, and lay a good foundation for the sustainable development of humanity [1]. At the same time, the green innovation concept also attaches importance to biodiversity protection, strengthens the protection of endangered wild species, enhances the construction of nature reserves, creates a good habitat for animals and plants to multiply, and gradually improves the ecosystem.

2.2. Efficient Utilization of Energy and Resources

The core connotation of the green innovation concept is the efficient utilization of energy and resources, advocating efficient and circular utilization models, with the goal of achieving the sustainable development of the environment, economy, and society. In this context, enterprises need to promote technological innovation and management innovation, optimize the allocation of various resources, use new processes and materials to improve production efficiency, and further increase the utilization rate of energy and resources, which can not only reduce production and operation costs but also improve economic benefits [2]. In addition, under the concept of green development, enterprises should also build a circular economy development model, such as recycling industrial wastewater to save water resources; recycling production waste to reduce industrial garbage generation, enabling various resources to be reused multiple times, further improving resource utilization efficiency, and achieving the goal of sustainable development of enterprises.

2.3. Promoting the Healthy and Sustainable Development of the Economy

With the proposal of the "dual carbon" strategy, green innovation has become a new trend in the transformation of China's market economy, promoting the rapid development of green industries, aiming to accelerate the realization of the beautiful vision of sustainable economic and social development. After the proposal of the green innovation concept, Chinese enterprises have vigorously developed green industries, such as new energy vehicles and solar power generation industries, reducing carbon emissions, better curbing air pollution and ozone layer destruction, making full use of renewable solar energy resources, promoting the rise of emerging green industries, and thus injecting vitality into the development of the socialist market economy with Chinese characteristics [3].

3. The Importance of the Green Innovation Concept for the Sustainable Development of Enterprise Economic Management

3.1. Helping Improve Enterprise Economic Benefits

Under the guidance of the green innovation concept, enterprises closely integrate environmental protection with production and operation, customer management and other work, further expand market development channels, expand target customer groups, and meet customers' green and environmental protection consumption concepts.

For example, the green innovation concept has transformed enterprises' development concepts. On the one hand, enterprises can recycle water resources and waste materials to reduce production costs [4]. Enterprises can also use big data to collect the needs, preferences, and suggestions of target customer groups for environmentally friendly products, and customize environmentally friendly products for customers, thereby expanding customer groups, attracting more loyal customers for the brand, helping to improve enterprise economic benefits and achieve sustainable development goals.

3.2. Helping Enhance Enterprise Comprehensive Strength

The green innovation concept can help enterprises establish a sound green management system, clarify management goals such as environmental protection equipment management, green production, technological research, and innovation capabilities, increase investment in environmental protection monitoring and governance, resource recycling, and green technology introduction, further innovate enterprise economic management models, and help enhance enterprise comprehensive strength [5]. At the same time, the green innovation concept has innovated enterprises' brand strategic management concepts, making enterprise decision-makers pay more attention to the introduction of scientific research projects and innovative talents, further improving their scientific research capabilities and technological achievement transformation capabilities, gradually increasing brand awareness, and laying a good foundation for the sustainable development of enterprise economic management.

3.3. Helping Reduce Enterprise Operation and Management Costs

Under the traditional management model, enterprises have high costs in raw material procurement, equipment maintenance, and waste disposal, which invisibly increases financial pressure. The green innovation concept can help enterprises solve this problem by optimizing various production links, workflows, and waste disposal links, reducing energy consumption, and thus achieving the goal of cost saving. In addition, under the green innovation concept, enterprises can apply clean production technologies to reduce the generation of industrial waste, thereby reducing waste disposal and environmental governance costs; they can also install solar photovoltaic power generation systems in the factory area to reduce electricity costs, helping to control enterprise operation and management costs [6].

3.4. Helping Establish a Good Social Image

A good social image is an important part of enterprise brand culture and an important indicator for consumers to measure enterprise comprehensive capabilities. In the new era, consumers not only pay attention to product quality and safety but also value enterprises' social responsibility. Therefore, the green innovation concept helps enterprises establish a good social image, showing consumers a good image of environmental protection and green energy saving, thereby stimulating their desire to consume, making them loyal customers of the enterprise, and further improving brand influence [7]. At the same time, enterprises should actively recycle various resources, reduce greenhouse gas emissions, use degradable packaging materials, actively fulfill their social responsibility of protecting the ecological environment, establish a good external image, and promote the sustainable development of enterprises.

4. Construction Paths of Sustainable Development Modes for Enterprise Economic

Management Under the Concept of Green Innovation

4.1. Transform Economic Management Concepts and Formulate Green Innovation Plans

Enterprise management should keep pace with the times, transform economic management concepts, incorporate environmental protection into enterprise strategic planning, promote the gradual transformation of economic management models towards circular and low-carbon directions, optimize production and operation, marketing, resource management, and customer service models, further implement the concepts of green development and sustainable development, and improve enterprise economic benefits. First, based on strategic planning and industrial characteristics, enterprise management should formulate long-term green innovation plans, clarify green innovation goals, implementation paths, technological innovation, and scientific research achievement transformation paths, allowing the green innovation concept to run through enterprise production and operation, customer management, technological achievement transformation and other links, and achieve the development goals of saving production costs, green production, resource recycling, and ecological environment protection [8]. For example, enterprises should introduce green production technologies and sewage treatment equipment according to the characteristics of production lines, reduce the generation of waste during production, treat industrial wastewater to meet national discharge standards, avoid pollution to water resources and soil, and practice the concept of green development. Second, enterprises should strive to create a good green innovation atmosphere, enhance employees' awareness of green production, environmental protection, and social responsibility, encourage them to actively participate in green innovation projects and strictly implement green production standards, further improving the level of enterprise production materials and environmental protection governance [9]. For example, enterprises can release short videos promoting green innovation through WeChat official accounts, WeChat groups, and Weibo accounts, explain them in combination with specific products and production links, take the production workshop as the background of the short videos, explain the green innovation concept in a simple and understandable way, and actively interact with employees online to deepen their understanding of the green innovation concept, thereby encouraging employees to actively participate in the research and development of green products and clean technologies and implement the enterprise's sustainable development goals.

4.2. Improve Internal Management Mechanisms and Perfect the Green Innovation System

Enterprises should actively establish a sound green innovation mechanism, clarify departmental responsibilities, introduce professional talents, ensure the smooth progress of green innovation projects, thereby improving the sustainable development model and further enhancing enterprise comprehensive strength. Enterprises should set up green innovation institutions, introduce professional talents with relevant backgrounds in green environmental protection and scientific research management, clarify management responsibilities, performance appraisal, and reward standards for technological achievement transformation, further promote cross-departmental cooperation, integrate green innovation resources, and ensure the solid progress of green projects [10]. To stimulate employees' enthusiasm for participating in green innovation projects, enterprises can formulate green innovation reward standards according to production lines and job requirements, and give certain material and spiritual rewards to teams and individuals who have performed outstandingly in the research and development and implementation of green innovation projects, green technological research, green supply chains, and green marketing, so as to stimulate employees' enthusiasm for participating in green innovation projects and improve enterprises' scientific research and innovation capabilities [11]. In addition, the government should increase support for green innovation projects, encourage local enterprises to introduce green industries, and provide policy support such

as tax incentives, government subsidies, and green finance for relevant enterprises; establish an environmental supervision system, conduct environmental monitoring and evaluation of local key enterprises, regularly evaluate the achievements of green innovation projects, help enterprises solve technical and financial problems encountered in the project implementation process, and promote the development of regional green industries.

4.3. Attach Importance to Scientific Research Talent Training and Improve Enterprises' Independent Innovation Capabilities

A professional scientific research team is an important foundation for enterprises to implement the green innovation concept and achieve sustainable development transformation goals. Therefore, enterprises should attach importance to scientific research talent training, build a scientific research team with solid professional knowledge, outstanding scientific research capabilities and innovation capabilities, accelerate the research and development of green energy-saving technologies, new processes, and new materials, and further improve their scientific research capabilities. First, enterprises should strengthen cooperation with universities and scientific research institutes, build an integrated industry-university-research cooperation platform, introduce outstanding graduates from universities and researchers from scientific research institutes, jointly develop new projects, accelerate the transformation of scientific and technological achievements, and thus improve enterprise production efficiency and product competitiveness. For example, enterprises, universities, and scientific research institutes can jointly develop green innovation projects such as new energy vehicles and solar photovoltaic power generation, transport more scientific research and innovation talents for enterprises, help enterprises solve problems encountered in the implementation of green innovation projects, and promote the long-term development of enterprises [12]. Second, enterprises should encourage internal employees to innovate independently, set up green innovation project funds for different positions, support employees to actively research and develop new technologies and materials, help employees apply for invention patents, apply employees' patents to enterprise production practice, transform scientific research achievements into productive forces, thereby improving enterprise production efficiency and product quality, further promoting the sustainable development of green innovation projects, and helping enterprises improve economic benefits and market competitiveness. For example, enterprises should set up green innovation project funds every year, encourage employees to innovate internal equipment, production processes, and materials, assist them in applying for scientific research projects and invention patents, and provide financial support to further improve employees' scientific research capabilities and lay a solid talent foundation for the sustainable development of enterprises [13].

4.4. Broaden Project Financing Channels and Solidly Promote Green Innovation Projects

Enterprises should broaden the financing channels for green innovation projects, deepen cooperation with financial institutions, strive for support such as green finance and green bonds, alleviate financial pressure, lay a good foundation for the development of green innovation projects, accelerate the research and development progress of green projects, and transform project achievements into productive forces as soon as possible, thereby promoting the sustainable development of enterprise green industries [14]. For example, enterprises can actively apply for special support funds for green innovation projects to support the smooth development of green innovation project research and development; attract external funds through equity financing and venture capital, and solve financial problems through diversified financing channels to ensure the smooth implementation of green innovation projects. In addition, enterprises should dynamically adjust the capital structure of green innovation projects,

make good capital planning, clarify the project procurement, implementation, management and acceptance cycles, capital allocation, and talent allocation, avoid resource surplus, realize the optimal allocation of green innovation project resources, further improve the quality of enterprise green innovation projects, create more economic benefits and establish a better brand image for enterprises, and accelerate the realization of enterprise sustainable development goals [15]. In short, enterprises should strengthen the capital management of green innovation projects, broaden external financing channels, strengthen internal capital management, ensure that funds are used effectively, ensure the smooth implementation of projects, accelerate their transformation into productive forces, and comprehensively improve enterprise economic benefits and social image.

5. Conclusion

In summary, the green innovation concept points out a new direction for the sustainable development of enterprises. It helps transform enterprises' economic management concepts, urge them to connect environmental protection with production and operation, scientific research projects, customer service and other management work, coordinate the relationship between environmental protection and economic benefits, and is conducive to achieving the goal of high-quality development of enterprises. In the future, enterprises should try to use new technologies such as artificial intelligence, big data, and the Internet of Things to promote green innovation projects, accelerate the development of emerging industries, promote the sustainable development of regional economies, and make Chinese enterprises go global.

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Current Situation, Problems and Improvement of Cross-Border Railway Transport Rules for the New International Land-Sea Trade Corridor in Western China

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Abstract: In recent years, with the proposal and steady advancement of the "Belt and Road" Initiative, the New International Land-Sea Trade Corridor in Western China (NILSTC) has emerged as a crucial cross-border logistics channel. Ensuring its orderly and efficient operation is of great significance for enhancing trade facilitation and promoting regional economic cooperation. As an important foundation for the smooth development of cross-border railway transport along the NILSTC, the improvement of transport rules directly affects the effectiveness of cross-border railway transport. It can effectively improve transport efficiency, optimize the transport environment, and thus safeguard the high-quality development of cross-border railway transport along the NILSTC. Therefore, this paper first elaborates on the current situation of cross-border railway transport rules for the NILSTC, then analyzes the existing problems, and finally proposes a series of effective improvement strategies, aiming to provide certain reference for relevant researchers.

Keywords: New International Land-Sea Trade Corridor in Western China; Cross-border railway transport; Rules; Current situation; Problems; Improvement

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1. Introduction

Under the background of economic globalization, cross-border railway transport is playing an increasingly important role. As a key link connecting western China with ASEAN and other regions, the New International Land-Sea Trade Corridor in Western China actively promotes regional cooperation and local economic development, among which transport rules play a vital role as the key to realizing the sustainable development of cross-border railway transport. However, there are still some urgent problems in the cross-border railway transport rules for the NILSTC. These problems affect service quality and transport efficiency, and restrict the

development of cross-border railway transport. Therefore, in-depth exploration of the current situation, problems and improvement of cross-border railway transport rules for the NILSTC is of great significance.

2. Current Situation of Cross-Border Railway Transport Rules for the New International Land-Sea Trade Corridor in Western China

2.1. Innovative Practices in Digital Rules

In terms of innovative practices in digital rules, cross-border railway transport along the NILSTC has carried out multi-dimensional explorations. On the one hand, it actively promotes the application of blockchain technology in the transport process. Utilizing the tamper-proof and traceable characteristics of blockchain, it records and shares information such as the transport trajectory and status changes of goods. This enables shippers, freight forwarders, carriers and other parties to grasp the dynamics of goods in real time, improving the transparency and safety of transport [1]. On the other hand, big data technology is also widely used in the optimization of transport rules. By collecting and analyzing a large amount of transport data, such as cargo flow, transport time, and transport costs, bottlenecks and problems in the transport process can be accurately identified. Based on these data analysis results, relevant departments can adjust transport plans and optimize route arrangements in a targeted manner to improve transport efficiency. At the same time, big data can provide market prediction and decision support for enterprises, helping them better plan transport business [2].

2.2. Initial Construction of the Rule System

First, at the domestic level, provinces along the cross-border railway transport of the NILSTC have formulated a series of rules in combination with national policies and regulations based on their own conditions, such as rules on customs clearance procedures, cargo supervision, and railway transport organization. For example, in terms of railway transport organization, the processes of transport plan declaration, approval, and execution are clarified to continuously improve the rationality of resource allocation and transport efficiency. Second, at the international cooperation level, China has jointly promoted the alignment of cross-border railway transport rules with countries along the NILSTC. For instance, bilateral or multilateral cooperation agreements have been signed to reach a consensus on transport documents, quarantine and epidemic prevention, and customs supervision. Some countries have implemented online verification and customs information sharing, which has significantly shortened cargo clearance time and reduced enterprise transport costs [3].

2.3. Accelerated Improvement of Infrastructure Network

In recent years, remarkable progress has been made in the construction of the infrastructure network for cross-border railway transport along the NILSTC. Railway lines have been continuously expanded, with new trunk lines and branch lines put into operation, enriching the transport network layout and expanding the scope of cargo transport. Areas that were previously inaccessible have been incorporated into the transport system. At the same time, the construction of railway stations has been strengthened. Many stations have been upgraded and renovated to improve loading, unloading and turnover efficiency. Newly built stations are equipped with advanced equipment and facilities, and supporting facilities around them are improved to realize seamless connection between railway and other transport methods, enhancing comprehensive transport efficiency. Significant progress has also been made in information infrastructure. The railway transport management system has been upgraded to realize real-time information monitoring and intelligent dispatching. The application of electronic data interchange systems

reduces information communication costs and delays, and the expansion of communication network coverage ensures smooth communication.

3. Problems Faced by Cross-Border Railway Transport Rules for the New International Land-Sea Trade Corridor in Western China

3.1. Restrictions by Infrastructure Bottlenecks

Nowadays, some railways of the NILSTC are aging and have poor track quality, which affects the speed and stability of train transport and reduces transport timeliness. The loading and unloading equipment at some stations has a low degree of automation, resulting in low loading and unloading efficiency and prolonged cargo in-transit time [4]. At the same time, the supporting service facilities along the NILSTC are not perfect enough to fully meet transport needs. In addition, individual routes of the NILSTC have insufficient transport capacity, making it difficult to adapt to the continuously increasing cargo volume. Trains often have to queue up and wait. Moreover, the connection between railway lines in different regions is not smooth, which seriously affects the efficiency of cargo multimodal transport and hinders the sustainable development of cross-border railway transport [5].

3.2. Non-Unified Rule Standards

Different countries and regions have their own rules and standards for cross-border railway transport. There are differences in cargo packaging, measurement, inspection and quarantine, etc., which requires goods to be adjusted and re-inspected multiple times during cross-border transport, increasing transport costs and time. The formats and requirements of transport documents also vary. Enterprises need to spend a lot of energy preparing and processing documents of different standards, reducing work efficiency. Furthermore, there is a lack of unified regulations on the division of transport responsibilities and compensation standards. In the event of transport accidents or disputes, it is difficult to quickly clarify responsibilities and make compensation, which affects enterprises' confidence in transport. This non-unification of rule standards hinders the smooth progress of cross-border railway transport along the NILSTC [6].

