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Research on the Influencing Factors of Tourism Happiness of the Silver-haired Group in Xichang City from the Perspective of PERMA Theory

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Abstract: With the deepening of aging in China, the silver-haired tourism market is emerging. This study aims to explore the influencing factors of tourism happiness among the silver-haired group in Xichang City from the perspective of PERMA theory. The study collected relevant data on silver-haired tourists in Xichang City using a combination of questionnaire surveys and in-depth interviews. The results show that the happiness of silver-haired tourists in Xichang City is mainly influenced by five dimensions: Positive emotion, engagement, relationship, meaning, and accomplishment, as well as factors such as tourism service quality, the degree of improvement of tourism infrastructure, and the diversification of tourism products. The findings of this study will help tourism management departments and enterprises in Xichang City better understand the needs of silver-haired tourists, formulate targeted tourism development strategies, enhance the tourism experience and happiness of elderly tourists, and promote the healthy development of the silver-haired tourism market in Xichang City.

Keywords: Silver-haired group; Tourism happiness; PERMA theory; Influencing factors

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1. Introduction

The PERMA theory, proposed by positive psychologist Martin Seligman, emphasizes five core elements of individual happiness: Positive emotion, engagement, relationship, meaning, and accomplishment. This theory provides a new perspective for studying individual happiness and has been widely applied in fields such as education and management. In recent years, scholars have begun to introduce PERMA theory into tourism research to explore the influencing factors and improvement paths of tourist happiness. This article intends to explore the key influencing factors of tourism happiness among the silver-haired population in Xichang City from five dimensions: Positive emotions, engagement, interpersonal relationships, sense of meaning, and sense of accomplishment. On the one hand, this study helps to improve the application of PERMA theory in the field of tourism and expand the research on the influence mechanism of tourism happiness among the silver-haired group; on the other hand, the research results can provide decision-making reference for the optimization of the

silver-haired tourism market and the improvement of the well-being of the silver-haired group in Xichang City and other regions.

2. Literature review

Research on silver-haired group tourism has shown that tourism happiness is influenced by factors such as natural environment, service quality, socioeconomic status, and social relationships. Foreign studies have focused earlier on the motivations, limitations, and impacts of silver-haired group tourism, while domestic research has been conducted from perspectives such as consumer psychology and tourism modes. Tourism motivations include pursuit, indulgence, transcendental, and identity motivations, and limiting factors involve economics, psychology, and the suitability of tourism products. Tourism has a positive impact on the quality of life, social participation, and mental health of the silver-haired group, and mechanisms such as traveling with companions and experiencing value can significantly enhance happiness. Although existing research covers a wide range of topics, there are issues such as insufficient depth, a singular methodology, and limited perspectives. In the future, it is necessary to further explore specific influencing factors, strengthen cross-cultural research, expand research on the happiness of destination residents and service personnel, improve measurement methods, and develop targeted tourism products to support the development of silver-haired group tourism and improve their quality of life.

3. Data sources and research methods

3.1. Research case

Xichang City is located in the Liangshan Yi Autonomous Prefecture of Sichuan Province, with rich natural landscapes and ethnic cultural resources. It is an important tourist city in Sichuan Province. In recent years, with the deepening of aging, the silver-haired tourism market has gradually emerged, and Xichang City has also attracted a large number of elderly tourists. This study selects Xichang City as a case study to explore the influencing factors of tourism happiness among the silver-haired group in Xichang City from the perspective of PERMA theory.

3.2. Research methods

This study uses a questionnaire survey to obtain data on tourism happiness among the silver-haired group in Xichang City. The questionnaire design covers basic information about the silver-haired group (such as age, gender, education level, pre-retirement occupation, etc.), evaluation of tourism happiness, and factors that affect tourism happiness. The questionnaire content is based on the PERMA theoretical framework and designs questions from five dimensions: Positive emotion, engagement, relationships, meaning, and accomplishment, to comprehensively evaluate the tourism happiness of the silver-haired group. Additionally, this study uses in-depth interviews to complement the results of the questionnaire survey. Through deep dialogue and communication, we can better understand the silver-haired group's feelings about tourism happiness and their views on influencing factors. The interviewees include silver-haired individuals of different ages, genders, educational backgrounds, and pre-retirement occupations to obtain comprehensive and diversified data. The interview content focuses on tourism experience, social interaction, emotional experience, self-value realization, etc., to further explore the deep-level information behind the questionnaire data. Besides questionnaire surveys and in-depth interviews, this study also collects Xichang City's tourism development planning documents, relevant statistical data on silver-haired group tourism, and domestic and foreign research literature on silver-

haired tourism and happiness, which are used to assist in analyzing and verifying the results of the primary data.

3.3. Data sources

During the research process, a field survey was conducted among the silver-haired population in Xichang City, using a combination of questionnaire surveys as the primary method and semi-structured interviews as a complementary approach. Firstly, the questionnaire survey was administered, which included basic information about the respondents (such as age, gender, education level, pre-retirement occupation, etc.), tourism participation, evaluation of tourism happiness, and factors influencing tourism happiness. The questionnaire design was based on the PERMA theoretical framework, covering five dimensions: Positive emotion, engagement, relationships, meaning, and accomplishment, to comprehensively evaluate the tourism happiness of the silver-haired population. Secondly, semi-structured interviews were conducted, selecting silver-haired individuals from different communities and backgrounds in Xichang City, including retired teachers, retired enterprise employees, freelancers, etc., as a complement to the questionnaire survey. The interview content focused on the tourism experience, tourism motivation, emotional experience during travel, social interaction, self-value realization, and other aspects of the silver-haired population, exploring the specific impact of tourism on their happiness. Additionally, the interviews covered various dimensions such as the silver-haired population's views on Xichang's tourism resources, satisfaction with tourism services, tourism consumption capacity, changes in social relationships, and expectations for future tourism activities.

4. Empirical research on factors influencing tourism happiness of silver-haired population in Xichang City

4.1. Natural environment and tourism resources

Xichang City is located in the southwest of Sichuan Province, at the junction of Sichuan and Yunnan, boasting a unique natural environment and abundant tourism resources. Xichang attracts a large number of tourists, especially the silver-haired population, with its spring-like climate all year round, beautiful Qionghai-Lushan scenic area, and unique Yi culture. As the second largest freshwater lake in Sichuan Province, Qionghai has become an ideal destination for elderly people to relax and vacation, thanks to its clear lake water and surrounding wetland landscapes. Lushan, with its dense forests and fresh air, provides an excellent place for elderly people to hike, enjoy scenic views, and maintain their health. Additionally, Xichang is a famous aerospace city in China, and its aerospace-themed tourism projects offer a unique cultural experience for the silver-haired population.