3.3. Lagging Development of Digital Rules

With the advent of the digital era, the efficient operation of cross-border railway transport is closely related to digital rules, but the existing digital rules for cross-border railway transport along the NILSTC are lagging behind. Currently, countries along the corridor are insufficient in digital information sharing, mainly because their data systems are relatively independent, with inconsistent standards and interfaces, making it impossible to share cross-border railway transport information accurately and in real time. In addition, there are shortcomings in electronic documents and electronic payments. Due to differences between regions and countries, there are significant differences in payment systems and financial regulatory policies, which not only increases the difficulty of electronic payments but also raises payment risks and costs. At the same time, the mutual recognition of electronic documents is not high enough. Some enterprises still use paper documents, which are not only inefficient but also prone to problems such as document damage [7].

4. Improvement Paths of Cross-Border Railway Transport Rules for the New International Land-Sea Trade Corridor in Western China

4.1. Strengthen Infrastructure Interconnection

Currently, effectively addressing the bottlenecks of cross-border railway transport infrastructure along the NILSTC can be achieved by strengthening infrastructure interconnection, as follows: First, vigorously renovate aging railway lines. Establish a professional team to conduct a comprehensive assessment of existing lines, scientifically formulate railway renovation and upgrading plans, actively introduce cutting-edge materials and track technologies to further improve track quality, ensure the stable, fast and safe operation of trains, and continuously improve transport timeliness [8].

Second, update station loading and unloading equipment in a timely manner. Introduce automated loading and unloading equipment such as automatic sorting systems and intelligent cranes along the cross-border railways of the NILSTC to effectively improve cargo loading and unloading efficiency and reduce in-transit time. In addition, rationally plan supporting service facilities. For example, optimize the distribution of maintenance stations to ensure that trains receive timely maintenance during cross-border railway transport along the NILSTC and fully meet transport needs; build large-scale modern warehousing centers in combination with the transport needs of various countries and regions to further expand warehousing space [9].

Third, expand and renovate sections with saturated transport capacity. To improve the cross-border railway transport capacity of the NILSTC, it is necessary to optimize route design, increase the number of railway tracks, effectively improve route operation capacity, and ensure the reduction of train waiting time. At the same time, effectively connect railways in different regions, eliminate route breakpoints, realize seamless connection of railway transport, and improve the efficiency of cargo multimodal transport [10].

4.2. Promote Hard and Soft Connection of the Rule System

First, hard connection. In addition to renovating and upgrading railway lines and stations, we should also strengthen the connection with surrounding transport methods. Build a multimodal transport system integrating railway, highway, waterway and air transport, and construct comprehensive transportation hubs to realize convenient transfer between different transport methods and efficient transshipment of goods [11]. For example, plan and construct highway freight stations and port terminals near railway stations to enable rapid conversion of goods between different transport methods and improve overall logistics efficiency. At the same time, pay attention to the intelligence and greenization of infrastructure construction. Introduce intelligent transportation systems to realize real-time monitoring and intelligent dispatching of railway transport, further improving transport safety and efficiency. Promote the use of environmentally friendly materials and energy-saving technologies to reduce the environmental impact of railway transport and realize sustainable development [12].

Second, soft connection. Coordinate and unify the cross-border railway transport rule standards of the NILSTC, and actively participate in the revision and formulation of cross-border transport rules to ensure that the formulated transport rule system is universal. For example, build internationally recognized inspection and testing standards to avoid repeated inspection of goods during cross-border transport and reduce transport costs; conduct in-depth research and consultation on differences in transport documents, inspection and quarantine, measurement, and cargo packaging, and formulate unified standards and norms. In addition, conduct active communication with countries along the NILSTC on compensation standards and the division of transport responsibilities, clarify the rights and obligations of all parties, and thus effectively maintain the stability of cross-border railway transport

along the NILSTC [13].

4.3. Accelerate the Integration of Digital Rules

First, build a digital information sharing platform. Unite countries along the cross-border railway transport of the NILSTC, introduce professional technical forces to integrate various data systems, unify data standards and interfaces; introduce advanced technologies such as big data and artificial intelligence to ensure the accurate and real-time flow of cargo transport information [14].

Second, strengthen international financial cooperation. Financial regulatory authorities of countries along the cross-border railway transport of the NILSTC conduct in-depth communication, coordinate and unify financial regulatory policies, and build an electronic payment system with unified standards. At the same time, invite third-party institutions to participate, making cross-border payment services more convenient and safe, thereby reducing payment risks and costs. In addition, use blockchain technology to innovate payment models, realize safe traceability and rapid settlement, and improve the reliability of the payment process [15].

Third, improve the mutual recognition of electronic documents. Jointly formulate unified formats and standards for electronic documents, establish an international mutual recognition mechanism for electronic documents, continuously improve the legal effect of digital transport documents, and minimize the use of paper documents. In addition, to avoid document damage and loss and improve document processing efficiency, build a unified electronic document management system to realize online issuance, inspection and circulation of electronic documents [16].

5. Conclusion

In summary, the improvement of cross-border railway transport rules for the New International Land-Sea Trade Corridor in Western China is crucial for promoting regional economic cooperation and enhancing trade facilitation. Although certain progress has been made in the construction of the rule system and the innovation of digital rules, there are still many problems such as restrictions by infrastructure bottlenecks, non-unified rule standards, and lagging development of digital rules. Through improvement paths such as strengthening infrastructure interconnection, promoting hard and soft connection of the rule system, and accelerating the integration of digital rules, the existing problems can be gradually solved, laying a solid foundation for the high-quality development of cross-border railway transport along the NILSTC. In the future, with the continuous advancement of the "Belt and Road" Initiative, cross-border railway transport along the NILSTC will play a more important role in international trade. It is necessary to closely monitor international situations and industry trends, and adjust strategies in a timely manner to adapt to the ever-changing market needs.

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Latest Research Progress on the Size of Lyman Alpha Emitters

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Abstract: Research on the size of Lyman Alpha Emitters (LAEs) provides important clues for understanding the formation and structural characteristics of young galaxies. In recent years, with the accumulation of high-resolution imaging observations, significant progress has been made in understanding the size characteristics of LAEs. A large number of studies have shown that LAEs generally exhibit a compact galactic morphology, with their effective radii significantly smaller than those of typical star-forming galaxies, displaying characteristics of high stellar mass surface density and high specific star formation rate (sSFR). This compactness is believed to be closely related to their low dust content, strong feedback activities, and early assembly stage. Despite certain differences among different samples, current results generally support the compact size characteristics of LAEs. Overall, existing studies indicate that LAEs represent a class of compact young galactic systems, and their morphological characteristics provide important observational constraints for understanding the early stages of galaxy formation.

Keywords: Lyman Alpha Emitters (LAEs); High-redshift galaxies; Galaxy morphology

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1. Introduction

Lyman Alpha Emitters (LAEs) are a population of young, low-mass galaxies with high specific star formation rates (sSFR). Their intense Lyman alpha emission lines make them important observational windows for exploring early galaxy formation [1]. Since the widespread application of narrowband imaging and spectroscopic techniques [2-3], a large number of high-redshift LAE samples have been discovered, providing key data support for studying the physical mechanisms of galaxy formation, interstellar medium properties, and morphological structure evolution. Compared with aspects such as luminosity function, emission line properties, or ionization environment, the morphological characteristics of LAEs—especially their size structure—are equally significant in revealing the internal physical states of galaxies in the initial stages of formation [1].

In recent years, with the official launch of scientific observations by the James Webb Space Telescope (JWST)

[4], important progress has been made in detecting the structural characteristics of high-redshift Lyman alpha emitters (LAEs) [5-7]. Equipped with exceptional infrared imaging capabilities and high spatial resolution, JWST has provided unprecedented data support for the systematic study of the morphological properties of these distant celestial objects across a wide wavelength range. Observational studies have shown that LAEs typically exhibit significant spatial compactness, with their effective radii generally smaller than those of ordinary star-forming galaxies. This structural compactness is thought to be closely related to the high star formation surface density, low dust extinction, and intense galactic feedback activities within the galaxies. These physical conditions not only affect the efficiency of star formation but may also largely dominate the subsequent evolutionary paths of galaxies. Although several statistical studies have initially revealed the general rules regarding the size of LAEs, there are still certain differences among different observational samples. Factors such as imaging depth, sample selection methods, definition of continuum emission components, and measurement algorithms can all affect the estimation of structural parameters [8]. As JWST continues to conduct high-resolution, deep observations of LAEs, it is expected to resolve their morphological structures at finer scales, thereby further revealing the formation mechanisms and early evolutionary processes of LAEs and bringing new breakthroughs in understanding galaxy evolution.

This review aims to summarize the main research achievements on the morphological size of Lyman alpha emitters in recent years, sort out the current observational results and theoretical explanations, discuss the connection between size characteristics and galactic physical properties, and point out possible directions for future research. Through a systematic summary of existing literature, we hope to provide a more comprehensive perspective for understanding the structural nature of LAEs and their position in the framework of galaxy formation.

2. Definition of Galaxy Size

In observational astrophysics, the most commonly used and precise definition of galaxy size is the half-light radius r_e , obtained by fitting the two-dimensional surface brightness distribution of the galaxy with the Sérsic model. The mathematical form of this model is as follows:

$$I(r) = I_e \exp\{-b_n[(\frac{r}{r_e})^{\frac{1}{n}} - 1]\}$$

Where: I(r) is the surface brightness at radius r; I_e is the surface brightness at the half-light radius r_e; r_e (half-light radius) is the radius containing half of the galaxy's total luminosity, usually taken as the characteristic size of the galaxy; n is the Sérsic index, which describes the concentration of the galaxy's brightness distribution (when n=1, the profile decreases exponentially, corresponding to disk galaxies; when n=4, it conforms to the de Vaucouleurs law, corresponding to typical elliptical galaxies); b_n is a normalization constant related to n, ensuring that half of the total luminosity is contained within the radius r_e. Through this fitting, r_e provides a robust scale that excludes background noise and reflects the intrinsic structural characteristics of the galaxy.

3. JWST Observational Progress

The James Webb Space Telescope (JWST), with its exceptional infrared imaging and spectroscopic capabilities, has brought revolutionary progress to the morphological study of Lyman Alpha Emitters (LAEs), particularly achieving key breakthroughs in the structural resolution and radiation mechanism research of high-redshift

sources [9-10]. Its Near-Infrared Camera (NIRCam) features high angular resolution and deep detection capabilities, enabling fine morphological decomposition of LAEs at redshifts z>3 on sub-kiloparsec scales. Meanwhile, the Mid-Infrared Instrument (MIRI) has further expanded the ability to detect Lyman alpha radiation in dust-obscured environments, providing a new window for understanding the radiation transfer processes in the early stages of galaxy formation.

In terms of size measurement, JWST's high-resolution images have advanced the study of LAE structures to a new stage. For example, Liu et al. used JWST/NIRCam to fit the Sérsic model to 10 spectroscopically confirmed LAEs at redshift z≈3.1 in the UDS field. The results showed that the median value of their typical half-light radii is 0.36 kpc, consistent with the characteristic of LAEs generally exhibiting compact structures on sub-kiloparsec scales [6]. This difference may stem from JWST's superior spatial resolution, which can more accurately distinguish between compact cores and extended components. Further supporting this trend, Ning et al. conducted a similar analysis on 14 spectroscopically confirmed LAEs at redshift z≈6 in the COSMOS field. The half-light radius obtained based on NIRCam data was further reduced to approximately 0.22 kpc, indicating a possible structural compactification trend in higher-redshift samples [7]. Additionally, Witten et al. found signs of merging in some LAEs, which are associated with the escape of Lyman alpha photons [5].

These observational results highlight JWST's unique advantage in resolving the morphological details of galaxies during the dawn of the nearby universe. Beyond the precise measurement of structural parameters, JWST's multi-wavelength joint observation capability allows researchers to compare the distribution of Lyman alpha radiation with the stellar mass distribution in the same galaxy, thereby revealing the interaction between photon transfer processes and the interstellar medium.

4. Conclusion

Systematic research on the size of Lyman Alpha Emitters (LAEs) provides a key observational window for understanding the formation and initial structure of galaxies in the early universe. This review summarizes the latest observational progress based on the James Webb Space Telescope (JWST), with the main conclusions as follows:

The launch of JWST has advanced LAE size research to new depths and precision. Its near-infrared high-resolution data not only confirms the compact nature of LAEs but also reveals a possible evolutionary trend: among samples from redshift z≈3 to z≈6, the measured half-light radii show a decreasing trend (e.g., from 0.36 kpc to 0.22 kpc). This may indicate that galaxies were structurally more compact at higher redshifts (earlier cosmic epochs). More importantly, JWST's multi-wavelength capability enables astronomers to compare the size of Lyman alpha emission with the size of the stellar mass distribution, opening up new avenues for directly studying radiation transfer processes (such as photon scattering) and gas distribution within galaxies.

In summary, observational studies have clearly shown that LAEs are a class of compact objects on sub-kiloparsec scales, and their structural characteristics are closely related to physical properties such as low dust content and high star formation rate. Leveraging JWST's powerful capabilities, the research paradigm is shifting from mere morphological description to in-depth analysis of physical mechanisms. In the future, conducting statistical research using JWST's growing larger samples and combining in-depth interpretation with radiative transfer models will be key to accurately revealing the origin of LAE sizes, understanding their star formation patterns on small scales, and determining their position in the galaxy evolution sequence.

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Digital Divide, Health Literacy, and the Release of Silver Economy Consumption Potential — A Mechanism Study Based on the New Path of "Health Improvement + Digital Empowerment"

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Abstract: Amid the aging population trend, the silver economy has become a key engine for expanding domestic demand and promoting consumption, driving the elderly group toward a high-quality life. The advent of the digital economy has accelerated the development of "digital health" formats represented by internet-based medical services, wearable devices, and smart elderly care platforms, providing more intelligent health management and services for the elderly. However, the emergence of the digital divide leads to insufficient health literacy among the elderly, inhibiting the release of their consumption potential. Based on this, this paper analyzes the internal connections and impacts among the digital divide, health literacy, and the release of silver economy consumption potential, explores the relevant paths, and provides new ideas for the development of the silver economy.

Keywords: Silver economy; Elderly group; Digital divide; Health literacy; Population aging

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1. Introduction

Against the backdrop of the intersection of population aging and the digital economy, the potential of silver consumption as a new engine for domestic demand growth has become increasingly prominent, driving the elderly group toward a healthy and high-quality life. However, the digital divide creates barriers to information access and service usage, reducing the health literacy of the elderly and affecting their consumption willingness and capabilities in areas such as healthcare and smart elderly care [1]. Constructing a digital health service system, breaking down barriers through digital health popularization platforms and age-appropriate transformation of intelligent terminals, and realizing the precise connection between digital empowerment and health needs provide

a new paradigm for releasing the potential of the silver economy.

2. Digital Divide, Health Literacy, and Silver Economy Consumption Potential: An Analysis of Supply-Demand Mismatch Based on Mediating Mechanism

2.1. The Digital Divide Inhibits the Formation of Health Literacy

According to the definition of the World Health Organization (WHO), health literacy refers to an individual's ability to obtain, understand, and apply health information and services to make appropriate health decisions and maintain and promote their own health. Eight departments including China's National Health Commission further clarified in the Notice on Comprehensively Carrying Out Healthy Family Construction that it includes dimensions such as mastery of health knowledge, possession of health skills, and practice of civilized and healthy lifestyles. Against the backdrop of the rapid development of digital health, the health literacy of the elderly directly affects their long-term consumption willingness and behaviors, while the digital divide inhibits the formation of their digital literacy. On one hand, due to economic, physiological, and other constraints, the elderly are at a disadvantage in accessing intelligent terminals and internet connectivity, making it difficult for them to access digital health resources, with information channels limited to traditional media; on the other hand, their ability to screen and distinguish digital health information is weak, making them vulnerable to misleading false information, which hinders the improvement of their health literacy [2].

2.2. Health Literacy Influences the Release of Silver Economy Consumption Potential

Health literacy is the core bridge connecting health status and consumption behavior, exerting a key impact on the release of silver economy consumption potential by influencing the elderly's health needs identification, consumption decision-making, and behavioral choices. From the perspective of health needs identification, health literacy determines the depth of the elderly's understanding of their own health status and the accuracy of their needs. Elderly individuals with high health literacy can clearly identify their own health shortcomings, while those with low health literacy struggle to accurately judge their needs due to a lack of scientific understanding of health issues, leading to irrational consumption [3]; in addition, health literacy affects the elderly's ability to choose health consumption products and services. For example, those with high health literacy can distinguish product quality and service value based on scientific evidence and rationally select suitable products; while the elderly with low health literacy are easily influenced by false propaganda, resulting in damage to their consumer rights and interests, which affects their consumption willingness and thus the growth of silver economy consumption potential [4].

2.3. Low Health Literacy is a Major Factor Widening the Digital Divide and Inhibiting Silver Economy Consumption Potential

The digital divide does not directly affect the release of silver economy consumption potential but exerts an indirect impact through health literacy as an intermediary variable. On one hand, the emergence of the digital divide to a certain extent weakens the elderly's ability to obtain and process health information, reduces their health literacy level, and makes it difficult for them to form effective demand for high-quality health consumption [5]; on the other hand, the insufficient health literacy of the elderly group will further amplify the impact of the digital divide on the development of the silver economy, leading to a "supply-demand mismatch" between the digital health consumption market and the needs of the elderly, thereby compressing the upgrading space of their consumption and hindering the release of silver economy consumption potential.

3. The Impact of the Digital Divide on the Release of Silver Economy Consumption Potential

3.1. Access Divide: Narrowing Consumption Scope and Affecting Resource Acquisition

Digitalization and population aging are two important characteristics of China's current modernization drive, and the rapid development of digital technology has a significant impact on addressing the issue of population aging [6]. Due to factors such as economic conditions, physiological functions, and cognitive concepts, the smartphone ownership rate among Chinese elderly aged 60 and above is about 68.2%, while that among young people aged 18-35 is as high as 98.7%, with the elderly group's ownership rate of intelligent devices far lower than that of young people. In addition, network coverage is also a key factor affecting the consumption of the elderly group. Even if they have intelligent devices, it is difficult for them to achieve stable and low-cost network access, making it impossible for them to continuously participate in digital consumption activities and enjoy the consumption convenience and rich resources brought by digitalization.

3.2. Usage Divide: Weakening the Operational Experience and Participation Willingness of Silver Consumption

The rapid development of intelligent devices and science and technology has a certain impact on the elderly group's ability to use devices. In terms of digital operation capabilities, due to physiological characteristics such as memory decline and reduced learning ability, the elderly group has a low acceptance of complex digital interfaces and operational processes. Most digital consumption products do not fully consider the usage habits of the elderly, making it difficult for the elderly group to master specific operations [7]. At the same time, most current digital consumption services such as e-commerce platforms, health APPs, and online payment tools have insufficient investment in age-appropriate aspects such as interface design, function simplification, and voice interaction, lacking exclusive service modules and manual assistance channels for the elderly, which further exacerbates the difficulty of use for the elderly.

3.3. Capability Divide: Reducing the Decision-Making Quality and Market Trust of Silver Consumption

The digital consumption market is flooded with complex information and false information. On the one hand, there are a large number of exaggerated health product advertisements and false consumption preferential information in the digital space. Due to the lack of systematic digital media literacy education, the elderly group is difficult to distinguish the authenticity and reliability of information, and is easily misled into irrational consumption behaviors, resulting in consumption risks [8]; on the other hand, due to concerns about false information, the elderly group holds a skeptical attitude toward digital products, making it difficult to establish stable consumption trust, leading to the inability to effectively release their potential in high-quality consumption areas such as health preservation, smart elderly care, and quality life.

4. Constructing a New Path Based on "Health Improvement + Digital Empowerment"

4.1. Improve Health Literacy to Stimulate the Consumption Awareness of the Elderly Group

The health literacy of the elderly group is an important factor in realizing the release of silver economy

consumption potential. The key lies in systematically improving health cognition, accurately identifying health needs, and enhancing consumption decision-making capabilities to stimulate the consumption awareness of the elderly group, promoting their transformation from passive response to active planning, and achieving rapid improvement in health quality.

First, break the limitations of traditional knowledge dissemination to help the elderly group establish scientific and systematic health cognition, thereby awakening their internal demand for health consumption [9]. With the help of digitalization, precise push and scenario-based presentation of health knowledge can be achieved, such as building community health digital screens that roll out scenario-based content such as seasonal health preservation and emergency rescue, supplemented by voice explanations and graphic prompts.

Second, communities should vigorously develop and promote digital health management tools to help the elderly group dynamically grasp their own health status, transforming vague health demands into specific consumption needs, and providing a clear direction for the implementation of consumption awareness. At the same time, digital health management tools can collect real-time health data of the elderly group with the help of wearable devices and intelligent monitoring instruments, such as heart rate, blood pressure, sleep quality, and exercise steps, helping the elderly understand their health status, thereby selecting health products in a targeted manner and promoting consumption. Third, due to limited information access channels and insufficient discrimination ability, the elderly group is easily influenced by false advertisements. The government should guide and encourage relevant enterprises to develop and establish digital health service platforms, providing comprehensive and objective consumption information and decision support for the elderly group, and providing correct health consumption information for the elderly group, thereby reducing the perceived consumption risks of the elderly group and enhancing their trust in the health consumption market [10].

4.2. Optimize the Age-Appropriate Digital Service System to Bridge the Digital Divide

To better bridge the digital divide, relevant departments should optimize the digital service system based on the impact of the digital divide on the release of silver economy consumption potential, laying a technical foundation for health improvement and consumption release.

First, the government should cooperate with enterprises to increase digital equipment and network support for the elderly group. At the same time, standardize the age-appropriate design standards for intelligent terminals, requiring equipment manufacturers to consider the physiological characteristics of the elderly at the hardware level to ensure that the elderly can easily obtain digital tools [11]; second, the digital consumption industry should reconstruct the age-appropriate service process based on the characteristics and health needs of the elderly group, simplify operational steps, and develop convenient interaction methods such as voice interaction and image recognition to replace complex text input and multi-level menu operations, reducing the understanding and operational burden of the elderly group and enhancing the age-appropriate experience of digital health services; finally, communities should build a hierarchical and classified digital skills training system based on the aging trend and the current status of health literacy formation among the elderly group, focusing on practical skills related to health consumption, such as basic operation of intelligent devices, use of health APPs, and appointment of online medical services, avoiding theoretical and generalized training [12]. At the same time, integrate digital skills training with health knowledge popularization, incorporating content such as health information discrimination and false advertisement prevention into training to achieve the simultaneous improvement of digital literacy and health literacy.

4.3. Construct a Collaborative Service Mechanism to Provide Support for the Release of Silver Economy Consumption Potential

Aging is not the end of consumption but the starting point of structural transformation. When health levels improve and digital tools are adapted, the elderly group may also become an important force in high-quality consumption. Therefore, constructing a multi-subject collaborative service mechanism can effectively realize the effective connection of digital technology, health literacy, and silver economy consumption potential, solving the problem of aging.

First, enterprises and health service institutions should develop adapted products and services based on demand data, realizing the precise matching of digital empowerment tools, health improvement services, and consumption needs, and improving resource utilization efficiency. In addition, it is necessary to give full play to technological and market advantages and increase investment in the research and development of age-appropriate products and services.

Second, communities need to build an offline service network, set up physical sites such as digital elderly assistance service stations and health literacy improvement centers, and equip them with professional service personnel and age-appropriate equipment to provide face-to-face digital skills training, health consultation, equipment debugging and other services for the elderly [13]; finally, the elderly's resistance to digital technology often stems from unfamiliarity and insecurity, and family emotional support can effectively alleviate this anxiety. Family members need to create an inclusive digital acceptance atmosphere, encourage the elderly to try digital tools, and at the same time carry out fragmented and targeted guidance based on the elderly's learning rhythm and key needs, gradually establishing the elderly's confidence in digital use. The establishment of a tripartite collaborative mechanism can break the limitations of single-subject services, ensure the effective improvement of health literacy, and provide support for the release of silver economy consumption potential.

5. Establishing Economic Strategies for Releasing the Consumption Potential of the Silver Economy

To further release the consumption potential and purchasing power of the elderly and promote the development of the silver economy, the following economic strategies can be formulated:

5.1. Enhance the Income Security of the Elderly Group to Consolidate the Consumption Foundation

First, establish a dynamic adjustment mechanism for basic pensions for urban and rural residents linked to economic development and price levels to ensure that the actual purchasing power of pensions does not shrink due to inflation. It is recommended that the average annual growth rate of pensions be moderately higher than the CPI growth rate, with inclination toward vulnerable elderly groups such as the elderly, disabled, and rural residents. Second, actively expand diversified supplementary pension income channels. On the premise of controllable risks, steadily promote "housing-for-pension" (reverse mortgage pension insurance), reducing the participation threshold through government credit enhancement, tax incentives, and standardized contract templates; at the same time, vigorously develop commercial pension insurance, encouraging funds in personal pension accounts to be invested in long-term and stable pension financial products. In addition, for low-income elderly over 60 years old, pilot issuance of targeted electronic consumption vouchers can be carried out, limited to "silver rigid demand" areas such as health management, rehabilitation aids, community housekeeping, elderly education, and short-

distance cultural tourism. Such consumption vouchers can not only accurately activate the marginal propensity to consume (MPC) but also guide resources to flow to the age-appropriate service industry, forming a virtuous cycle of "demand-supply".

5.2. Strengthen Tax and Financial Support to Reduce Consumption Costs and Enterprise Innovation Risks

On the supply side, it is recommended to provide substantial fiscal and taxation incentives for enterprises engaged in the research and development and production of age-appropriate products. For example, include intelligent nursing equipment, barrier-free home furnishings, and elderly nutritional food into the National Key Supported High-Tech Fields to enjoy the same R&D expense additional deduction treatment; implement immediate refund or reduction of value-added tax on the sales income of age-appropriate products to reduce enterprise costs, thereby promoting the decline of terminal prices. On the demand side, encourage banks, insurance companies, and consumer finance companies to develop exclusive financial tools for the elderly: such as pension savings deposits (providing higher interest rates than ordinary time deposits), interest-free installment loans for large-scale service consumption (applicable to elderly care community occupancy, travel pension packages, home age-appropriate transformation, etc.), and simplify the application process and accept joint guarantees from children. At the same time, explore the establishment of a "silver consumption credit evaluation system", incorporating social security payment, medical payment, and community service records into credit investigation dimensions to solve the financing difficulties faced by the elderly due to the lack of traditional credit records.

6. Conclusion

In summary, by analyzing the internal connections among the digital divide, health literacy, and the release of silver economy consumption potential, as well as the impact of the digital divide on the release of silver economy consumption potential, this paper provides a feasible plan for overcoming the elderly's digital predicament and activating the silver economy (**Figure 1**). In the future, the integration and innovation of digital technology and health services can be further deepened to help promote the coordinated development of Healthy China and an elderly-friendly society.

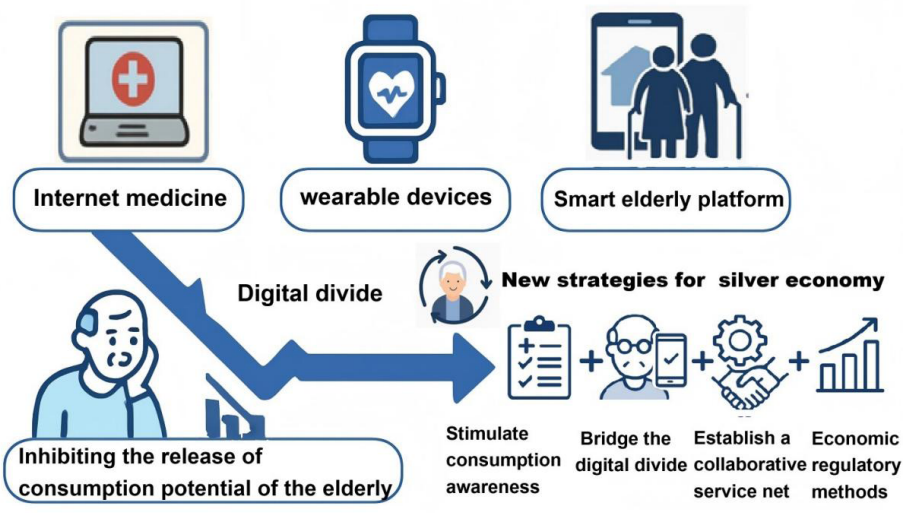

Figure 1. Research Model Diagram of Digital Divide, Health Literacy, and the Release of Silver Economy Consumption Potential

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Research on Carbon Emission Governance in a City in Southern Jiangsu Under the Goal of High-Level New-Type Industrialization

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Abstract: This paper focuses on the research of carbon emission governance in a city in southern Jiangsu under the goal of high-level new-type industrialization. With the increasingly severe global climate change, achieving green and low-carbon development has become the focus of attention of governments and academic circles around the world. As one of the regions with the highest industrialization level in China, southern Jiangsu has made remarkable achievements in economic development, but at the same time, it is facing enormous carbon emission pressure. Especially under the background of new-type industrialization, how to effectively control and reduce carbon emissions while maintaining high-quality economic development has become an important issue to be solved urgently in a city in southern Jiangsu. This paper first analyzes the current situation and characteristics of carbon emissions in a city in southern Jiangsu. Secondly, under the goal of high-level new-type industrialization, it conducts an in-depth study on carbon emission governance in the city, explores its governance experience and challenges in aspects such as policy and regulation guidance, industrial transformation and upgrading, construction of a green industrial system, digital intelligence R&D investment, and improvement of public environmental awareness, and puts forward operable policy suggestions and practical paths.

Keywords: High-level new-type industrialization; Carbon emission governance; Southern Jiangsu

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1. Introduction

In recent years, the direction and paradigm of the deepening of the international division of labor have been changing, and new trends have emerged in the evolution of the global value chain [1]. The Report to the 20th National Congress of the Communist Party of China proposed the goal of basically realizing new-type industrialization by 2035, and emphasized adhering to focusing on the real economy in developing the economy, promoting new-type industrialization, and building a manufacturing power [2]. In the process of new-type industrialization, strengthening carbon emission governance is not only an inevitable requirement for addressing

climate change but also an important way to promote economic transformation and upgrading and achieve high-quality development [3]. The industrial sector is a key field of energy and resource consumption and the main source of carbon emissions in China [4]. Driven by the goal of profit maximization, enterprises have a strong motivation to transfer carbon emissions to the upstream and downstream of the industrial chain by reducing product quality and restructuring product manufacturing models, which is inconsistent with the goal of promoting China's high-level new-type industrialization and high-quality economic development. Promoting high-level new-type industrialization, forcing enterprises to adopt high and new technologies to reduce carbon emission levels, and guiding industrial structure upgrading are the necessary paths to help achieve carbon peaking and carbon neutrality [5,6]. Focusing on carbon emission governance under the goal of high-level new-type industrialization, this paper takes a city in southern Jiangsu, an industrially developed city, as the research sample, aiming to explore effective governance strategies and paths by in-depth analyzing the current situation and problems of carbon emissions in the current industrialization process, and provide theoretical support and practical guidance for achieving high-quality economic development.

2. Current Situation of Carbon Emissions in a City in Southern Jiangsu

Carbon emissions in a city in southern Jiangsu mainly come from energy production and consumption. As an economically developed city, it has a large energy consumption, and the combustion of high-carbon resources (such as coal, oil, and natural gas) is the main source of carbon emissions. According to the characteristics of the industrial structure of the city, the industrial distribution of carbon emissions is mainly concentrated in: the industrial sector, including traditional industrial industries such as iron and steel, chemical industry, electric power, and textiles; the transportation sector, including transportation methods such as highways, railways, and aviation. With the increase in traffic flow, carbon emissions in the transportation sector are also increasing; the construction sector, including the production of building materials, construction processes, and energy consumption during building operation.

To address the problem of carbon emissions, the Three-Year Action Plan for Improving the Basic Governance Capacity of the Ecological Environment in a City in Southern Jiangsu (2022-2024) clearly proposes the goal of reducing carbon dioxide emissions per unit of GDP by more than 13% by 2024 compared with 2020. In response, the government of the city has taken a series of emission reduction measures, including: optimizing the industrial structure, promoting the transformation and upgrading of traditional industries, developing green and low-carbon industries, and reducing the proportion of high-energy-consuming and high-emission industries; improving energy efficiency, promoting energy-saving technologies and equipment, improving energy utilization efficiency, and reducing energy consumption and carbon emissions; developing renewable energy, actively developing renewable energy such as solar energy and wind energy, and increasing the proportion of renewable energy in energy consumption; strengthening policy guidance, introducing relevant policies and measures to encourage enterprises and individuals to participate in carbon emission reduction actions and promote green and low-carbon development [7,8].