The tourism resources in Xichang City not only provide diversified tourism options for the silver-haired population but also enhance their tourism happiness through the healing effects of the natural environment and the richness of cultural experiences. For example, the wetland parks around Qionghai offer opportunities for elderly people to take walks, bird watching, and photography, helping them relax and unwind. The hiking trails and observation decks on Lushan cater to the pursuit of healthy living among the elderly. Meanwhile, cultural festivals such as the Torch Festival and Yi New Year provide opportunities for the silver-haired population to participate in cultural interactions and experience ethnic customs, enhancing their sense of social participation and cultural identity.

Despite the abundance of tourism resources in Xichang City, there is still room for improvement in developing tourism products and supporting services specifically tailored to the silver-haired population. For instance, accessibility facilities in some scenic areas are not yet perfect, which may cause inconvenience for elderly tourists during their visits. Furthermore, health management services and personalized travel route

design for the silver-haired population also need to be further strengthened. By optimizing tourism resources and improving service quality, the needs of the silver-haired population can be better met, further enhancing their tourism happiness.

4.2. Socioeconomic factors: Income, employment, and education

The rapid development of the tourism industry in Xichang City has created more economic opportunities for the local silver-haired population, indirectly improving their income level and quality of life. Many silver-haired individuals have obtained additional economic income by participating in tourism-related activities such as operating homestays, providing tour guide services, or selling handicrafts. This increase in income not only improves their material living conditions but also enhances their sense of economic security and self-esteem, significantly boosting their happiness. Furthermore, the prosperity of the tourism industry has provided opportunities for some silver-haired individuals to rejoin the workforce, enabling them to achieve personal value through social participation and further enhancing their life satisfaction and happiness.

Education level is also an important factor influencing the tourism happiness of the silver-haired population in Xichang City. Silver-haired individuals who have received good education usually have stronger learning and adaptability skills, enabling them to better participate in tourism activities and derive satisfaction from them. For example, educated elderly people are more likely to master tourism-related knowledge and skills, such as using smart devices to book tourism services or understanding the cultural background of tourism destinations, thereby improving the quality of their tourism experience. Additionally, education enhances the silver-haired population's awareness and ability to participate in society, allowing them to more actively engage in social interactions during tourism activities and further increasing their happiness.

To further enhance the tourism happiness of the silver-haired population in Xichang City, local governments and various sectors of society should increase their support for this group. For instance, vocational skills training and tourism-related knowledge popularization courses can be provided to help the silver-haired population better adapt to the development needs of the tourism industry. Simultaneously, the government should encourage tourism enterprises to develop employment positions suitable for the silver-haired population, such as tourism advisors and cultural interpreters, providing them with more economic opportunities and channels for social participation. Furthermore, improving community education facilities and resources to offer lifelong learning opportunities for the silver-haired population is also an important way to enhance their happiness.

4.3. Social relationships and social capital

Social relationships refer to the interactions and connections between individuals, including relatives, friends, neighbors, and community organizations. Social capital, on the other hand, denotes the resources and support that individuals gain through their social relationships, such as trust, cooperation, a sense of belonging, and social support.

In Xichang City, the silver-haired population has strengthened their emotional connections with each other through interactions with family, friends, and companions during tourism activities. For instance, many silver-haired groups choose to travel with family or friends, and this shared experience not only deepens their emotional bonds but also provides them with emotional support and a sense of security. Additionally, social interactions in tourism activities, such as participating in collective activities, cultural exchanges, and volunteer services, offer opportunities for the silver-haired population to expand their social networks and enhance their sense of social belonging.

However, the social relationships and social capital of the silver-haired population in Xichang also face some challenges. Some elderly people lack stable social support in their daily lives due to their children working or living away, leading to increased loneliness. Furthermore, physical limitations or economic constraints can hinder some silver-haired individuals from fully engaging in social interactions during tourism activities, affecting their travel experience and sense of happiness.

To enhance the social relationships and social capital of the silver-haired population in Xichang, several measures are suggested. Firstly, communities and tourism organizations can organize more social activities tailored to the silver-haired group, such as cultural lectures, health talks, and interest groups, providing platforms for interaction and exchange. Secondly, encouraging family members to accompany the elderly in tourism activities can strengthen family cohesion. Additionally, the government and social organizations can establish volunteer service teams for the elderly, promoting mutual assistance and support among the silver-haired population and enhancing their sense of social belonging and self-worth. By strengthening social relationships and building social capital, Xichang can create a warmer and more supportive social environment for the silver-haired population, significantly improving their travel happiness and quality of life. Such efforts not only contribute to the physical and mental health of the silver-haired group but also provide crucial support for building harmonious communities and promoting sustainable tourism development.

5. Strategies to improve tourism happiness for the silver-haired population in Xichang City

5.1. Strengthening natural environment and tourism resource protection

Xichang City's natural resources, such as Qionghai Lake and Lu Mountain, and the Yi culture landscape are key to enhancing tourism happiness for the silver-haired population. To address environmental pressures and the risk of overexploitation due to rapid tourism development, resource protection is crucial. The government should develop scientific plans, establish ecological protection zones, limit tourist numbers, and increase investment in environmental protection infrastructure. Tourism management agencies should promote green tourism concepts, protect intangible cultural heritage, and enhance the silver-haired population's sense of participation. Simultaneously, raising environmental awareness among residents and tourists through educational campaigns and volunteer activities is essential. Through collaboration, Xichang can achieve sustainable resource utilization, providing a high-quality tourism experience for the silver-haired population, enhancing their happiness, and supporting sustainable tourism development and harmonious coexistence between humans and nature.

5.2. Promoting comprehensive socioeconomic development

Socioeconomic factors play a significant role in influencing tourism happiness for the silver-haired population. Xichang needs to focus on economic development, improving income levels, employment opportunities, and education for the silver-haired group to enhance their living conditions and happiness.

5.2.1. Promoting industrial diversification and innovation

By leveraging Xichang's unique natural resources and cultural heritage, tourism development can be optimized to promote industrial diversification. For instance, combining the natural beauty of Qionghai Lake and Lu Mountain with the cultural characteristics of the Yi people, health and wellness tourism, cultural experience tourism, and eco-tourism products suitable for the silver-haired population can be developed. Innovating tourism service models, such as offering customized travel routes and health management services, can cater

to the diverse needs of the silver-haired group. Additionally, integrating tourism with other industries, like promoting local specialty agricultural products and handicrafts, can increase the silver-haired population's economic income and provide more employment and entrepreneurial opportunities, enhancing their economic security and happiness.