3. Characteristics and Advantages of Carbon Emission Governance in a City in Southern Jiangsu

A city in southern Jiangsu has actively responded to the national major strategic decision of carbon peaking and

carbon neutrality, formulated and implemented a series of local carbon emission reduction policies [9], such as the Carbon Peaking Implementation Plan of a City in Southern Jiangsu and the Innovation Pilot Work Plan for Synergistic Improvement of Pollution Reduction and Carbon Reduction in a City in Southern Jiangsu, which have further refined specific carbon emission reduction measures and goals, provided a clear policy orientation and planning blueprint for carbon emission reduction work, and offered clear policy guidance and strategic planning for total carbon emission control. The city has set quantitative specific emission reduction goals in its carbon peaking implementation plan, such as reducing energy consumption per unit of regional GDP by 14% by 2025 compared with 2020, and reducing carbon dioxide emissions per unit of regional GDP by more than 65% by 2030 compared with 2005. These goals provide a quantitative basis for total carbon emission control. As an important economically developed city, it has a strong economic foundation and comprehensive strength, providing sufficient financial support and material basis for the implementation of carbon emission reduction policies.

A city in southern Jiangsu has strong strength in technological innovation, and can continuously promote the research and development and application of low-carbon technologies, such as energy efficiency improvement technologies, clean energy technologies, and carbon capture, utilization, and storage technologies, providing technical support and solutions for total carbon emission control. By introducing and cultivating low-carbon technology enterprises and R&D institutions, the city has continuously improved its own low-carbon technology level, providing strong technical support for the implementation of carbon emission reduction policies. It has also studied the use of advanced technical means such as big data and cloud computing to build a carbon emission monitoring and management system, conduct real-time monitoring of carbon emission data, and analyze carbon emission trends and characteristics.

At present, a city in southern Jiangsu is accelerating the construction of a green and low-carbon industrial system, building a high-level new-type industrialized city, and promoting the transformation and upgrading of traditional industries and the development of strategic emerging industries [10]. It has actively promoted energy structure adjustment and green and low-carbon transformation, and the construction of a new energy industrial chain has initially achieved results. The city has implemented a series of emission reduction measures for high-energy-consuming and high-emission industries such as iron and steel, chemical industry, and building materials, such as ultra-low emission transformation and energy efficiency improvement. The implementation of these measures has not only reduced the carbon emission intensity of these industries but also set an emission reduction model for other industries [11]. The government of the city has introduced a series of supportive policies to promote the development of the new energy industry and increase the proportion of clean energy consumption. It has performed excellently in the development of the new energy industrial chain, forming a relatively complete industrial chain layout. In 2023, the operating income and industrial output value of the new energy industry in the city both achieved significant growth, injecting strong momentum into the development of the modern industry of the city.

A city in southern Jiangsu has favorable conditions in policy, economy, technology, society, environment, and other aspects to promote the implementation of carbon emission reduction policies [12]. It has taken the lead in exploring the carbon inclusive mechanism in the province and built a carbon fashion public welfare platform. By quantifying emission reduction behaviors and endowing them with certain value, it encourages more people to participate in carbon emission reduction actions. With the popularization and improvement of environmental awareness, the understanding and support of citizens in the city for carbon emission reduction are also constantly improving [13]. They have begun to pay attention to their own carbon emission behaviors and actively participate in various energy-saving and emission reduction activities. The formation of this social atmosphere provides a good

mass foundation for the implementation of carbon emission reduction policies.

4. Experience and Challenges of Carbon Emission Governance in a City in Southern Jiangsu

4.1 Summary of Carbon Emission Governance Experience in a City in Southern Jiangsu

(1) In terms of carbon emission governance, the city has very clear industrial preferences and plans. It regards new energy as an important direction for promoting new-type industrialization and an important aspect for cultivating new quality productive forces, and is committed to building a "capital of new energy equipment" [14]. This clear industrial positioning and planning have pointed out the direction for the development of the new energy industry in the city.

(2) The government of the city has strong forward-looking in policy formulation, and after years of operation, has transformed and formed a new industrial chain layout.

(3) The city has a strong industrial foundation and enterprise clusters. For example, it is home to well-known enterprises such as Suntech Power, Lead Intelligent Equipment, and Longi Hydrogen Energy. These enterprises have a leading position in their respective fields, providing strong support for the city to achieve the goal of high-level new-type industrialization.

(4) From the government to enterprises, the city attaches great importance to technological innovation and continuously improves the technical level. For example, Lead Intelligent Equipment in the city continues to innovate in the field of new energy intelligent equipment, providing customers with comprehensive services from single-machine solutions to whole-line system integration and digital factories; Extreme Light Energy focuses on the industrialization of perovskite batteries, striving to solve technical problems faced by large-scale commercialization.

(5) The government of the city fully provides policy support and continuously optimizes the business environment to encourage and attract high-level new-type industrial enterprises to settle in the city [15]. For example, it has introduced a series of policies and measures to promote the development of the new energy industry, increasing support for new energy enterprises; at the same time, it optimizes the government service process, improves work efficiency, and creates convenient conditions for enterprises.

4.2 Challenges Faced by Carbon Emission Governance in a City in Southern Jiangsu

(1) Restricted by the negative impact of the domestic and foreign macro environment, the high-level new-type industrialization of the city is also facing certain impacts. High-level emerging industrial enterprises in the city need to continuously improve their competitiveness to remain invincible in the fierce market competition.

(2) After years of hard work, the city has initially achieved industrial transformation and upgrading, but the industrial chain coordination needs to be strengthened.

(3) Restricted by the trend of deglobalization, the city is facing high international environmental uncertainty, which has a certain impact on the green transformation and upgrading of its industries. It needs to spend more energy to actively respond to various risks, bringing considerable challenges to carbon emission governance.

5. Conclusion and Outlook

The actual impact of carbon emission governance on the high-level new-type industrialization of a city in southern Jiangsu is mainly reflected in: carbon emission governance requires the city to accelerate the elimination of high-energy-consuming, high-emission, and low-efficiency backward production capacity, continuously adjust and optimize the industrial structure, and promote the economy to develop in a more environmentally friendly, efficient, and sustainable direction; carbon emission governance requires enterprises to increase investment in technological innovation, reduce production costs and energy consumption levels, improve overall economic benefits, and enhance product added value and market competitiveness; carbon emission governance has promoted the adjustment of the energy structure of the city, reducing the consumption of traditional high-carbon resources such as coal; carbon emission governance has prompted the city to take renewable energy such as photovoltaic power generation and wind power generation as one of the key development directions through policy guidance and market mechanism innovation, promoting the rapid development of the renewable energy industry; carbon emission governance requires the city to increase investment in technological R&D in fields such as energy conservation and emission reduction and clean energy, encouraging enterprises in the city to strengthen cooperation and exchanges with universities, scientific research institutes, etc., to carry out joint technological innovation activities, providing strong technical support for high-level new-type industrialization; through a combination of policy support and market guidance, the city has actively promoted advanced energy-saving and emission reduction technologies and products, encouraging enterprises to adopt advanced technologies and equipment for transformation and upgrading to reduce energy consumption and carbon emissions; carbon emission governance is conducive to reducing pollutant emissions in the industrial process of the city. By implementing strict environmental protection standards and supervision measures, the city has effectively curbed the occurrence and development of environmental pollution problems.

In the future, to do a good job in carbon emission governance while pursuing the goal of high-level new-type industrialization, a city in southern Jiangsu needs to take a series of comprehensive measures to achieve a win-win situation between high-level new-type industrialization and environmental protection. The city should formulate clear and operable new-type industrialization and carbon emission governance goals in combination with its actual situation, and clarify phased tasks and long-term plans. Continuously improve relevant laws and regulations, clarify the responsibilities and obligations of enterprises in carbon emissions, strengthen law enforcement, establish and improve the supervision system, and ensure the effective implementation of various policies and measures. At the same time, introduce a series of policies and measures to support new-type industrialization and carbon emission governance, including financial subsidies, tax incentives, and green finance, to encourage enterprises to actively participate. Give key support to strategic emerging industries and high and new technology industries, such as new energy, new materials, and energy conservation and environmental protection, to promote the transformation and upgrading of traditional industries and gradually eliminate high-energy-consuming, high-emission, and low-efficiency backward production capacity. Vigorously develop renewable energy such as solar energy and wind energy, increase the proportion of clean energy in energy consumption, and gradually reduce dependence on high-carbon resources. Strengthen the collaborative cooperation of enterprises in the upstream and downstream of the industrial chain, promote the green and low-carbon development of the entire industrial chain, and form a green supply chain system. At the same time, improve the carbon emission trading mechanism, and naturally optimize the economic structure through market-oriented methods. Actively carry out international cooperation and exchanges, information disclosure and public participation, advocate a green and low-carbon lifestyle, and strengthen ecological civilization construction.

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Research on Entrepreneurship Education for Vocational Medical Students Returning Home in the Context of the Rural Revitalization Strategy

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Abstract: Under the Rural Revitalization Strategy, promoting the all-round development of rural areas has become a core task. As part of rural construction, primary medical services are a key factor in realizing a healthy countryside. Against this backdrop, vocational medical students returning home to start businesses has become an important path to supplement grassroots medical forces and support the construction of healthy countryside. Therefore, enhancing the willingness and competence of vocational medical students to return home for entrepreneurship and transporting high-quality grassroots talents for rural revitalization is of great practical significance. Based on the value and current situation of vocational medical students returning home to start businesses under the Rural Revitalization Strategy, this paper discusses specific practical paths to help implement the Rural Revitalization Strategy.

Keywords: Rural revitalization; Medical students; Entrepreneurship education; Returning home; Grassroots medical care

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1. Introduction

The Report to the 20th National Congress of the Communist Party of China clearly regards the construction of "Healthy China" as an important aspect of China's overall development goals by 2035. Therefore, in the process of advancing the Rural Revitalization Strategy, it is necessary to give priority to people's health. However, the current shortage of rural grassroots medical resources and the serious loss of professional talents have become prominent bottlenecks affecting the development of rural health undertakings. With their training orientation, vocational medical students have become a key group to supplement rural medical forces and drive the development of rural health industries. Their return to hometown to start businesses is an important path connecting medical education resources with rural needs [1]. In this context, conducting research on entrepreneurship education for vocational medical students returning home is of urgent practical significance. It can not only solve the current difficulties faced by vocational medical students returning home to start businesses but also cultivate compound

talents suitable for rural needs, providing talent support for the construction of healthy countryside and the implementation of the Rural Revitalization Strategy.

2. Value of Vocational Medical Students Returning Home to Start Businesses Under the Rural Revitalization Strategy

2.1. Fill the Gap in Rural Medical Services and Lay the Foundation for Rural Construction

The core of entrepreneurship education for vocational medical students returning home is to directly fill the gap in rural medical services through entrepreneurial practice, provide accessible and high-quality medical and health services for grassroots residents, and consolidate the talent and service foundation for the construction of healthy countryside. On the one hand, vocational medical students have received systematic professional medical training and possess core medical skills such as diagnosis and treatment of common diseases, chronic disease management, and public health services. Their rooting in rural areas can directly supplement the rural medical talent team, alleviating the dilemma of aging rural doctors and insufficient professional capabilities [2]; on the other hand, the entrepreneurial activities of vocational medical students, such as establishing village clinics, health service stations, and family doctor studios, can increase rural medical service carriers, break the limitations of traditional rural medical services in scope and form, and help rural areas optimize grassroots medical construction. In addition to grassroots medical diagnosis and treatment, medical students can also carry out public health services such as health check-ups, chronic disease follow-ups, health popularization, and maternal and child health care with their professional capabilities, meeting the diversified health needs of rural residents.

2.2. Solve the Dilemma of Shortage of Rural Medical Talents and Inject Talent Momentum

At present, the construction of rural grassroots medical care is facing the dilemma of talent introduction and retention, leading to insufficient supply and low quality of grassroots medical services, thus affecting the progress of the Rural Revitalization Strategy. As the main position for talent cultivation, higher vocational education needs to give full play to its own advantages. Through innovation and entrepreneurship education, students can recognize the entrepreneurial space and social value in the rural medical field, and stimulate their sense of responsibility and willingness to serve their hometown [3]. At the same time, higher vocational innovation and entrepreneurship education courses are both basic and ideological and political. They are important forces for cultivating high-quality medical professional innovation and entrepreneurship talents, improving the construction of the county-township-village three-level medical and health system, promoting the Rural Revitalization Strategy, and ensuring the health of grassroots people. They can optimize students' professional skills and strengthen service awareness around the enhancement of medical skills, teaching of operation and management knowledge, and policy application guidance. On this basis, it can not only directly increase the supply of rural medical talents but also promote vocational college students to take the initiative to return to their hometowns to start businesses, injecting stable and high-quality human capital into the rural medical team [4].

2.3. Promote the Reform of Higher Vocational Medical Education and Connect with Rural Medical Needs

Currently, the core mission of vocational education is to cultivate high-quality technical and skilled talents to serve regional economic development. This indicates that its educational reform needs to be based on the real status and needs of the region, optimize curriculum teaching and talent cultivation, and promote education to

shift from discipline-oriented to demand-oriented. Under the Rural Revitalization Strategy, the construction of rural health urgently needs a large number of excellent medical entrepreneurial talents. Therefore, the reform of higher vocational medical education should promote the in-depth integration of educational content and training models with the needs of rural revitalization, realizing the precise connection between vocational education and rural needs. Students are allowed to carry out internships and practical training around real rural medical entrepreneurship scenarios, such as participating in the operation of village clinics, the development of health products, and health popularization activities [5], prompting them to transform theoretical knowledge into practical capabilities. This can improve the pertinence and practicality of higher vocational medical education, promote the transformation of vocational education towards cultivating entrepreneurs, and make higher vocational medical education truly a carrier for serving rural revitalization.

3. Dilemmas in Entrepreneurship Education for Vocational Medical Students Returning Home Under the Rural Revitalization Strategy

3.1. Vocational College Students Have Low Recognition of Rural Professions

Affected by traditional education and the priority development of cities, some vocational college students have low recognition of rural employment. The superposition of students' negative perceptions of the value, development space, and working environment of rural professions leads to their low recognition of rural employment. Currently, vocational college students generally narrow the value of rural medical entrepreneurship to grassroots medical services, ignoring its social value and public attributes in the construction of healthy countryside [6]. At the same time, influenced by the inclination of urban medical resources, students are prone to form the inherent perception that rural medical technology is backward and service level is low, believing that rural medical entrepreneurship cannot realize professional value and professional achievement. Thus, students have cognitive biases towards starting businesses in rural grassroots medical services and lack internal motivation to return to their hometowns to start businesses.

3.2. Insufficient Construction of Collaborative Education Mechanisms

Entrepreneurship education for vocational medical students returning home involves multiple subjects such as colleges and universities, governments, and rural medical institutions. It is necessary to integrate resources from all parties through collaborative education mechanisms to form educational synergy. However, the current entrepreneurship education for vocational medical students returning home generally faces the dilemma of lacking collaborative education mechanisms, and all parties lack effective linkage. On the one hand, although relevant departments have macro policies for rural revitalization and entrepreneurship support, there is insufficient special policy support for vocational medical students returning home to start medical businesses, such as lack of targeted entrepreneurship subsidies, loan preferences, and training grants. Moreover, the connection between policy publicity and implementation is not in place, making it difficult for colleges and universities to efficiently obtain rural medical needs and enterprise practice resources; on the other hand, the cooperation between colleges and universities and rural medical institutions is mostly short-term internships, failing to deeply participate in core links such as talent training program formulation, curriculum design, and practical teaching, resulting in cooperation that cannot truly meet the needs of rural medical entrepreneurship education.

3.3. Disconnection Between Entrepreneurship Education Content and Medical Needs

Currently, some higher vocational innovation and entrepreneurship education still stays in the traditional framework combining general entrepreneurship theories and basic medical knowledge, resulting in students lacking practical capabilities to cope with rural entrepreneurship challenges and being unable to meet the needs of rural medical services and the development of health industries. Specifically, educational content generally lacks interpretation of the rural medical market environment, grassroots medical policies, and the characteristics of rural residents' health cognition. Students have a vague understanding of the market space, policy boundaries, and service models of rural medical entrepreneurship [7]; at the same time, due to the rapid speed of rural construction, vocational medical students need to have forward-looking thinking and professional skills. However, current higher vocational entrepreneurship education mainly focuses on general entrepreneurship theories, and fails to design targeted content combined with the characteristics of rural grassroots medical care, such as the development of rural health products, low-cost operation strategies for rural medical services, and the combination model of rural e-commerce and health services. As a result, the entrepreneurial knowledge mastered by students is difficult to be directly applied to rural medical scenarios, further affecting the effectiveness of entrepreneurship education for vocational medical students returning home.

4. Practical Paths of Entrepreneurship Education for Vocational Medical Students Returning Home Under the Rural Revitalization Strategy

4.1. Change Cognitive Concepts and Enhance Internal Motivation for Rural Entrepreneurship

As the main force of socialist construction, college students are the backbone to help rural revitalization and realize common prosperity. However, due to low recognition of returning home to start businesses, most medical students choose to start businesses or find employment in more economically developed big cities after graduation, leading to a serious shortage of rural medical talents. Therefore, it is extremely important to change their concepts of returning home to start businesses and strengthen their cognitive awareness.