5.2.2. Strengthening educational resource investment and development

Emphasis should be placed on lifelong education for the silver-haired population in Xichang, improving and expanding the coverage and quality of educational resources. For example, community education centers and universities for the elderly can provide health knowledge, tourism skills, and cultural literacy training to help the silver-haired population better adapt to tourism activities and social life. By improving education levels, the silver-haired group can acquire more knowledge and skills, enhancing their social participation and self-worth, further boosting their happiness. Additionally, focusing on the inheritance and development of Yi traditional culture through cultural education activities can strengthen the silver-haired population's cultural identity and sense of belonging.

5.2.3. Enhancing the construction of the social security system

Improving Xichang's social security system is crucial to ensure that the silver-haired population enjoys basic social security and welfare benefits. Providing services like healthcare, pension insurance, and travel accident insurance can address practical issues faced by the silver-haired population during travel and daily life, increasing their sense of security and happiness. Furthermore, the government and social organizations can support the silver-haired population's participation in tourism activities through special funds or subsidy policies, alleviating their economic burden.

Promoting comprehensive socioeconomic development in Xichang is a vital strategy to enhance tourism happiness for the silver-haired population. Through industrial diversification, strengthening educational resource investment, and developing the social security system, the economic situation and living conditions of the silver-haired group can be significantly improved, boosting their happiness. While implementing these strategies, emphasis should be placed on fairness and sustainable development to ensure long-term stability in Xichang's tourism industry and sustainable happiness for the silver-haired population. This comprehensive approach not only contributes to the personal development of the silver-haired group but also lays a solid foundation for the sustainable development of Xichang's tourism industry.

6. Conclusion and suggestions

6.1. Conclusion

Through the theoretical lens of PERMA, this study analyzed the five core influencing factors of tourism happiness for the silver-haired population in Xichang City: Positive emotions, engagement, relationships, meaning, and accomplishment. The research findings indicate that these factors play a significant role in the silver tourism market of Xichang. Specifically, the experience of positive emotions is enhanced through the design of age-friendly tourism products and the provision of a safe and comfortable tourism environment. The sense of engagement is strengthened by organizing cultural theme tourism projects and setting staged goals. Relationships are improved by promoting interaction among elderly tourists and encouraging family participation. The sense of meaning is reflected through the deep exploration of Xichang's cultural elements and community involvement. Finally, a sense of accomplishment is achieved by offering personalized services and souvenirs.

6.2. Suggestions

6.2.1. Optimizing tourism products and services

Designing age-friendly tourism products, such as the “Slow Travel in Xichang” series, focusing on a relaxed pace, safety, and comfort. Develop customized products themed around health and wellness, cultural exploration, and other topics to meet diverse needs. Simultaneously, strengthen the construction of age-friendly facilities in scenic areas, provide voice guides, health consultations, and other age-friendly services to enhance the sense of safety and convenience for elderly tourists.

6.2.2. Emphasizing emotional care and social interaction

Communication and interaction among elderly tourists should be promoted by organizing activities such as senior tourism festivals and cultural salons, enhancing their sense of belonging and happiness. Encourage family participation in silver tourism to provide companionship and emotional support for the elderly.

(1) Exploring cultural elements and community involvement

Based on Xichang’s natural resources and cultural landscapes, create integrated tourism products that combine culture and tourism, such as the “Aerospace Culture and Health Maintenance” package. Set staged goals and achievement points to allow elderly tourists to gain a sense of accomplishment after completing each goal.

(2) Promoting the integrated development of silver tourism and local economy

Foster the integration of culture and tourism to attract more silver-haired tourists. Develop the silver economy industrial chain, forming diversified development models such as “tourism and elderly care” and “tourism and medical care.” Establish a silver tourism service standard system, standardize the service behavior of tourism enterprises, improve overall service quality, and promote the sustainable development of Xichang’s silver tourism market.

6.2.3. Research limitations and future research directions

This study focused on the silver-haired population in Xichang City and has limitations. Firstly, regionality and group specificity limit the generalizability of the results. Future research can expand to silver-haired groups in different regions and cultural backgrounds. Secondly, data collection primarily relied on questionnaires, which may introduce subjective biases. Future studies can combine methods such as in-depth interviews and observations to obtain more comprehensive and accurate data. Thirdly, potential factors such as cultural heritage and community involvement were not fully explored. Future research can delve into their impact mechanisms. Additionally, the implementation of happiness enhancement strategies may be constrained by resources, policies, and cultural factors. Future studies can analyze their feasibility through practical case studies. The study also did not incorporate perspectives from stakeholders such as governments and businesses. Future research can provide more systematic solutions through multi-party comparisons. Finally, future research can explore innovations in Xichang’s tourism model, such as health and wellness tourism and cultural experiences, integrate services like health management and accommodation, create multi-functional experience zones, and improve strategic suggestions by comparing different stakeholder viewpoints to promote sustainable tourism development and enhance the happiness of the silver-haired population.

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TR Equipment Manufacturing Enterprise Technology Innovation Performance Evaluation

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Abstract: The correct evaluation of enterprise technological innovation performance is the premise and foundation to improve the efficiency of enterprise innovation. This paper first puts forward the index system of enterprise technological innovation performance evaluation, then establishes the model of technological innovation performance evaluation, explores the quantitative evaluation of enterprise innovation performance by using the DEA method, and finally makes an empirical study on the technological innovation performance of the TR enterprise.

Keywords: Equipment manufacturing industry; Innovation performance; Data envelopment analysis

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1. Introduction

Innovation-driven industrial upgrading is an essential path for the development of the equipment manufacturing industry. As one of the traditional pillar industries in China, the equipment manufacturing sector plays a significant role in enhancing the country's independent innovation capabilities, securing a competitive edge in traditional industries, and addressing environmental and resource challenges. The development of the equipment manufacturing industry is influenced by numerous factors. For enterprises to make scientifically sound decisions regarding technological innovation, it is crucial to establish a proper evaluation system for technological innovation performance. As a direct tool for enterprises to anticipate future technological trends, technological innovation performance evaluation can assist companies in planning related decisions more scientifically. TR Enterprise, as a subsidiary of a state-owned enterprise, still faces issues in technological innovation management that need improvement. Currently, technological innovation performance plays a vital role in enterprises, making it necessary to establish a scientific and reasonable technological innovation evaluation system to promote the rational allocation of innovation resources within the company.