First of all, entrepreneurship teachers in vocational colleges should, based on social cognition, explain the importance of returning home to start businesses for rural development from the perspectives of values and emotional attitudes, and guide students to understand the social value of grassroots doctors in combination with the current situation of grassroots medical care [8]. For example, teachers can interpret healthy countryside policies online and carry out grassroots medical case teaching, allowing students to understand the core role of rural medical entrepreneurship in solving people's livelihood issues such as difficulty in seeing a doctor and long distances to medical facilities, and recognize its irreplaceable value in the construction of healthy countryside; in addition, rural grassroots medical doctors can be invited to give sharing sessions to convey professional values and entrepreneurial concepts, stimulating students' sense of social responsibility and professional mission.

Secondly, teachers can eliminate students' concerns about the low benefits of rural entrepreneurship by combining relevant policies and entrepreneurship subsidies, and compare with urban entrepreneurship to let students see the prospects of rural entrepreneurship; at the same time, analyze the application prospects of technologies such as smart medical care and remote health consulting in rural areas, enabling medical students to recognize that rural medical entrepreneurship can achieve professional ability improvement and career advancement through technological innovation; finally, organize students to conduct in-depth rural medical needs surveys and health industry status analysis, allowing students to intuitively feel the market space of rural medical

entrepreneurship. In addition, volunteers can be used to let students feel the urgency of rural medical needs through direct contact with rural residents, and accumulate professional achievement in participating in grassroots medical services, health popularization and other practices, thereby enhancing their motivation to return home to start businesses [9].

4.2. Establish an Integration Mechanism of Professional Education and Entrepreneurship Education to Cultivate Students' Compound Capabilities

To achieve the goals of the Rural Revitalization Strategy, it is necessary to focus on cultivating compound talents among vocational medical students. This requires vocational colleges to establish an integration mechanism of professional education and entrepreneurship education based on industrial needs, enabling medical students to examine the demand pain points in the rural medical and health field from an entrepreneurial perspective while mastering medical professional knowledge [10]. First, focus on rural medical needs to cultivate students' innovative thinking. Offer courses such as "Integration of Rural Health Industries" to guide students to explore rural characteristic resources, such as the combination of traditional Chinese medicine, ecological agriculture, cultural tourism and medical services, and cultivate innovative thinking for the integrated development of medical care and other rural industries. At the same time, set up courses around the entire process of rural medical entrepreneurship, such as rural medical project planning, low-cost operation and management, and rural health service marketing, focusing on cultivating students' project design, cost control, and customer development capabilities, so that medical students can improve their entrepreneurial capabilities while strengthening their professional skills; second, higher vocational medical professional courses should break traditional disciplinary boundaries, combine rural medical needs under the background of rural revitalization, and tap entrepreneurial education elements in courses. For example, in public health courses, content such as the design of entrepreneurial models for rural health management services and the operation and promotion of rural public health projects can be integrated to improve the pertinence of returning home to start businesses. Third, build a practical platform for the integration of professional education and entrepreneurship education, allowing medical students to carry out entrepreneurial practice in simulated rural medical scenarios, combining the application of professional skills with the drill of entrepreneurial processes. In addition, interdisciplinary teaching teams can be formed, with medical professional teachers and entrepreneurship education teachers co-teaching and guiding projects, realizing the complementarity of professional knowledge and entrepreneurial experience, and improving the integration and effectiveness of the teaching process.

4.3. Build a Service Platform for Returning Home to Start Businesses and Strengthen the Guarantee of Grassroots Medical and Health Talents

At present, entrepreneurship education for vocational medical students returning home still has problems such as insufficient entrepreneurial awareness of college students, insufficient understanding of rural medical construction, and poor connection of entrepreneurship support policies. To better provide support and guarantee for medical students returning home to start businesses and enhance the effectiveness of innovation and entrepreneurship education, vocational colleges need to actively build a service platform for returning home to start businesses, providing a solid guarantee for medical students returning home to start businesses.

First, establish a systematic policy information integration mechanism, regularly collect and sort out medical and health policies and entrepreneurship support policies related to vocational medical students returning home

to start businesses, and accurately push policy information to medical students through various forms such as online service platforms, offline lectures, and one-on-one consultations. In addition, strengthen the integration of local real economy industries with medical students' entrepreneurship, provide conditions for innovation and entrepreneurship, and improve the accessibility and utilization efficiency of policy resources.

Second, relying on the faculty and scientific research resources of vocational colleges, set up a professional technical guidance team to provide medical students with guidance on medical technology upgrading, service product innovation, and entrepreneurial project optimization; at the same time, establish a rural medical entrepreneurship resource sharing library, integrating local resources such as rural medical service networks, volunteer teams, and rural governance organizations, helping medical students quickly integrate into the rural environment, realize the effective connection between entrepreneurial projects and rural resources, and improve the feasibility and sustainability of entrepreneurial projects.

Finally, build an entrepreneurship incubation base, an important carrier and support platform for empowering medical students to start businesses, providing medical students with comprehensive hardware support including free or preferential office space, advanced medical training facilities, and modern office equipment. At the same time, supporting systematic software services such as entrepreneurship ability training, management consulting services, market resource connection, and legal and financial guidance. Through the collaborative model of "hardware-software" dual-drive, effectively reduce the entrepreneurial threshold and initial operating costs of medical students, helping them gradually master key capabilities such as project planning, team management, and resource integration in practice, thereby steadily improving the sustainable development ability and market competitiveness of entrepreneurial projects.

5. Conclusion

In summary, as an important link connecting the supply of higher vocational medical talents with rural medical and health needs and an important force for promoting rural revitalization, entrepreneurship education for returning home focuses on realizing the coordinated cultivation of medical professional capabilities and entrepreneurial literacy by changing cognitive concepts, establishing an integration mechanism of professional education and entrepreneurship education, and building a service platform for returning home to start businesses, helping medical students develop entrepreneurial paths in the rural medical and health field.

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Research on the Synergistic Innovation Logic and Mechanism Construction of Digital Transformation and Circular Economy

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Abstract: Currently, digital transformation and circular economy development face numerous challenges: insufficient in-depth integration between digital technology application and circular economy models, and imperfect data sharing and collaborative mechanisms, which restrict the improvement of resource utilization efficiency; in the digital transformation of traditional industries, the penetration of circular economy concepts is insufficient, and the momentum of green development has not been fully stimulated. Based on this, this paper deeply explores the internal logic, operation mechanism, and implementation paths of the synergistic innovation between digital transformation and circular economy. It aims to achieve the dual development of high-quality economic growth and ecological environmental protection through various strategies.

Keywords: Digital transformation; Circular economy; Synergistic innovation logic; Mechanism construction

Online publication: December 31, 2025

1. Introduction

The Implementation Guide for the Coordinated Transformation and Development of Digitalization and Greenization clearly points out that we should adhere to innovation as the primary driving force for development, break through traditional thinking and methods, actively explore new concepts, technologies, formats, and models in the coordination of digitalization and greenization, promote the all-round integration of digitalization and greenization, and accelerate the development of new quality productive forces; adhere to innovation as the primary driving force for development, break through traditional thinking and methods, actively explore new concepts, technologies, formats, and models in the coordination of digitalization and greenization, promote the all-round integration of digitalization and greenization, and accelerate the development of new quality productive forces; promote experience exchange and resource sharing through multilateral and bilateral open cooperation,

create an open and inclusive cooperative environment for digitalization and greenization, continuously strengthen international cooperation and mutual recognition in policies, standards, technologies, and talents for the coordination of digitalization and greenization, and expand new space for international exchanges and cooperation [1]. Higher vocational colleges should follow the path in line with national development in accordance with national policy documents to better cultivate talents.

2. Internal Logic of Synergistic Innovation Between Digital Transformation and Circular Economy

2.1. Compatibility of Value Pursuits

2.1.1. Synergistic Improvement of Economic Value

Digitalization mainly provides enterprises with more value and profits by using information technology to improve production efficiency and save operating costs; the circular economy achieves cost savings by maximizing resource utilization and recycling. The two complement each other, boosting high-quality economic development and maximizing economic value [2].

2.1.2. Joint Enhancement of Social Value

Social value refers to improving public services for people's livelihood through digital transformation, such as smart medical care and smart education, to promote social equity and progress; ensuring the sustainable supply of resources, reducing pollution, and improving people's quality of life through the circular economy. Digital transformation and the circular economy form a joint force, creating a good social environment and increasing more welfare for society [3].

2.1.3. In-Depth Integration of Environmental Value

Digitalization provides an information foundation for precise environmental monitoring and governance, and uses big data to predict environmental development trends to support environmental decision-making; the circular economy reduces the generation of pollutants and waste at the source, reducing pressure on the environment. The two can promote the continuous optimization of the ecological environment and green development [4].

2.2. Driving Nature of Technological Innovation

2.2.1. Digital Technology Empowering Circular Processes

Informatization and intelligence empower precise environmental monitoring and governance, providing big data analysis and prediction basis for environmental forecasting and decision-making; "low-carbon and circular" production saves resources and reduces waste emissions at the source of production, reducing ecological and environmental pressure. The coupling of informatization, intelligence, and circular economy promotes the continuous improvement of the ecological environment and creates green development.

2.2.2. Innovative Models Expanding Development Boundaries

The Internet empowers new economic forms such as the sharing economy and platform economy, providing directions for exploring innovative development of the circular economy [5]. Shared manufacturing can realize the sharing of production capacity and capabilities, reducing redundant construction and idle waste of resources; platform economy can coordinate and integrate resources upstream and downstream of the industrial chain,

promoting the coordination of the circular industrial chain.

2.2.3. Technology Integration Promoting Industrial Upgrading

The integration of digital technology and circular economy-related technologies has become a new technological system and innovative technology application. For example, the application of digital twin technology in the circular economy can simulate and optimize the circular economy process, improving the intelligence level and resource utilization efficiency in the circular economy process [6].

2.3. Guidance of Market Demand

2.3.1. Driven by Upgraded Consumer Demand

More and more consumers are changing their consumption concepts to protect the environment, and the demand for green and sustainable products is increasing. To meet the market demand for green products and achieve sustainable development, enterprises implement digital transformation and the circular economy to provide green products and services and enhance their own capabilities [7].

2.3.2. Market Competition Pressure Promoting Innovation

Facing increasingly fierce market competition, enterprises aim to reduce their own production costs, obtain more profits, and increase the differentiated competitive advantage of their products. They seek synergistic innovation of digital and circular economy models to find the optimal business model and production method and achieve their own sustainable development [8].

2.3.3. Industry Development Trends Leading the Direction

Digital transformation and the circular economy have become major trends in global industrial development [9]. Various industries have formulated relevant development strategies to promote the transformation of industries towards digitalization and greenization. Enterprises conform to industry development trends and carry out synergistic innovation, which helps them occupy a favorable position in future market competition [10].

3. Operation Mechanism of Synergistic Innovation Between Digital Transformation and Circular Economy

3.1. Resource Integration Mechanism

3.1.1. Integration and Sharing of Data Resources

Build information systems to collect internal and external enterprise-related data, such as enterprise production and operation data, market data, and environmental data, break the information barriers between various databases, realize data exchange and sharing between different databases, provide complete and accurate data support for circular economy decision-making, and optimize resource allocation [11].

3.1.2. Integration and Coordination of Technical Resources

Integrate digital technology and circular economy-related technologies, such as energy-saving technology, environmental protection technology, and resource recycling technology. Form technical integration advantages, carry out joint research and technical innovation, promote the upgrading and upgrading of circular economy technology, and improve the technical level of resource recycling.

3.1.3. Integration and Optimization of Industrial Resources

Promote the connection between the digital transformation and circular economy development of different industries, and promote resource sharing between industries. For example, the integration of manufacturing and service industries uses digital services to further enhance the value of manufacturing and the level of circular economy; the integration of agriculture and industry realizes the recycling of agricultural waste [12].

3.2. Interest Coordination Mechanism

3.2.1. Fair and Reasonable Interest Distribution

Establish a fair and reasonable interest distribution mechanism to clarify the rights and responsibilities of each participating subject in synergistic innovation. According to the investment, contribution, and risk-taking of all parties, reasonably distribute the interests brought by innovative achievements, and stimulate the innovation enthusiasm and initiative of all parties [13].

3.2.2. Improvement of Risk Sharing Mechanism

Construct a risk sharing mechanism to reasonably share technical risks, market risks, environmental risks, etc. that may be faced in the process of synergistic innovation. Reduce the innovation risks of all parties and enhance the confidence and determination of innovation by signing cooperation agreements and establishing risk funds [14].

3.2.3. Flexible and Diverse Incentive Mechanisms

Improve the incentive mechanism and give material and spiritual rewards to subjects that have made outstanding contributions to synergistic innovation. Set up innovation awards, provide promotion opportunities, and give equity incentives to stimulate innovation vitality and promote the continuous and in-depth development of synergistic innovation.

3.3. Innovation-Driven Mechanism

3.3.1. Technological Innovation Leading Development

Focus on the innovation of digital technology and circular economy-related technologies to promote the development of synergistic innovation. Increase investment in the research and development of key technologies, encourage enterprises to carry out independent innovation and integrated innovation, break through technical bottlenecks, and improve the technical level and core competitiveness of synergistic innovation [15].

3.3.2. Model Innovation Expanding Space

Actively explore new models and formats combining digital transformation and the circular economy. For example, carry out the construction of digital circular economy parks, promote green supply chain management models, and develop new formats integrating the sharing economy and the circular economy, expanding the development space and market areas of synergistic innovation.

3.3.3. Management Innovation Improving Efficiency

Introduce advanced management concepts and methods to optimize the management processes and organizational structure of synergistic innovation. Establish a flat and flexible organizational model to improve decision-making efficiency and response speed; adopt tools such as project management and knowledge management to improve the management level and efficiency of synergistic innovation.

3.4. Market-Oriented Mechanism

3.4.1. Market Demand Driving Innovation Direction

Taking market demand as the orientation, determine the key directions and fields of synergistic innovation between digital transformation and the circular economy. Deeply understand the characteristics and trends of consumers' demand for green and sustainable products, develop products and services that meet market demand, and increase market share.

3.4.2. Market Competition Promoting Innovation Upgrading

In the fierce market competition, enterprises continuously increase investment in digital transformation and the circular economy to promote innovation upgrading to improve their competitiveness. Improve product and service quality, reduce costs, and enhance market competitiveness through technological innovation, model innovation, and management innovation.

3.4.3. Market Feedback Optimizing Innovation Achievements

Establish a market feedback mechanism to timely collect feedback information from the market on synergistic innovation achievements. According to market feedback, optimize and improve products and services, improve the market adaptability and satisfaction of innovation achievements, and realize the continuous iteration and upgrading of innovation achievements.

4. Implementation Paths of Synergistic Innovation Between Digital Transformation and Circular Economy

4.1. Enterprise-Level Implementation Paths

4.1.1. Formulate Strategic Plans

Enterprises should incorporate the synergistic innovation of digital transformation and the circular economy into their long-term development strategic plans, clarify innovation goals, key tasks, and implementation steps. Combine their own actual situation to formulate personalized synergistic innovation plans to ensure the scientificity and feasibility of strategic plans.

4.1.2. Increase Technical Investment

Increase investment in the research and development of digital technology and circular economy-related technologies, establish R&D institutions or carry out joint R&D in cooperation with universities and scientific research institutions. Introduce advanced technologies and equipment to enhance enterprises' independent innovation capabilities and technical levels, and provide technical support for synergistic innovation.

4.1.3. Optimize Business Processes

Comprehensively optimize and upgrade enterprises' production, management, marketing and other business processes using digital technology. Realize the intelligence of the production process, the refinement of management, and the precision of marketing, improve enterprises' operational efficiency and resource utilization efficiency, and promote the development of the circular economy.

4.2. Industry-Level Implementation Paths

4.2.1. Build Industrial Ecology

Supported by digital technology, build an industrial ecosystem for the coordinated development of digital transformation and the circular economy. Integrate resources such as upstream and downstream enterprises, scientific research institutions, and service institutions in the industrial chain to form an industrial coordinated development pattern, and promote resource sharing and recycling between industries.

4.2.2. Create Industrial Platforms

Build a public service platform for the digital transformation and circular economy industry to provide enterprises with one-stop services such as technology R&D, achievement transformation, talent training, and market docking. Through platform construction, reduce enterprises' innovation costs and transaction costs, and improve the synergistic innovation efficiency of the industry.

4.2.3. Promote Industrial Agglomeration

Guide enterprises related to digital transformation and the circular economy to gather in industrial parks to form industrial cluster effects. Through industrial agglomeration, realize resource sharing, co-construction of infrastructure, centralized pollution control, etc., reduce enterprises' operational costs and environmental costs, and improve the overall competitiveness of the industry.

4.3. Regional-Level Implementation Paths

4.3.1. Formulate Regional Plans

Local governments should formulate regional plans for the coordinated development of digital transformation and the circular economy in combination with regional actual conditions. Clarify regional development goals, key industries, and spatial layout, guide resources to gather in key areas and fields, and promote the coordinated development of the regional economy.

4.3.2. Construct Infrastructure

Increase investment in the construction of digital infrastructure and circular economy infrastructure, such as 5G networks, data centers, sewage treatment facilities, and garbage classification and treatment facilities. Complete infrastructure provides hardware support for the development of digital transformation and the circular economy, and promotes the development of regional synergistic innovation.

4.4. National-Level Implementation Paths

4.4.1. Formulate National Strategies

Elevate the synergistic innovation of digital transformation and the circular economy to a national strategy, and clarify national development goals and key tasks. Formulate relevant policies, regulations, and development plans to guide the synergistic innovation of digital transformation and the circular economy nationwide, and promote the high-quality development of the national economy.

4.4.2. Strengthen Top-Level Design

Strengthen top-level design at the national level to coordinate the synergistic innovation work between various departments and regions. Establish a cross-departmental and cross-regional coordination mechanism, break

administrative barriers and interest barriers, and form a national synergistic innovation pattern.

5. Conclusion

The synergistic innovation of digital transformation and the circular economy is a key initiative to comply with the trend of the times and achieve a sustainable future. By deeply exploring the synergistic logic between the two and constructing a scientific and effective innovation mechanism, we provide new ideas for addressing resource and environmental constraints and cultivating new quality productive forces. In the future, it is necessary to continuously strengthen technology integration, policy guidance, and multi-party cooperation, let digitalization empower the circular economy, and let the circular economy expand application scenarios for digitalization, jointly moving towards a new journey of green prosperity.

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Analysis of Countermeasures for Colleges and Universities to Assist in the Construction of Rural Ecological Civilization Under the Rural Revitalization Strategy

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Abstract: Currently, in the advancement of the Rural Revitalization Strategy, the construction of rural ecological civilization faces numerous challenges: shortage of professional talents, disconnect between the talent supply of relevant disciplines in colleges and universities and rural needs; insufficient scientific and technological support, lagging research and promotion of practical technologies for rural ecology by colleges and universities; low popularity of ecological concepts, and inadequate in-depth ecological and environmental education and guidance for villagers by colleges and universities. Based on this, this paper explores the significance and countermeasures of colleges and universities assisting in the construction of rural ecological civilization under the Rural Revitalization Strategy. It aims to provide comprehensive support for rural ecological civilization construction through various strategies, promote rural ecological revitalization, and realize the coordinated and sustainable development of rural economy and ecology.

Keywords: Rural Revitalization Strategy; Ecological civilization construction; Ecological development

Online publication: December 31, 2025

1. Introduction

The Action Plan for Scientific and Technological Innovation in Colleges and Universities for Rural Revitalization (2018—2022) clearly states that we should fully implement the fundamental task of fostering virtue through education, coordinate educational resources and forces, give play to the important role of scientific research and practical education in the connotative development and high-quality talent training of higher education, and enhance the ability to cultivate innovative talents for rural revitalization; deepen the reform of the scientific and technological system in colleges and universities, innovate organizational models, strengthen collaborative innovation, improve the evaluation system, focus on tackling key scientific issues and core technologies in the

Rural Revitalization Strategy, and give full play to the role of colleges and universities as a source of scientific and technological innovation in the implementation of the Rural Revitalization Strategy; focus on the major needs in the implementation of the Rural Revitalization Strategy, optimize the disciplinary and professional structure of colleges and universities, promote the integration of industry and education, accelerate the construction of first-class agricultural universities and first-class agricultural disciplines, and strive to form a new situation where the connotative development of higher education is closely combined with promoting economic and social development [1]. Colleges and universities should adjust their talent training strategies in accordance with national policy documents and specific rural needs, so as to better cultivate more talents in line with social development.

2. Significance of Colleges and Universities Assisting in the Construction of Rural Ecological Civilization Under the Rural Revitalization Strategy

2.1. Improve Rural Ecology and Enhance Rural Livability Quality

Ecological livability is the key to rural revitalization. Colleges and universities assisting in the construction of rural ecological civilization can significantly improve the rural ecological environment. With professional research teams, colleges and universities can conduct research on rural problems such as water pollution, soil pollution, and garbage disposal, and develop low-cost and high-efficiency treatment technologies and equipment [2]. For example, develop small-scale sewage treatment devices suitable for rural areas to solve the problem of random discharge of domestic sewage; study soil improvement technologies to improve land quality. At the same time, through activities such as conducting ecological and environmental protection knowledge lectures and distributing publicity materials in villages, colleges and universities can enhance farmers' environmental awareness, guide them to develop green lifestyles, and reduce damage to the ecological environment [3].

2.2. Promote Industrial Transformation and Inject Vitality into Rural Economy

Industrial revitalization is the focus of rural revitalization. Colleges and universities assisting in the construction of rural ecological civilization provide technical and intellectual support for the green transformation of rural industries. In the agricultural field, colleges and universities can promote ecological planting and breeding technologies, guide farmers to reduce the use of chemical fertilizers and pesticides, develop organic agriculture, improve the quality and added value of agricultural products, and enhance market competitiveness [4]. For example, guide farmers to adopt biological pest control methods to produce green and pollution-free agricultural products. In addition, colleges and universities can assist rural areas in developing emerging industries such as ecotourism and leisure agriculture, tap rural ecological and cultural resources, create characteristic tourism projects, attract tourists, and drive the development of related industries such as catering and accommodation [5].

2.3. Cultivate Professional Talents and Strengthen Support for Rural Development

Talent is the primary resource for rural revitalization. As a cradle of talent training, colleges and universities assisting in the construction of rural ecological civilization can cultivate a large number of professional talents for rural areas [6]. Colleges and universities can set up relevant majors and courses such as environmental science, ecology, and rural regional development to targetedly cultivate compound talents who understand both ecological and environmental protection knowledge and are familiar with rural realities. By organizing students to carry out internships, practices, and research activities in rural areas, they can deeply understand the needs and current situation of rural ecological civilization construction and enhance their awareness and ability to serve rural areas.

At the same time, colleges and universities can provide continuing education and training opportunities for rural in-service personnel, update their knowledge and skills, and improve the ecological and environmental literacy of rural cadres and the masses [7].

3. Countermeasures for Colleges and Universities to Assist in the Construction of Rural Ecological Civilization Under the Rural Revitalization Strategy

3.1. Strengthen the R&D of Environmental Protection Technologies and Provide Technical Support

3.1.1. Focus on Rural Environmental Pain Points to Develop Technologies

Targeting prominent rural problems such as water pollution, soil pollution, and garbage disposal, colleges and universities can organize research teams to conduct special research to better find environmental protection technologies and equipment suitable for rural development, thereby further promoting the construction of rural ecological civilization [8].

3.1.2. Promote the Transformation of Environmental Protection Technology Achievements

Establish and improve the transformation mechanism of scientific research achievements, strengthen cooperation with enterprises, quickly transform the environmental protection scientific research achievements of colleges and universities into actual productivity, promote the wide application of environmental protection technologies in rural areas, and effectively improve the quality of the rural ecological environment [9].

3.1.3. Conduct Environmental Protection Technology Training and Guidance

Organize expert teams to go deep into rural areas, carry out environmental protection technology training and on-site guidance for farmers, teach environmental protection technology operation methods and maintenance skills, improve farmers' environmental protection technology level and application ability, and ensure the effective implementation of environmental protection technologies in rural areas.

3.1.4. Establish Environmental Protection Technology Demonstration Bases

Select appropriate areas in rural areas to establish environmental protection technology demonstration bases, display advanced environmental protection technologies and equipment, allow farmers to intuitively feel the effects and advantages of environmental protection technologies, stimulate their enthusiasm and initiative in applying environmental protection technologies, and promote the popularization of environmental protection technologies in rural areas [10].

3.2. Promote Ecological Agricultural Technologies and Facilitate Green Development

3.2.1. Develop and Promote Ecological Planting Technologies

Colleges and universities can promote technologies such as organic planting and green prevention and control to help farmers better understand the hazards of chemical fertilizers and pesticides to agricultural development, thereby further improving the quality of agricultural products.

3.2.2. Develop Ecological Breeding Technologies

Targeting the pollution problem of rural breeding industry, develop and promote ecological breeding models

and technologies, such as recirculating aquaculture and fermented bed breeding, realize the resource utilization of breeding waste, reduce breeding pollution emissions, and promote the green transformation of the breeding industry [11].

3.2.3. Conduct Ecological Agricultural Technology Training

Through training courses, on-site demonstrations and other methods, teach farmers ecological agricultural technology knowledge and operational skills, enhance their ecological agricultural awareness and production technology level, guide farmers to actively participate in ecological agricultural construction, and increase their income [12].

3.2.4. Establish Ecological Agricultural Demonstration Parks

Build ecological agricultural demonstration parks in rural areas to integrate and display technologies such as ecological planting, breeding, and processing, play a demonstration and leading role, drive the development of ecological agriculture in surrounding areas, form ecological agricultural industrial clusters, and promote the green upgrading of rural industries.

3.3. Optimize Professional Settings and Cultivate Professional Talents

3.3.1. Set Up Majors Related to Rural Ecological Civilization

After investigating the needs of rural ecological construction, colleges and universities can set up related majors such as environmental science, ecology, and agricultural resources and environment to cultivate more professionals with relevant expertise.

3.3.2. Adjust Professional Curriculum Systems

Optimize professional curriculum systems, add courses on rural ecological environmental protection, ecological agriculture, and rural environmental governance, focus on the combination of theory and practice, and improve students' comprehensive quality and ability to solve practical problems.

3.3.3. Strengthen Practical Teaching Links

Establish off-campus practical teaching bases, organize students to carry out internships, training, and graduation design activities in rural areas, allow students to deeply understand the current situation and problems of the rural ecological environment, and enhance their practical operation ability and social responsibility [13].

3.3.4. Conduct Innovation and Entrepreneurship Education

Encourage students to carry out innovation and entrepreneurship activities in the field of rural ecological civilization construction, cultivate their innovative spirit and entrepreneurial ability, and inject new vitality and motivation into rural ecological civilization construction.

3.4. Transport Outstanding Talents and Supplement Grassroots Forces

3.4.1. Guide Graduates to Work in Rural Areas

Introduce relevant policies and measures to encourage college graduates to work in rural grassroots engaged in ecological civilization construction-related work, such as environmental law enforcement, environmental monitoring, and ecological restoration, to provide talent support for rural ecological civilization construction.

3.4.2. Carry Out Targeted Talent Training

Cooperate with local governments to carry out targeted talent training projects, train professional talents in rural ecological environmental protection and ecological agriculture for rural areas, who will work directly in rural grassroots after graduation to solve the problem of rural talent shortage [14].

3.4.3. Establish Talent Exchange Mechanisms

Establish talent exchange mechanisms between colleges and universities and rural grassroots, regularly select college teachers to take temporary posts in rural areas, and invite rural grassroots cadres and technical personnel to further their studies in colleges and universities to promote two-way talent flow and exchange.

3.4.4. Provide Continuing Education Services for Talents

Provide continuing education services for rural in-service personnel, update the knowledge structure of rural talents through training courses and online learning, improve their professional level and comprehensive quality, and adapt to the new requirements of rural ecological civilization construction.

3.5. Tap Rural Ecological Culture and Inherit Fine Traditions

3.5.1. Conduct Rural Ecological Culture Research

Organize teachers and students to go deep into rural areas, carry out rural ecological culture research activities, tap traditional rural ecological cultural resources, such as ecological folk customs, ecological architecture, and ecological diet, and sort out and protect rural ecological cultural heritage [15].

3.5.2. Establish Rural Ecological Culture Databases

Sort out and digitize the rural ecological culture data collected through research, establish rural ecological culture databases, and provide basic data support for the research, inheritance, and utilization of rural ecological culture.

3.5.3. Hold Rural Ecological Culture Exhibitions

Hold rural ecological culture exhibitions in colleges and universities or rural areas, display traditional rural ecological cultural achievements, let more people understand the connotation and value of rural ecological culture, and enhance social awareness of the protection of rural ecological culture.

3.5.4. Promote the Innovative Development of Rural Ecological Culture

Combine the needs of the times to innovate and transform traditional rural ecological culture, develop rural ecological cultural products and services with modern characteristics, and promote the inheritance and development of rural ecological culture.

3.6. Carry Out Ecological Education and Improve Farmers' Ecological Awareness

3.6.1. Compile Rural Ecological Education Textbooks

Organize experts to compile ecological education textbooks suitable for rural characteristics and farmers' needs, covering ecological environmental protection, ecological agriculture, green life, etc., to provide systematic textbook support for rural ecological education.

3.6.2. Conduct Rural Ecological Education Training

Carry out ecological education training for farmers through lectures, training courses, etc., popularize ecological knowledge and environmental protection concepts, improve farmers' ecological awareness and environmental protection responsibility, and guide farmers to consciously participate in rural ecological civilization construction.

3.6.3. Establish Rural Ecological Education Bases

Establish ecological education bases in rural areas, such as ecological parks and ecological farms, as practical venues for ecological education, allowing farmers to learn ecological knowledge through personal experience and enhance their ecological protection awareness.

3.6.4. Use New Media to Carry Out Ecological Education

Use new media platforms such as the Internet and mobile phones to carry out rural ecological education publicity activities, produce ecological education short videos, WeChat official account articles, etc., expand the coverage and influence of ecological education, and improve farmers' ecological literacy.

3.7. Strengthen University-Local Cooperation and Form Joint Construction Forces

3.7.1. Establish a Long-Term Mechanism for University-Local Cooperation

Colleges and universities and local governments should establish a long-term and stable cooperation mechanism, sign cooperation agreements, clarify the rights and obligations of both parties, jointly formulate rural ecological civilization construction plans and implementation plans, and ensure the smooth development of cooperation work.

3.7.2. Co-Construct Rural Ecological Civilization Construction Platforms

University and local parties jointly build rural ecological civilization construction research platforms, technology promotion platforms, talent training platforms, etc., integrate resources of both parties, realize complementary advantages, and improve the efficiency and level of rural ecological civilization construction.

3.7.3. Carry Out Joint Research Project Tackling

Targeting major issues and key technologies in rural ecological civilization construction, university and local parties jointly carry out research project tackling, jointly apply for research projects, share research results, and provide scientific and technological support for rural ecological civilization construction.

3.7.4. Establish a Cooperation Evaluation and Feedback Mechanism

Regularly evaluate and summarize university-local cooperation work, timely discover problems and adjust cooperation strategies, establish a feedback mechanism, and continuously optimize cooperation content and methods according to the actual needs of rural ecological civilization construction to improve cooperation effects.

4. Conclusion

The Rural Revitalization Strategy has brought new opportunities for rural ecological civilization construction. As a key force, colleges and universities shoulder important missions. Through countermeasures such as optimizing talent training, strengthening scientific research innovation, deepening practical services, and enhancing publicity and guidance, colleges and universities can effectively assist in rural ecological civilization construction. In the

future, colleges and universities need to continue their efforts, work closely with rural areas, continuously explore new paths, and inject a steady stream of wisdom and motivation for building ecologically livable beautiful villages and realizing comprehensive rural revitalization.

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The Application Effect of Comprehensive and Refined Management in Quality Management of Unpaid Blood Donation at Blood Stations

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Abstract: Objective: To analyze the application effect of comprehensive and refined management in the quality management of unpaid blood donation at blood stations. Methods: A total of 330 unpaid blood donors at our blood station from July 2024 to July 2025 were selected and randomly divided into two groups, with 165 donors in each group. The control group received conventional management, while the observation group received comprehensive and refined management in addition. The success rate of one-time puncture, the occurrence of adverse events after blood collection, the blood discard rate, and the quality of the blood collection and supply environment were compared between the two groups. Results: The success rates of one-time puncture in the observation group and the control group were 98.19% and 93.33%, respectively, and the incidence rates of adverse events after blood collection were 5.45% and 18.79%, respectively ($P<0.05$). In terms of blood discard, the incidence rates of confidential blood discard, non-standard blood, clotted blood, abnormal plasma color, and abnormal testing process in the observation group were 1.21%, which was lower than the 6.67% in the control group ($P<0.05$). The quality pass rates of the observation group in terms of the air in the blood collection and supply environment, the surface of environmental objects, the skin of donors' arms, the hygienic hands of blood collection nurses, blood storage refrigerators, and blood specimen transport boxes were all higher than those of the control group ($P<0.05$). Conclusion: Implementing comprehensive and refined management in the management of unpaid blood donation at blood stations can improve the success rate of blood collection operations, reduce adverse events and blood discard, and improve the quality of the blood collection and supply environment, thereby comprehensively enhancing the quality management level of unpaid blood donation.