This paper takes the TR enterprise as the research object, takes the DEA method as the theoretical basis, and examines its technological innovation performance from the vertical dynamic evolution. Based on the characteristics of the equipment manufacturing industry, a multi-level technological innovation performance evaluation system is constructed. Based on the data envelopment analysis (DEA) model, the static and dynamic

evaluation of the technological innovation performance of TR enterprises is carried out in combination with the time series span. It reveals the characteristics of “excellent technology and weak scale” of TR enterprise’s technological innovation performance and clarifies the core bottleneck of insufficient scale efficiency. It is necessary to release technological potential through strategies such as capacity integration and supply chain optimization to lay an empirical foundation for the subsequent improvement path.

2. Related literature review

2.1. Research on enterprise technology innovation performance evaluation system

The equipment manufacturing industry is a unique concept under China’s economic system. The term “equipment manufacturing enterprise” does not appear in foreign literature. They all focus on the performance evaluation of the manufacturing industry. The research on the performance evaluation system of the manufacturing industry in foreign countries is earlier than that in China, and the research results obtained are also more comprehensive and systematic. Hong *et al.* think that the evaluation of technological innovation ability should be based on the enterprise’s investment ability, the ability to earn profits, the ability to resist risks and the ability of government support, and use the analytic hierarchy process to measure the technological innovation level of listed companies ^[1]. Sun establishes the evaluation index system of regional scientific and technological innovation ability by using the social network analysis method and software centrality analysis. The system includes four first-level indicators of scientific and technological innovation foundation, scientific and technological innovation input, scientific and technological innovation output, and scientific and technological innovation efficiency, 10 second-level indicators such as scientific and technological awareness and human input, and 32 related third-level indicators ^[2]. Sun focuses on the field of green technology innovation. Based on the positive and negative factors that can affect the green technology innovation of enterprises, the scholar constructs the corresponding index system ^[3]. The research object of Sun is the equipment manufacturing enterprises in Liaoning Province. From the perspective of technological innovation catalysis, the scholar divides it into three parts: Innovation catalytic investment, innovation catalytic operation, and innovation catalytic effect to formulate relevant innovation indicators, to provide theoretical basis and practical guidance for manufacturing industry to improve innovation ability in this field ^[4]. From the perspective of technology digitization, Zhang *et al.* constructs the evaluation index system of traditional enterprise digitization from four dimensions: Strategy, organization, business, and technology ^[5].

2.2. Research on the performance evaluation method of enterprise technological innovation

There are abundant research results on the construction of enterprise technological innovation performance evaluation indicators and the selection of evaluation methods in China. The selection of indicators is generally a multi-dimensional and multi-index synthesis. The evaluation methods are mainly studied from subjective and objective perspectives. In the research topic of technology sterilization, Li *et al.* involve the coupling innovation of technology management. For the innovation of this kind of management mode, scholars have adopted the evaluation method of constructing a grey language evaluation model, combining grey correlation analysis and using GLWAA for comprehensive calculation ^[6]. Through the combination of subjective and objective empowerment, Zhang Xiang studied the innovation and development of the equipment manufacturing industry through the analytic hierarchy process and the Delphi method ^[7]. Yang Chao and Li Lan have systematically sorted out the performance evaluation methods of technological innovation, and the analysis methods covered are more comprehensive. The qualitative method includes the peer review method and the Delphi method, and the quantitative analysis method includes the data envelopment method, statistical analysis method, and BP neural

network method.

3. The content of index system of evaluation system

Different enterprises will set the performance evaluation indicators according to their industries. By sorting out the CNKI, Wanfang, Duxiu, and other databases, there are search results on ‘equipment manufacturing enterprises,’ ‘data envelopment analysis,’ ‘innovation performance evaluation,’ and ‘financial performance evaluation.’ It is found that domestic and foreign scholars usually use corporate assets and costs as input indicators and income and profits as output indicators. Combined with the characteristics of equipment manufacturing enterprises, the impact of indicators on performance should be fully considered when selecting indicators. At present, since China has not yet formed a standard for innovation performance evaluation system, this paper considers the frequency and availability of indicators and constructs an evaluation system that conforms to the characteristics of TR’s technological innovation under the system design principles and objectives. Finally, three input indicators and two output indicators were selected. The technology research and development of enterprises is generally measured from the perspective of manpower and capital investment. Referring to the research results of relevant literature, in terms of manpower investment, this paper selects the index of R&D personnel; in terms of capital investment, R&D expenses and patent application indicators are selected. The output index of technological innovation selects the number of patent authorizations and the sales revenue of new products.

The above indicators can reflect the level of technological innovation performance of equipment manufacturing enterprises. Therefore, the input and output indicators of technological innovation performance evaluation of TR enterprises are shown in **Table 1** below:

Table 1. Statistical description

	Index	Observed value	Mean value	Standard deviation	Minimum value	Maximum value
Input	Number of technical personnel	300	808.86	377.81	336	1321
	Research and development Expenditure	300	197.46	171.90	25.06	533.99
	Patent application number	300	324.53	192.47	110	729
Output	Patent grants	300	152.86	102.81	42	369
	New product sales	300	3716.15	1516.44	1984.59	6057.37

4. Evaluation system construction

DEA is one of the commonly used methods in the field of performance evaluation. It evaluates the performance of similar decision-making units by comparing their relative efficiency. Specifically, DEA weights the input and output indicators of each DMU to find the optimal weight combination so that the efficiency value of each DMU is maximized. In the DEA model, the efficiency value is equal to the sum of the weighted output divided by the sum of the weighted input. When the efficiency value is equal to 1, it means that the DMU is at the optimal efficiency boundary; when the efficiency value is less than 1, the efficiency of DMU is lower than the optimal level.

(1) The CCR model is the basic model of the DEA method. It is a non-parametric method based on linear programming to evaluate the relative efficiency of production decision-making units. The CCR model assumes that the production process has a constant return to scale; that is, the proportional relationship between input and output is constant.

In the CCR model, the comprehensive efficiency (total efficiency) includes two parts: Technical efficiency and scale efficiency. Technical efficiency reflects the ability of a decision-making unit to achieve maximum output under a given input. Scale efficiency reflects the production efficiency of a decision-making unit at its current scale. When the comprehensive efficiency of a decision-making unit is equal to 1, it shows that the decision-making unit is efficient in the production process. When the comprehensive efficiency is less than 1, it means that the decision-making unit has efficiency loss in the production process.

$$h_i = \frac{u^t y_i}{v^t x_i} = \frac{\sum_{s=1}^k u_s y_{si}}{\sum_{t=1}^m v_t x_{ti}}, i = 1, 2, \dots, n \quad (1)$$

$$s. t. \begin{cases} \min \theta \\ \sum_{i=1}^n \lambda_i x_i - s^- = \theta x_0 \\ \sum_{i=1}^n \lambda_i x_i - s^+ = y_0 \\ \lambda_i \geq 0, s^- \geq 0, s^+ \geq 0, j = 1, \dots, m; i = 1, \dots, n \end{cases} \quad (2)$$

(2) The BCC model is an extended model of the DEA method. Different from the CCR model, the BCC model assumes that the production process has variable returns to scale. The proportional relationship between input and output is variable. Under this assumption, the BCC model is mainly used to calculate the pure technical efficiency of the decision-making unit and exclude the impact of scale efficiency on the overall efficiency.