Keywords: Blood station; Unpaid blood donation; Quality management; Comprehensive and refined management; Blood discard rate

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1. Introduction

Blood stations, as public welfare health institutions responsible for recruiting voluntary blood donors, collecting and preparing blood, storing it, and supplying it for clinical use, have their management levels that not only affect

donors' willingness to participate and the prevention of adverse reactions during blood donation but also relate to the quality and safety of blood products. They are a crucial link in ensuring the safe clinical use of blood [1]. During the process of blood collection and supply, if staff members do not operate in accordance with standards, such as incomplete disinfection, improper puncture, or incorrect labeling, the risk of errors increases easily, affecting blood quality [2]. Therefore, strengthening quality management in blood stations is of great significance. Comprehensive and refined management, as a management model centered on systematic thinking and refined operations, optimizes the entire process of blood collection, including pre-, during-, and post-collection stages, as well as personnel operations. This approach can improve the quality and efficiency of blood collection, reduce adverse reactions in donors, and promote the safe and efficient utilization of blood resources [3]. Studies have indicated that applying comprehensive and refined management to blood donation services in blood stations can optimize nursing quality, reduce adverse reactions in donors and cases of blood wastage, and enhance donor satisfaction [4]. Therefore, this study will compare the differences between comprehensive and refined management and conventional management in terms of the success rate of single puncture, the incidence of adverse events after blood collection, the blood wastage rate, and the qualification rate of the blood collection and supply environment, exploring its application effects in the quality management of voluntary blood donation in blood stations.

2. Materials and Methods

2.1. General Information

After approval by the Medical Ethics Committee, 330 volunteers who donated blood voluntarily at our blood station from July 2024 to July 2025 were included. There were no statistically significant differences in general information between the two groups ($P > 0.05$), as shown in **Table 1**.

Table 1. General Information [($\bar{x} \pm s$), Cases (n)]

Group	n	Gender (M/F)	Age (years)	BMI (kg/m²)	Education Level		
					Junior High or Below	High School/ Vocational	College or Above
Observation Group	165	93/72	35.59 ± 6.20	24.85 ± 1.47	32 (19.39)	67 (40.61)	66 (40.00)
Control Group	165	101/64	34.82 ± 5.09	24.56 ± 1.82	40 (24.24)	54 (32.73)	71 (43.03)
t/χ^2		0.801	1.265	1.592		2.468	
P-value		0.371	0.207	0.112		0.291	

2.2. Inclusion and Exclusion Criteria

Inclusion Criteria: (1) All participants meet the requirements specified in the "Health Examination Requirements for Blood Donors" [5]; (2) Male participants weigh ≥50 kg and female participants weigh ≥45 kg; (3) Participants have no history of severe systemic diseases such as heart, liver, or kidney diseases, as well as no history of infectious diseases; (4) All blood donors have signed an informed consent form.

Exclusion Criteria: (1) Individuals with a fear of needles, blood, or severe psychological phobias; (2) Individuals who do not meet blood donation criteria due to anemia, hypertension, diabetes, or other conditions prior to donation; (3) Individuals who experience acute adverse reactions or interrupted blood collection during the donation process; (4) Individuals under the age of 18.

2.3. Methods

The control group received routine management: (1) Information registration was conducted first, followed by health consultations, physical examinations, and preliminary blood screening. The blood collection process and precautions were explained, and participants were guided in preparing mentally and physically, with emphasis on the importance of cooperation during the procedure. (2) During blood collection, strict adherence to standardized puncture and disinfection procedures was maintained. Personal protective equipment was worn, disposable supplies were used in accordance with regulations, and relevant equipment and contact surfaces were disinfected after blood collection, with proper hand hygiene practices observed. (3) After blood collection, participants were assisted in applying pressure with a bandage to stop bleeding. They were instructed to remove the bandage themselves after 30 minutes and to keep the wound dressing in place for 4 hours. They were informed of possible adverse reactions and were asked to remain under observation for 30 minutes. If no abnormalities were observed, they could leave on their own. (4) Collected blood samples were packaged, labeled, stored, and registered according to standard requirements. The blood collection room was statically disinfected using ultraviolet lamps for 1 hour every morning and evening.

The observation group was supplemented with comprehensive and refined management: (1) A comprehensive and refined management team for the blood station was established, consisting of management staff, blood collection personnel, and quality control specialists. It was divided into five subgroups responsible for blood collection, preparation, storage, transportation, and infection prevention and control, with each subgroup collaborating in their respective areas. Weekly quality meetings were held to analyze problems and formulate corrective measures. Statistical assessments were conducted on blood collection volume, discard rates, and adverse events, fostering a mechanism for continuous improvement. Additionally, the "Blood Station Quality Management Manual" was compiled, detailing operational standards and a reward-and-punishment system. (2) Two centralized training sessions and skill assessments were organized monthly, covering blood collection procedures, aseptic techniques, error prevention, emergency response, and humanistic communication. These sessions combined theoretical learning, scenario-based drills, and practical assessments. Rewards were given to top performers, while those who did not meet the standards were required to undergo retraining until they passed. (3) The blood station adhered to a "people-oriented" service philosophy, with staff patiently receiving blood donors, explaining procedures and precautions, and alleviating their anxiety. Before blood collection, educational brochures were distributed, and knowledge videos were played. During blood collection, staff closely monitored donors' expressions and provided timely communication and reassurance. After blood collection, videos on post-donation care were played, guiding donors on diet and rest. Donors were observed for 15 minutes to ensure no abnormalities before leaving the station. (4) Strict adherence to aseptic techniques and verification procedures was enforced, following the principle of "one needle, one tube, and one towel per person." Before blood collection, information, blood type, and volume were verified. After blood collection, the blood was immediately mixed with anticoagulant, and label verification was completed. Two dedicated personnel inspected blood collection equipment, consumables, and blood storage containers daily. (5) The blood collection and supply environment underwent daily scheduled disinfection, utilizing ozone machines, negative ion generators, and chlorine-based disinfectants to maintain clean air and surfaces. Quality supervisors were assigned in each department to cooperate with the quality control department for inspections. Key areas were subject to video surveillance and regular sampling inspections. Strict adherence to hand hygiene, waste classification, and protective measures was enforced. (6) Blood preparation was handled by dedicated personnel responsible for component separation, quality inspection, and data recording, maintaining aseptic conditions throughout the process. In the storage and transportation phase, temperature visualization monitoring was implemented, with blood storage

refrigerators maintained at 2-6°C, equipped with temperature recording and alarm systems, as well as independent power supplies. Blood distribution followed the "first-in, first-out" principle, with regular inventory checks to control discard rates. During transportation, the cold chain status was verified.

2.4. Observation Indicators

(1) Record the success rate of a single puncture and the occurrence of adverse events (local skin redness and swelling, subcutaneous congestion, infection, nausea, fainting, and pallor) in the two groups of voluntary blood donors.

(2) Blood discard situations include confidential blood discard, non-standard volume blood, clotted blood, abnormal plasma color, and abnormal testing process.

(3) Quality testing of the blood collection and supply environment includes collecting air samples from the center and four corners of the blood collection room (approximately 1 m from the wall and at a height of 0.8-1.5 m), as well as samples from environmental object surfaces, the hands of blood collection nurses, the skin of donors' arms, blood storage refrigerators, and the surfaces of blood transportation boxes. These samples are cultured at 37°C for 48 hours before colony counting. The criteria for evaluation are as follows: air ≤ 4 CFU/(5 min·plate), blood storage equipment ≤ 8 CFU/(10 min·plate), disinfectant in use ≤ 10 CFU/mL, object surfaces and hands of blood collection nurses ≤ 10 CFU/cm², and the irradiation intensity of ultraviolet lamps ≥ 70 μW/cm².

2.5. Statistical Analysis

Statistical analysis was performed using SPSS 25.0 software. Count data were expressed as n (%) and the chi-square test was performed. Measurement data were expressed as ($\bar{x}$±s), and the t-test was performed. A P-value < 0.05 was considered statistically significant.

3. Results

3.1. Success Rate of a Single Puncture and Incidence of Adverse Events After Blood Collection

The success rate of a single puncture in the observation group was higher than that in the control group, and the incidence of adverse events after blood collection was lower than that in the control group (P < 0.05). See **Table 2**.

Table 2. Success Rate of a Single Puncture and Incidence of Adverse Events After Blood Collection [Cases (%)]

Group	n	First-Attempt Success Rate [n(%)]	Post-Blood Draw Adverse Events [n(%)]						Total Adverse Event Rate [n(%)]
			Local Skin Redness	Subcutaneous Bruising	Infection	Nausea	Fainting	Pale Complexion	
Observation Group	165	162 (98.19)	2 (1.21)	1 (0.61)	0 (0.00)	2 (1.21)	1 (0.61)	3 (1.82)	9 (5.45)
Control Group	165	154 (93.33)	6 (3.64)	3 (1.82)	2 (1.21)	5 (3.03)	2 (1.21)	13 (7.88)	31 (18.79)
χ^2-value		4.774							13.769
P-value		0.029							<0.001

3.2. Blood discard rate

Compared with the control group, the observation group had a lower blood discard rate ($P < 0.05$). See **Table 3**.

Table 3. Blood discard rate [Case (Percentage)]

Group	n	Confidential Discard	Non-Standard Volume	Clotted Blood	Abnormal Plasma Color	Testing Process Abnormality	Total Discard Rate
Observation Group	165	0 (0.00)	1 (0.61)	0 (0.00)	0 (0.00)	1 (0.61)	2 (1.21)
Control Group	165	1 (0.61)	2 (1.21)	1 (0.61)	1 (0.61)	6 (3.64)	11 (6.67)
χ^2-value							6.486
P-value							0.011

3.3. Quality of blood collection and supply environment

The quality of the blood collection and supply environment in the observation group was superior to that in the control group ($P < 0.05$). See **Table 4**.

Table 4. Quality of blood collection and supply environment [Case (Percentage)]

Group	n	Air Quality in Blood Collection/Supply Environment	Environmental Surface	Donor's Arm Skin	Healthcare Worker's Hand Hygiene	Blood Storage Refrigerator	Blood Specimen Transport Container
Observation Group	165	161 (97.58)	159 (96.36)	163 (98.79)	165 (100.00)	160 (96.97)	160 (96.97)
Control Group	165	152 (91.12)	150 (90.91)	156 (94.55)	158 (95.76)	151 (91.52)	148 (89.70)
χ^2-value		5.024	4.119	4.608	7.152	7.366	7.013
P-value		0.025	0.043	0.032	0.007	0.007	0.008

4. Discussion

The demand for clinical blood use continues to grow, with an average annual increase of 10% to 15%. This necessitates blood stations to optimize their blood management processes to ensure the safety of clinical blood use and reduce the occurrence of blood discards [6]. As the primary source of clinical blood products, blood stations are responsible for managing key processes such as blood collection, testing, preparation, storage, and distribution. The quality of their operations directly impacts the safety and efficiency of clinical blood transfusions. The successive issuance of documents such as the "Measures for the Administration of Blood Stations," "Quality Management Standards for Blood Stations," and "Quality Management Standards for Blood Station Laboratories" by the state since 2006 has facilitated the standardization and institutionalization of blood management processes. However, studies have shown that from 2015 to 2019, the main non-compliant aspects in blood station quality management were concentrated in quality control, blood collection and acceptance, as well as storage and transportation, with proportions of 31.68%, 27.06%, and 2.97%, respectively [7]. Research by Zhu Xiaoqin [8] also pointed out that issues in record management, blood donation services, and blood testing were prominent, requiring strengthened supervision and continuous improvement. Therefore, this study will introduce comprehensive and refined

management to systematically, standardly, and traceably manage the entire process of blood collection and supply.

This study indicates that the observation group had a higher success rate of single puncture and lower rates of adverse events after blood collection and blood discard compared to the control group ($P < 0.05$). The study by Cao Hualin [9] and others also pointed out that the introduction of comprehensive nursing management into the quality management of voluntary blood donation at blood stations can improve the success rate of one-time puncture and reduce the risk of adverse events after blood collection. This is because comprehensive and meticulous management establishes a management team, enabling clear division of labor and a quality tracking mechanism in the blood collection process. The normalization of skill training and assessment helps strengthen the standardization of operations, which is reflected in more precise key steps such as puncture site selection, needle insertion angle, and needle fixation. Strict implementation of the verification system before operation, including information verification and equipment inspection, avoids puncture failures caused by information omission or equipment abnormalities. The seamless connection of multi-link management makes the operation process more stable, thereby enhancing the success rate of one-time puncture. The decrease in the incidence of adverse events after blood collection is mainly attributed to the knowledge education and psychological counseling provided to blood donors before blood collection, which reduces their anxiety levels. After blood collection, on-site observation and dietary guidance ensure safety during the short-term recovery period and reduce the occurrence of delayed reactions. Meanwhile, the implementation of aseptic operation procedures reduces the risks of skin redness, bleeding, and infection. The meticulous execution of hand hygiene management, consumable replacement, and surface disinfection further reduces local reactions after puncture. The decrease in blood discard rate indicates stricter quality control in the collection, testing, storage, and distribution processes, as well as more standardized sample preservation and information management. This is manifested in the timely mixing of anticoagulants and accurate label verification during the collection process; the implementation of temperature monitoring and alarm systems during storage and transportation to prevent temperature fluctuations from affecting blood components; equipment inspections and independent power supplies to ensure continuous cold chain operation; and adherence to the "first-in, first-out" principle during distribution to reduce discards. Regular environmental disinfection, combined with quality control inspections and video monitoring, effectively maintains air and surface cleanliness, ensuring a stable environment for blood preparation and preservation [10]. The quality of the blood collection and supply environment in the observation group was superior to that in the control group ($P<0.05$), suggesting that comprehensive and meticulous management can enhance the environmental hygiene level and quality compliance rate throughout the entire blood collection and supply process.

In summary, comprehensive and refined management has established a multi-departmental collaborative management system, strengthened personnel training and skill assessments, rigorously enforced aseptic and verification procedures, standardized cold chain storage and transportation as well as environmental disinfection processes. This has made the blood collection process more standardized, risk prevention and control more rigorous, and the blood collection and supply environment cleaner and more stable. Consequently, it has effectively increased the success rate of one-time punctures, reduced adverse events after blood collection and the rate of blood discard, and improved the pass rates of quality tests for air, surface hygiene, and hand hygiene of operators.

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Safety Adaptation Technologies and Management Strategies for Unmanned Aerial Vehicle Operations in Highland Mountainous Environments: A Case Study of Yunnan Province

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Abstract: With the rapid development of drone technology, its applications in fields such as geological exploration and emergency rescue in the plateau and mountainous regions of Yunnan Province are becoming increasingly widespread. However, special environmental factors such as low air pressure and strong radiation seriously affect flight safety, and the adaptability of the existing management system is insufficient. Taking Yunnan Province as a sample, this paper systematically analyzes the impact mechanisms of plateau and mountainous environments on drones, focusing on the safety adaptation technologies for core modules such as power systems, navigation, and positioning. Combining with the current management situation in the province, it proposes countermeasures from dimensions such as regulations, supervision, and talent, providing support for improving the safety of drone use in special environments.

Keywords: Plateau and mountainous regions; Drones; Safety adaptation technology; Management countermeasures; Yunnan Province

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1. Introduction

1.1. Research background and significance

Unmanned aerial vehicles (UAVs), with their advantages of high flexibility and low cost, are driving the digital transformation of various industries. In Yunnan Province, mountainous areas account for 88.64% of the total land area, with an elevation range spanning from 76.4 meters to 6,740 meters. The province boasts diverse climatic conditions, making transportation and resource exploration highly challenging. UAVs have found applications here in landslide monitoring, terraced field plant protection, and mountainous search and rescue operations, effectively overcoming environmental constraints.

However, the plateau environment frequently causes malfunctions in drones: low air pressure reduces engine power, strong ultraviolet rays accelerate equipment aging, and complex terrain blocks signals. According to data from the Emergency Management Department of Yunnan Province, there were 47 drone flight malfunctions across the province in 2023, with 32 of them related to inadequate environmental adaptability, resulting in direct economic losses exceeding RMB 2 million. Therefore, researching adaptive technologies and management strategies is of great significance for ensuring operational safety and promoting industrial development.

1.2. Current research status at home and abroad

In domestic research, Wang Jian et al. proposed a low-temperature preheating technology for drone batteries on the Qinghai-Tibet Plateau, maintaining a discharge efficiency of over 80% at -10°C; Li Juan et al. proposed a management system of "government supervision + corporate self-discipline + technological prevention and control" for the southwestern mountainous regions [1–2]. However, existing research mostly focuses on single environmental factors and lacks systematic studies on the composite environment of "high altitude, diverse terrain, and strong radiation" in Yunnan Province, with management strategies not closely aligned with local realities.

1.3. Research content and methods

Research Content: Firstly, analyze the environmental characteristics of the Yunnan Plateau and their impact on drones; secondly, develop core adaptive technologies such as power and navigation; thirdly, propose strategies based on the current management situation. Research Methods: (1) Conduct field surveys to collect drone operational data from six locations, including Kunming and Lijiang; (2) perform experimental analyses to test the effectiveness of technologies in simulated laboratories; (3) Conduct literature research to sort out relevant achievements and policies.

2. Environmental characteristics of plateau and mountainous areas in Yunnan Province and their impact on UAV flight

2.1. Core environmental characteristics

The plateau environment in Yunnan exhibits three major characteristics: First, there is a significant variation in altitude, with Meili Snow Mountain in northwest Yunnan exceeding 6,700 meters, while Hekou County in southeast Yunnan stands at only 76.4 meters. For every 1,000-meter increase in altitude, the air pressure drops by 10 kPa, and the oxygen content decreases by 12% to 15%. Second, the climate is complex, with some regions experiencing temperature differences of over 20°C between day and night, an average of more than 50 thunderstorm days per year, and annual precipitation reaching 2,000 millimeters in western Yunnan. Third, the terrain and radiation are unique, featuring numerous canyons and terraced fields, with dense vegetation that easily blocks signals, and an annual sunshine duration of 2,200 to 3,000 hours, with ultraviolet intensity 30% to 50% higher than that in plain areas.

2.2. Mechanisms of environmental impact on UAVs

2.2.1. Performance degradation of power systems

Fuel-powered UAVs experience reduced air intake and combustion efficiency at low air pressures. For a certain type of fuel engine, the maximum thrust decreases by 42% and the takeoff run distance increases by two times at an altitude of 5,000 meters [3]. Electric UAVs are more significantly affected by low temperatures; in winter in

Diqing (-5°C), the endurance of a mainstream model decreases from 30 minutes to 12 minutes, posing a risk of power failure.

2.2.2. Decline in navigation and positioning accuracy

Complex terrain causes satellite signal obstruction. In the canyon areas of western Yunnan, the number of visible GPS satellites drops from 12 to fewer than 4, and positioning accuracy degrades from the meter level to over 10 meters [4]. Ionospheric disturbances triggered by severe convective weather can cause brief interruptions in navigation.

2.2.3. Insufficient stability in communication transmission

Microwave communication is obstructed by mountain vegetation. In the rainforest areas of Xishuangbanna, the communication range of drones decreases from 5 kilometers to 1.5 kilometers, and latency increases from 50ms to over 200ms [5]. Strong ultraviolet radiation accelerates the aging of communication components, increasing the error rate of data transmission.

2.2.4. Vulnerability of airframe structure

The average annual wind speed in the northwestern plateau of Yunnan is 3-5 meters per second, with gusts exceeding 10 meters per second, which can easily cause fluctuations in the airframe's attitude; the large diurnal temperature variation causes material expansion and contraction, leading to cracks. Research indicates that the incidence of structural failures in drones in mountainous areas is 28% higher than that in plains, manifesting as propeller breakage, etc. [6].

3. Research and development of safety adaptation technologies for drones in plateau and mountainous environments

3.1. Power system adaptation technology

3.1.1. Adaptive adjustment technology for fuel engines

To address the issue of engine power degradation caused by low atmospheric pressure at high altitudes, an adaptive adjustment system based on real-time atmospheric parameter monitoring has been developed. This system utilizes pressure sensors and oxygen concentration sensors installed on the body of unmanned aerial vehicles (UAVs) to collect real-time atmospheric data from the flight environment. After analysis by the central processing unit, it automatically adjusts the engine's air intake and fuel injection ratio. By employing variable nozzle turbocharger technology, the system increases the engine's intake pressure, resulting in a 38% increase in air intake and a 25% improvement in combustion efficiency compared to traditional engines at an altitude of 5,000 meters. Experimental validation shows that UAVs equipped with this technology maintain power output stability above 90% of that at plain levels when operating in the Meili Snow Mountain region of Yunnan Province (at an altitude of 5,200 meters), meeting the demands of high-altitude operations [7].

3.1.2. Low-temperature protection technology for lithium batteries

To mitigate the impact of low temperatures on lithium battery performance, an integrated battery management system featuring "preheating-insulation-energy recovery" has been developed. Flexible heating films are installed within the battery compartment, and temperature sensors continuously monitor the battery temperature. When

the temperature drops below 5°C, the preheating function is automatically activated, rapidly raising the battery temperature to between 15°C and 20°C. The battery compartment is wrapped with a vacuum insulation layer to minimize heat loss, maintaining the battery temperature above 10°C in -10°C environments. Additionally, energy recovery technology is introduced to convert the kinetic energy of the UAV during descent into electrical energy, supplementing the battery charge and extending flight time by 20% to 30%. This technology has demonstrated excellent performance in winter operations in the Diqing region of Yunnan Province, extending the UAV's flight time from 12 minutes to 18 minutes and meeting the demands of long-duration operations such as emergency rescue [1].

3.2. Navigation and positioning adaptation technology

3.2.1. Multi-source navigation fusion positioning technology

This technology integrates GPS, Beidou, GLONASS, and Inertial Navigation Systems (INS) to establish a multi-source navigation fusion positioning framework. It employs the Kalman filtering algorithm to fuse and process positioning data from various navigation systems. When satellite signals are obstructed, it automatically switches to an inertial navigation-dominated mode, utilizing sensors such as gyroscopes and accelerometers embedded in the unmanned aerial vehicle (UAV) to calculate flight attitude and position information in real time. Additionally, terrain matching navigation technology is introduced, which pre-stores Digital Elevation Model (DEM) data of the operational area and matches the real-time terrain data collected by the UAV with the pre-stored data to correct positioning errors. During testing in the western Yunnan canyon region, this technology maintained the UAV's positioning accuracy within 3 meters, representing a 60% improvement over single satellite navigation systems [4].

3.3.2. Anti-jamming navigation enhancement technology

In response to the issue of satellite signal interference caused by severe convective weather, a navigation anti-jamming module based on adaptive frequency hopping technology has been developed. This module can monitor the interference intensity of navigation signals in real-time, automatically switch operating frequencies to avoid interference bands, and employ signal enhancement algorithms to improve the reception capability of weak signals. In terms of antenna design for unmanned aerial vehicles (UAVs), multi-polarized antennas are adopted to enhance the reception capability of satellite signals from different directions and reduce the impact of signal blockage. Experiments have shown that in thunderstorm-prone areas of Yunnan Province, such as the Pu'er region, the interruption time of UAV navigation signals equipped with this technology has been reduced from an average of 8 seconds to less than 1 second, significantly enhancing the reliability of the navigation system [8].

3.3. Communication transmission adaptation technology

3.3.1. Relay communication and multi-link backup technology

To address the issue of communication blockage caused by complex terrain, a collaborative operation mode of "primary UAV + relay UAV" has been proposed. The relay UAV is deployed at a high altitude to serve as a communication relay node, enabling indirect communication between the primary UAV and the ground station, and extending the communication distance from 1.5 kilometers to over 8 kilometers. Meanwhile, a multi-link communication backup system has been constructed, integrating microwave communication, 4G/5G public network communication, and satellite communication. When one communication link is interrupted, the system automatically switches to other links to ensure communication continuity. In tests conducted in the tropical

rainforest region of Xishuangbanna, Yunnan Province, this system reduced the UAV communication interruption rate from 25% to 1.2% [5].

3.3.2. Optimization of radiation-resistant communication modules

To address the impact of intense ultraviolet radiation at high altitudes on communication modules, radiation-resistant materials are employed to encapsulate the modules. A UV-resistant polytetrafluoroethylene material is selected for the outer casing, while reinforced chips are used for the internal electronic components to enhance radiation resistance. Additionally, the heat dissipation structure of the communication module is optimized by combining heat fins with a microfan to reduce the module's temperature in high-temperature environments, preventing damage to components due to overheating. After testing, the optimized communication module demonstrated a performance degradation rate of only 5% after six consecutive months of operation in Lijiang, Yunnan Province (with an annual UV radiation intensity of 3500 $\mu W/cm^2$), representing a 20 percentage point reduction compared to traditional modules [3].

4. Airframe structure reinforcement technology

The airframe structure is optimized using lightweight, high-strength materials. The main body of the airframe is constructed from carbon fiber composite materials, resulting in a 30% weight reduction and a 45% increase in strength compared to traditional aluminum alloy materials. To address airframe stability issues in strong wind conditions, the UAV's aerodynamic layout is optimized by adopting a delta-wing design to reduce wind resistance, while increasing the area of the tail fins to enhance flight attitude control accuracy. For propeller design, variable-pitch propeller technology is employed, enabling automatic adjustment of the blade angles in response to changes in wind speed, thereby improving propulsion efficiency. During testing in the strong wind regions of northwest Yunnan Province, UAVs equipped with this structure maintained stable flight at wind speeds of 8 m/s, with a 50% reduction in airframe vibration amplitude compared to traditional UAVs [6].

5. Current situation and existing problems in the use and management of unmanned aerial vehicles (UAVs) in Yunnan Province

5.1. Current management situation

Yunnan has issued documents such as the "Interim Measures for the Flight Management of Unmanned Aerial Vehicles", clarifying departmental responsibilities and establishing a "hierarchical and classified" regulatory framework. As of June 2024, 12 flight service stations have been established, with 86,000 UAVs registered, achieving a registration rate exceeding 90%. Detection equipment has been deployed in key areas, with 132 cases of illegal flights handled in 2023, and over 12,000 training sessions for operators conducted throughout the year.

5.2. Existing problems

5.2.1. Inadequate adaptability of the regulatory framework

The existing regulations largely draw on management experiences from plain regions, failing to fully consider the unique environmental characteristics of Yunnan's plateau and mountainous areas. For instance, the flight altitude limit for UAVs stipulated in the "Interim Measures for the Flight Management of Unmanned Aerial Vehicles in Yunnan Province" (120 meters below in general areas) renders UAVs incapable of performing tasks such as

topographic mapping and disaster monitoring in some high-altitude mountainous regions (e.g., Diqing), where the terrain elevation exceeds 3,000 meters. Furthermore, the absence of standards for UAV environmental adaptability technologies leaves undefined performance indicators and modification requirements for UAVs operating in plateau and mountainous areas. Consequently, some enterprises, aiming to reduce costs, use UAVs not adapted to high-altitude environments for operations, thereby increasing flight risks [2].

5.2.2. Shortcomings exist in the regulatory system

Firstly, the regulatory coverage is limited. Most mountainous areas in Yunnan Province are located in remote regions where unmanned aerial vehicle (UAV) regulatory equipment has not been deployed, resulting in regulatory blind spots. Among the 47 UAV malfunction incidents that occurred across the province in 2023, 28 took place in mountainous areas without regulatory coverage. Secondly, the inter-departmental coordination mechanism is inadequate. The information sharing among civil aviation, public security, emergency management, and other departments is not timely, leading to insufficient dynamic regulatory capabilities for UAV flights. For example, when emergency rescue UAVs fly beyond the designated airspace at disaster sites, ground stations are unable to promptly transmit flight information to air traffic control departments, which may result in conflicts with manned aircraft flights. Thirdly, technological regulatory means are lagging. The existing regulatory equipment is primarily designed for medium and large-sized UAVs, and lacks the detection capabilities for small and micro UAVs, making it difficult to meet the regulatory needs for the large number of small UAVs operating in mountainous areas [9].

5.2.3. Weak talent and technological support

Yunnan Province faces a shortage of UAV professionals, particularly compound talents who possess both UAV technology expertise and familiarity with the characteristics of plateau and mountainous environments. Among UAV-related enterprises across the province, less than 30% of operators hold professional qualifications. Some operators have not undergone systematic training and lack proficiency in UAV operation techniques and emergency response capabilities in plateau environments. In terms of technological support, there are few UAV research and development enterprises within the province, which mainly rely on technology introduction from outside the province. The research and development capabilities for adapting technologies to Yunnan's specific environmental conditions are weak, with low technology transfer efficiency, making it difficult to quickly meet market demands.

5.2.4. Inadequate safety responsibility system

Some users operate in violation of regulations, such as an agricultural company in Pu'er illegally modifying batteries, which led to a drone crash. The determination of accident liability is ambiguous, making it difficult to define the responsibilities of multiple parties [4].

6. Countermeasures for the safe management of drone use in Yunnan Province

6.1. Improve adaptive regulations and standards

Revise the "Interim Measures for the Administration of Drone Flight," implementing restrictions based on "reference altitude plus relative altitude," with a relative altitude limit of 120 meters in general areas, and clarifying priority flight rights in special fields. Introduce the "Safety Technical Standards for Drones in Plateau and

Mountainous Regions", stipulating that the engine decay rate should be ≤15% below an altitude of 5,000 meters, and battery endurance at -10℃ should be ≥60% of that in plain areas, establishing an adaptation certification system [3].

6.2. Establish a comprehensive supervision system

Deploy portable detection equipment in disaster-prone areas to establish a data link among "drones, ground stations, and supervision platforms." Set up a hotline for reporting violations to encourage public participation. Establish an inter-departmental joint meeting system and build an information-sharing platform to achieve real-time synchronization of emergency flight information. Develop AI recognition technology to enhance the detection capabilities for small and micro drones, and use big data to predict flight risks [5].

6.3. Strengthening talent and technological support

Yunnan University and other higher education institutions have established unmanned aerial vehicle (UAV) majors and offered specialized courses on high-altitude flight. They have implemented an integrated "training-assessment-certification" training program, attracted high-end talent, and provided subsidies. Special research and development funds have been set up, and technological transformation platforms have been constructed to facilitate the implementation of technologies such as low-temperature protection. Additionally, university-enterprise cooperation has been strengthened to introduce and adapt advanced technologies [4].

6.4. Improving the safety responsibility system

The primary responsibilities of user entities have been clarified, and a safety credit evaluation system has been established to deduct points from or blacklist violators. The "Measures for Handling UAV Flight Accidents" have been formulated, and a multi-departmental investigation team has been established to define the responsibilities of manufacturers, user entities, and others, as well as establish an accident compensation mechanism [2].

7. Conclusion and outlook

7.1. Research conclusions

Factors such as low air pressure and low temperatures on the Yunnan Plateau have led to issues such as reduced UAV power and decreased navigation accuracy. Technologies such as adaptive adjustment of fuel engines and multi-source navigation fusion developed to address these challenges have effectively enhanced flight safety. Regarding management issues such as inadequate regulatory compliance, proposed countermeasures such as improving standards and strengthening supervision hold practical value.

7.2. Future outlook

In the future, drone adaptation technology will evolve towards intelligence, such as AI-powered autonomous obstacle avoidance and improved communication stability through 5G. In terms of management, blockchain can be utilized for data certification, while digital twins can support training and planning. The research achievements in Yunnan can serve as a reference for other plateau regions, and it is necessary to strengthen cross-regional cooperation to promote the unification of technical standards and management norms.

Disclosure statement

The authors declare no conflict of interest.

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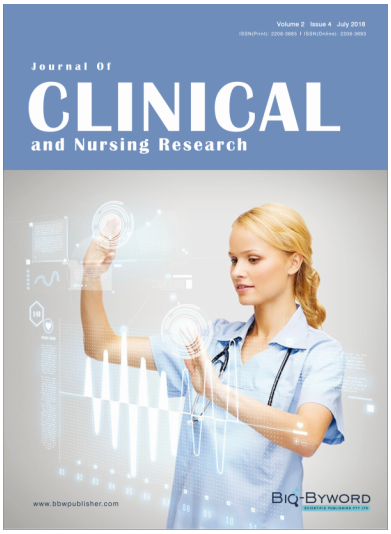

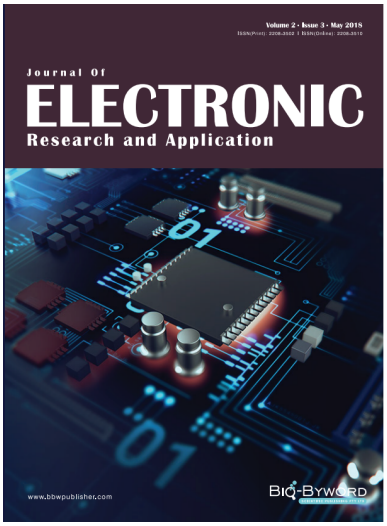

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