Pure technical efficiency reflects the ability of a decision-making unit to achieve maximum output under a given input, regardless of production scale. When the pure technical efficiency of a decision-making unit is equal to 1, it means that the decision-making unit is efficient in the production process. When the pure technical efficiency is less than 1, it means that the decision-making unit has a loss of technical efficiency in the production process.

The mathematical expression of the BCC model is similar to that of the CCR model. The difference is that the BCC model adds a constraint condition: $\sum_{i=1}^n \lambda_i = 1$.

The BCC model is widely used in many fields. For example, by evaluating the pure technical efficiency of different enterprises in the same industry, inefficient enterprises can be found and improved to improve the technical level of the whole industry. In a large enterprise, the BCC model can be used to evaluate the pure technical performance of different departments to find out which departments need to be improved to improve the technical efficiency of the whole enterprise. Moreover, the BCC model can be used to evaluate the pure technical efficiency of public service institutions, such as schools and hospitals, to determine which institutions have room for improvement at the technical level. By comparing the pure technical efficiency of different banks, we can find inefficient banks and improve them to improve the technical level of the whole banking industry.

5. Selection of evaluation model

This paper analyzes the technological innovation performance of TR equipment manufacturing enterprises vertically and horizontally and analyzes the financial data of a total of 15 years from 2008 to 2022 vertically.

The data is sorted out and output as a notepad file: TR.txt, using DEAP calculation software, the relevant parameters are set as follows:

tr.txt	data file name
tr-out.txt	output file name
15	number of firms
1	number of time periods
2	number of outputs
4	number of inputs
0	0 = input and 1 = output orientated

1 0 = crs and 1 = vrs

0 0 = DEA(multi-stage), 1 = cost-DEA, 2 = malmquist-DEA, 3 = DEA(1-stage), 4 = DEA(2-stage)

Run the DEA 2.1 program, use the BCC model for calculation, and the output calculation result is TRout.txt. After further collation by Microsoft Excel, the 15-year innovation performance measurement results of TR enterprises are as follows **Table 2.** shown:

Table 2. TR 2008–2022 BCC model calculation results

DMU	Comprehensive technical efficiency	Pure technical efficiency	Scale efficiency	Returns to scale
2008	1.000	1.000	1.000	-
2009	1.000	1.000	1.000	-
2010	1.000	1.000	1.000	-
2011	1.000	1.000	1.000	-
2012	1.000	1.000	1.000	-
2013	0.787	1.000	0.828	irs
2014	0.700	0.951	0.754	irs
2015	0.817	0.928	0.882	irs
2016	0.914	0.926	0.957	irs
2017	1.000	0.956	1.000	-
2018	1.000	1.000	1.000	-
2019	1.000	1.000	1.000	-
2020	0.927	1.000	0.927	irs
2021	1.000	0.970	0.955	-
2022	1.000	1.000	1.000	-

(1) Comprehensive efficiency analysis

Based on the BCC model, the performance evaluation results of TR equipment manufacturing enterprises from 2008 to 2022 show that the allocation structure of technological innovation resources of TR enterprises from the initial stage of listing to 12 years is reasonable, and the performance is relatively excellent. In the selected 15 sets of data, the comprehensive efficiency, technical efficiency, and scale efficiency of 2008–2012 for five consecutive years are 1 at the same time. It shows that the enterprise is in a state of complete efficiency in the five years, the technology management is mature, there is no waste of resources, the production scale matches the market demand, and it is in the stage of constant returns to scale. It shows that the proportion of input and output is fully coordinated at this stage, and there is no need to adjust the scale. In 2013–2016, TR enterprises entered a recession period, the comprehensive efficiency decreased from 0.787 in 2013 to 0.700 in 2014, and then slowly recovered to 0.914 in 2016. It shows that TR equipment manufacturing enterprises made full use of the existing internal resources in 2013, and the technology application has reached the optimal level. It may be due to changes in market demand or lagging adjustment of internal resources, resulting in a decline in scale efficiency.

In 2014, the rapid expansion of scale led to insufficient technical management capabilities, such as process chaos and waste of resources. In 2016, although the scale efficiency rebounded, the technical efficiency has not yet recovered, forming a ‘scale dependence’ path. The inefficiency of this stage shows that there is an imbalance between input and output in the data of TR equipment manufacturing enterprises based on innovation activities.

In the four years after the introduction of technology, the effect of gradually increasing input is not as good as before. There may be non-financial problems in management efficiency, which indirectly leads to the waste of resources, thus failing to achieve Pareto optimality. Although the innovation investment of TR enterprises is high, the emphasis on R&D is not low, the output effect is not as expected, and some adjustments need to be made. In addition to the external shocks such as the pandemic in 2020, in the following years, TR enterprises offset the technology gap through scale expansion, the comprehensive efficiency reached 1 again, the technology and scale efficiency were double excellent, and the golden period state was restored.

The comprehensive efficiency of TR enterprises is equal to 1 in 10 years of 15 years, indicating that the technical management foundation of TR equipment manufacturing enterprises is relatively stable. The rapid recovery of scale efficiency in 2017 and 2022 shows that TR enterprises have strong scale adjustment ability, but scale expansion and technical management are prone to alternating fluctuations, such as in 2013–2016. Therefore, TR equipment manufacturing enterprises need to establish a collaborative optimization mechanism to cope with market fluctuations with scale elasticity, consolidate the cornerstone of efficiency with technical standardization, and achieve long-term steady growth.

(2) Pure technical efficiency analysis

From **Table 2**, it can be seen that in 2008–2012, the pure technical efficiency of TR equipment manufacturing enterprises was one for five consecutive years, there was no shortage in technical management, and the resource utilization efficiency was the best. It reflects the mature standardized production process, stable R&D investment and technological innovation, efficient management team, and low resource waste rate of TR enterprises at this stage. In 2013, the pure technical efficiency of TR equipment manufacturing enterprises showed the first inflection point of decline, and the trend of change changed inversely with the growth of input, and it did not rebound until 2017. The failure of technical efficiency leads to a downward trend in the efficiency of the enterprise's comprehensive level. Specifically, in 2013, the pure technical efficiency remained 1.000, but the scale efficiency decreased to 0.828, indicating that the technical management at this stage was not affected by the scale adjustment. However, after 2013, the TR equipment manufacturing enterprises expanded rapidly, resulting in increased management complexity, and the original technical process could not adapt to the new scale. In 2014, the pure technical efficiency fell below one for the first time to 0.951. The reason behind it may be that the resources are not fully utilized, and part of the investment does not produce technological transformation and become a profitable product. Enterprises need to improve their innovation ability from the aspects of technology introduction, enterprise cooperation, and employee ability training, so that the input and output can be matched properly. At the same time, the “explosive” expansion of scale has destroyed the rational division of labor within the R&D center, and the increase in innovation projects has increased the difficulty of coordinating production relations, thus reducing efficiency. As the project increases, the management class emerges. At the same time as the consumption of human resources, employee compensation will also increase (the proportion of employee compensation in the R&D department is more than 70%). Managers usually have low production capacity but high salaries. In this way, if there is chaos within each manager, it will bring about a reduction in production efficiency. In 2015–2016, due to the continuous decline in the proportion of R&D expenses, the dispersion of R&D investment, the tilt of resources to scale expansion, and the crowding out of the technology upgrading budget, the pure technical efficiency of the two years continued to be low. In addition to the above reasons, the weak demand from the macro market, the reduction of the competitive advantage of the original production line, and the lag of the benefits of new products have all tested the management of TR enterprises.

In addition to the temporary resource mismatch caused by supply chain disruption in 2021, which led to a slight decrease in the pure technical efficiency of TR enterprises to 0.970, the pure technical efficiency of TR

equipment manufacturing enterprises will return to 1.000 in 2018–2022. The key to the success of TR equipment manufacturing enterprises lies in the reconstruction of technical standardization, the introduction of a lean production system, and the reduction of resource waste; at the same time, resources are concentrated on core processes, such as a 30% increase in the number of patents in 2017.

(3) Scale efficiency analysis

From **Table 2**, the returns to scale of TR are not in a stable state. In the calculation of the 15 periods, there are 10 periods to achieve the best scale. In 2008–2012 for five consecutive years, the scale efficiency is equal to 1, in a state of constant returns to scale, production capacity and market demand perfect match. It reflects the stable market demand and accurate capacity planning of TR equipment manufacturing enterprises, and the efficient and coordinated operation of the supply chain while allocating resources. Later, due to capacity expansion lagging behind demand growth, the scale efficiency fell to 0.828 for the first time in 2013. In the face of short-term demand surges, TR equipment manufacturing enterprises lack long-term planning. When the order volume increases by 20%, the capacity can only increase by 10%. In 2014, the scale efficiency continued to fall to 0.754. Due to excessive expansion, resources were dispersed, the utilization rate of new factories was less than half, and the coordination ability of the supply chain and production was insufficient. In 2015–2016, the capacity optimization was started, the inefficient capacity was gradually contracted, and two redundant factories were closed, so that the scale efficiency rose to 0.957. After 2017, except that the epidemic led to the disruption of the supply chain from 2020 to 2021, the shortage of key components, and the slight decline in scale efficiency, the scale efficiency returned to 1.000 in other years, which means that TR equipment manufacturing enterprises achieved the best allocation of technological innovation resources at this stage. The level of capital utilization is also good, and the return to scale is constant. If the input is increased, the output will not increase accordingly, and the output efficiency is already the best efficiency value under the corresponding input. The key to the recovery of scale efficiency is that TR equipment manufacturing enterprises adopt asset-light mode-outsourcing and cooperative production to reduce the risk of fixed investment. Based on the market demand forecast, the production capacity is dynamically adjusted, the scale efficiency is fully restored through resource integration and accurate production capacity, and the production capacity elasticity is enhanced.

Disclosure statement

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Accelerating the Construction of Remote Medical Service Network in Qinhuangdao City: Countermeasures and Suggestions to Improve Rural Elderly Care Services

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Abstract: With the intensifying aging population, rural elderly care services are facing challenges such as uneven medical resources and inadequate facilities. Taking Qinhuangdao City as an example, this paper explores ways to improve rural elderly care services through the construction of a remote medical service network. This paper analyzes the current status of rural elderly care services in Qinhuangdao City, pointing out that issues such as the uneven distribution of medical resources between urban and rural areas, poor accessibility, and low service quality urgently need to be addressed. The necessity of accelerating the construction of a remote medical network is proposed, including reducing medical costs, optimizing resource allocation, and disease prevention. Specific measures cover aspects such as policy support, integration of medical and elderly care services, talent cultivation, and technology promotion. At the same time, the potential challenges and risks faced by the remote medical service network in improving rural elderly care services are evaluated, and corresponding countermeasures and suggestions are proposed. Research shows that remote medical care can effectively improve the quality of rural elderly care services and help achieve proper medical care for the elderly.

Keywords: Telemedicine; Service network; Rural elderly care services

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1. Research background and significance

1.1. Research background

Since the implementation of the “14th Five-Year Plan,” various regions across the country have taken multiple measures to seize the “window period” to actively address population aging. As China’s aging process accelerates, the issue of caring for rural elderly people has become increasingly prominent. Among them, medical treatment is an important challenge faced by rural elderly people. With the continuous implementation of the Beijing-Tianjin-Hebei coordinated development strategy, the cross-regional allocation of resources has created new opportunities for the development of elderly care services in Qinhuangdao City. However, medical resources in rural areas,

especially in remote mountainous areas, are still relatively scarce. Due to inconvenient transportation and limited medical facilities, rural elderly people still face obstacles in obtaining timely medical services^[1]. As a new medical service model, remote medical services can effectively alleviate the shortage of medical resources in rural areas and improve the level of rural elderly care services.

1.2. Research significance

1.2.1. Remote medical services can effectively alleviate the uneven distribution of medical resources in rural areas

Better medical institutions are usually located in economically developed and conveniently located areas. However, due to factors such as remote geographical location and relatively backward economic conditions, rural elderly people often find it difficult to obtain the same quality of medical services as those in cities^[2]. With the rapid development of information technology, especially the wide application of technologies such as the internet, big data, and cloud computing, it provides strong technical support for remote medical services. By extending high-quality medical resources from cities to rural areas, the equalization of medical services can be achieved, enabling rural elderly people to enjoy the same level of medical services as those in cities.

1.2.2. Remote medical services can effectively improve rural elderly people's self-health management abilities

Under the traditional medical service model, patients often lack understanding and management abilities regarding their health status^[3]. Remote medical services allow doctors to monitor patients' physiological indicators in real-time, detect abnormalities promptly, and provide corresponding treatment suggestions. Simultaneously, through regular health education courses, online Q&A sessions, etc., the efficiency and quality of medical services are improved, significantly enhancing the quality of life and health level of rural elderly people.

This study selects Qinhuangdao City, Hebei Province, as the research subject, aiming to explore how to use technological means, especially information technology applications, to compensate for deficiencies in medical services in rural areas and contribute to improving the rural elderly care service system. By enhancing medical service levels in rural areas, it is possible to not only improve the health status of rural elderly people but also attract more young talents to return to the countryside, thereby driving the comprehensive development of the rural economy. Through the depth of this study, it is hoped that new ideas and solutions can be provided for optimizing China's rural elderly care service system.

2. Current situation and existing problems of rural elderly care medical services in Qinhuangdao City

In recent years, the rural elderly care service in Qinhuangdao City has formed a development pattern that is oriented towards urban-rural integration, with family care as the basic mode, focusing on serving elderly people with special difficulties, and adopting mutual assistance as the main model, continuously expanding services for all rural elderly people. However, facing the challenge of the rural population aging in the new era and the needs of economic and social development, rural elderly care services are still facing a severe situation.

2.1. Current situation of rural elderly care medical services in Qinhuangdao City

Affected by the outflow of the working-age population and the "siphon effect" of cities, the problem of population aging in Qinhuangdao City is particularly prominent in rural areas. According to statistics, the elderly population aged 60 and above in Qinhuangdao City (registered population) has reached 724,500, accounting for 24.12% of

the city's total population. Among them, 520,100 are rural registered elderly people, accounting for 71.8% of the city's total elderly population, mainly distributed in Qinglong Manchu Autonomous County, Changli County, and Lulong County. There are 58 elderly care institutions in the city, including 16 public elderly care institutions and 42 private elderly care institutions, with 9,500 beds and 55% of nursing beds. 82 regional elderly care service centers, 212 day care service facilities, and 1,527 rural mutual aid happy homes have been established. According to the "China City Statistical Yearbook (2022)," there are 86 hospitals in Qinhuangdao City, including 38 non-municipal districts, accounting for 44.19%; there are 15,596 hospital beds, including 4,674 non-municipal districts, accounting for 29.97%; there are 10,601 licensed (assistant) physicians, including 3,542 in non-municipal districts, accounting for 32.56% shown as **Table 1** ^[4]. The distribution of rural elderly care service institutions is still uneven, and there is still a large gap compared with the huge demand for elderly care among rural elderly groups. At the same time, most rural elderly care institutions have insufficient medical and nursing capabilities, and the nursing needs of disabled and partially disabled elderly people cannot be effectively met.

Table 1. Statistical table of hospitals, beds, and doctors in Qinhuangdao City

	City-wide	Municipal district	Municipal district %	Non-municipal districts	Proportion of non-municipal districts
Number of hospitals	86	48	55.81%	38	44.19%
Number of hospital beds	15596	10922	70.03%	4674	29.97%
Number of licensed (assistant) physicians	10601	7149	67.44%	3452	32.56%

2.2. Problems in rural elderly care medical services in Qinhuangdao City

2.2.1. Uneven distribution of medical resources

Medical resources in Qinhuangdao City, such as medical institutions, equipment, and professionals, are mainly concentrated in urban areas. The limited number and outdated equipment of health care institutions in rural areas make it difficult to meet the basic medical needs of the elderly.

2.2.2. Poor accessibility of medical services

Due to inconvenient transportation and limited medical facilities in rural areas, rural elderly people still face obstacles in accessing medical services, especially in emergencies where a fast and effective medical response mechanism is lacking.

2.2.3. Heavy burden of medical expenses

Although the new rural cooperative medical system has alleviated the medical expense burden of rural residents to some extent, for some major diseases, the issue of medical expenses is particularly prominent for rural elderly people with lower incomes.

2.2.4. Low quality of medical services

Due to the lack of professional medical staff and insufficient medical equipment, the quality of medical services in rural areas is generally not as good as that in urban areas.

2.2.5. Outdated medical concepts and weak health awareness

Limited by their educational level and cultural background, some rural elderly people do not pay enough attention to health issues or have delays and resistance to seeking medical treatment, which may lead to delays and deterioration of the disease.

3. The necessity of accelerating the construction of a telemedicine service network in Qinhuangdao City

3.1. Reducing transportation and time costs

Rural elderly people face heavy economic, time, and energy burdens when seeking medical treatment in city hospitals. The inconvenience of travel and long distances affect their willingness to seek medical treatment ^[5]. Building a telemedicine network allows rural elderly people to obtain professional medical advice at home through online services, saving time and money.

3.2. Lowering the hospitalization rate of rural elderly people

Many chronic disease patients among the rural elderly population require long-term monitoring and regular treatment. Frequent medical visits increase the burden of life and the frequency of hospitalization. Doctors can effectively manage chronic diseases and reduce emergency hospitalizations through real-time remote monitoring and timely intervention using home monitoring equipment.

3.3. Improving the efficiency of medical resource utilization

Urban medical centers are rich in expert resources, but rural patients have difficulty accessing the same services due to geographical restrictions. Establishing a telemedicine network can extend advanced resources to rural areas. Experts can transmit knowledge and experience to primary care doctors through remote consultations and education, improving the level of diagnosis and treatment and reducing repeated examinations and unnecessary treatments caused by misdiagnosis and missed diagnosis ^[6].

3.4. Reducing the use of emergency medical services

Telemedicine can identify health risks and intervene daily, reducing acute attacks. Non-emergency situations can be initially judged, reducing reliance on emergency medical services and related costs.

3.5. Providing preventive medical services

The telemedicine service network has a wide coverage capability, able to reach every rural resident who needs health knowledge. It can not only significantly reduce the incidence of chronic diseases caused by unhealthy lifestyles but also help reduce potential future medical expenses to some extent. It plays a positive role in improving residents' health status and optimizing the allocation of medical resources ^[7].

4. Measures to improve rural elderly care services through telemedicine in Qinhuangdao City

4.1. Strengthening institutional normalization guidance to further accelerate the construction of telemedicine services in Qinhuangdao City

Adhere to the basic principles of government leadership, social and market coordination, overall development, and security, increase financial investment in the construction of telemedicine networks, and formulate policies to encourage multi-party participation. The government has set up special funds to support infrastructure construction and guide medical resources to be inclined toward rural areas, including encouraging city doctors to serve in rural areas and improving the treatment of rural medical staff ^[8].

4.2. Strengthening the diversified construction of elderly care services and continuously improve the quality of integrated medical and elderly care services

Plan the development of the pension industry by local conditions, encourage rural public pension institutions

to carry out public-private partnerships through contracting, entrusted operations, etc., and encourage qualified counties (districts) to establish state-owned pension service enterprises to uniformly operate public pension institutions within the county. Establish an urban-rural collaboration mechanism by combining the capital, technology, and market advantages of the city with the environmental, spatial, and human advantages of the countryside. Combining the construction of Qinhuangdao's "One Comprehensive, One Specialized, and One Central" national regional medical center promotes the expansion and sinking of high-quality medical resources and the balanced layout of the region. Accelerate the construction of a telemedicine service platform connecting medical institutions in rural areas with large hospitals in urban areas. Encourage medical institutions to sign cooperation agreements with pension institutions to provide medical, rehabilitation, nursing, and other services to achieve resource sharing and mutual benefit ^[9].

4.3. Strengthening the promotion of rural medical and elderly care services, and guide the updating of the traditional concept of "medical treatment for the elderly"

Actively promote the implementation of the basic elderly care service list, strengthen the care services for disabled elderly in public pension institutions, continue to implement the construction and renovation of public pension institutions, and improve the ability to care for disabled elderly. Gradually change the traditional concept of rural elderly people about medical treatment for the elderly through policy support, propaganda, organizing professional medical staff or volunteers to regularly conduct health lectures and educational activities in rural areas, and guide the elderly to establish a scientific concept of elderly care. Establish a demonstration site for integrated medical and elderly care services in some rural areas so that the elderly can see the actual effects of integrated medical and elderly care services, effectively enhancing the trust of rural elderly people.

4.4. Strengthening talent cultivation and subsidy policies to provide remote health education and consulting

Improve the training mechanism for elderly care talents, strengthen pre-job and on-the-job training for elderly care practitioners. Improve the incentive mechanism for elderly care talents, encourage pension institutions to hire elderly care nursing staff who have obtained professional skill level certificates, and promote the professional development of the industry. Support vocational colleges (including technical schools) to offer relevant majors or courses in elderly care services, explore the development of qualified pension institutions into practical training sites, and guide students to seek employment in the pension service industry. Hold vocational skills competitions for elderly care nursing to continuously improve the quality of elderly care practitioners. Encourage rural elderly people to sign family doctor services with township health centers and provide timely medical advice and intervention through the telemedicine platform ^[10]. Provide remote medical technology training for rural medical institution staff in batches to ensure that they are proficient in the use of remote medical equipment, thus providing high-quality remote medical services.

4.5. Exploring remote medical reimbursement policies and promoting smart health equipment

Explore and formulate a reimbursement policy for telemedicine services to reduce the economic burden on rural elderly people. At the same time, guide rural elderly people to use smart health monitoring equipment, such as smart bracelets and blood pressure monitors. These devices can be connected to the telemedicine platform to monitor the health status of the elderly in real-time, effectively reducing the phenomenon of "delaying treatment for minor illnesses, enduring major illnesses, and only going to the hospital when close to death" among rural elderly people.

5. Conclusion

Accelerating the construction of a telemedicine service network in Qinhuangdao City and improving the level of rural elderly care services are not only specific actions to respond to the national call and implement the rural revitalization strategy but also important measures to address the challenge of population aging. Governments, medical institutions, enterprises, and social forces should participate together, starting with policy support, integration of medical and elderly care, construction of elderly care service facilities, talent cultivation, and subsidy policies, to jointly promote the improvement of rural elderly care services. By optimizing the development environment of elderly care services, promoting smart elderly care services, strengthening publicity, and improving the elderly care service system, we can provide better quality and convenient elderly care services for rural elderly people, achieving the goal of providing care and medical services for the elderly. By improving the level of rural elderly care services, we can effectively alleviate the social pressure brought about by the aging of the rural population and promote social stability and harmonious development.

Disclosure statement

The author declares no conflict of interest.

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Perspective on Mergers and Acquisitions: Exploring Financial Management Issues and Forward-looking Management Strategies

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Abstract: This article focuses on financial management issues in mergers and acquisitions (M&A). It provides an in-depth analysis of the financial risks and management challenges faced by contemporary businesses during various stages of M&A, such as pre-merger valuation pricing difficulties, unreasonable financing structures, risks in payment method selection, obstacles to financial integration, and lack of risk management. Targeted management strategies are proposed to address these issues. This paper suggests strengthening due diligence and valuation management, optimizing financing structures, rationally selecting payment methods, deepening financial integration, and improving tax planning. These strategies aim to enhance the level of financial management in M&A, promote economic synergies and management effects, help companies quickly achieve M&A goals, and drive sustainable business development.

Keywords: Mergers and acquisitions; Financial management; Management strategies; Financial risks; Synergies

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1. Introduction

In the context of economic globalization and increasingly fierce market competition, companies often choose mergers and acquisitions (M&A) to integrate resources and expand their market presence to achieve rapid expansion and breakthroughs in a complex and changing business environment, thereby enhancing their core competitiveness^[1]. M&A has become a crucial strategic tool for businesses. Financial management, as the core component of M&A activities, permeates every stage of the process, from valuation of the target company and financing planning before the merger to the choice of payment methods and tax planning during the merger and, finally, to financial integration and risk monitoring after the merger. Decisions made at each stage directly impact the success or failure of the M&A^[2]. Therefore, a deep analysis of financial management issues in corporate M&A, coupled with the development of scientific and effective management strategies, not only helps to optimize resource allocation, reduce financial risks, and increase the success rate of M&A, but also has significant practical implications for the long-term development and sustainable operation of businesses.

2. Overview of relevant theories on corporate mergers and acquisitions

2.1. Forms of corporate mergers and acquisitions

Classification based on industry relationship: Corporate mergers and acquisitions can be divided into horizontal M&A, vertical M&A, and conglomerate M&A. Among them, horizontal M&A refers to mergers and acquisitions between enterprises that produce or operate similar products within the same industry, aiming to enhance market competitiveness through “strong alliances.” Vertical M&A involves enterprises at different stages of production and operation, with forward M&A expanding downstream and backward M&A extending upstream. Conglomerate M&A, on the other hand, involves parties from different industries, aiming to diversify risks through diversified operations ^[3].

Classification based on payment methods: Corporate mergers and acquisitions can be categorized into cash M&A, equity M&A, and mixed M&A. Cash M&A refers to the acquisition of target company shares or assets by paying cash. Equity M&A involves the issuance of shares to acquire the equity of the target company, avoiding large cash outflows. Mixed M&A, on the other hand, utilizes a combination of cash, equity, bonds, and other payment methods, flexibly adjusting the payment ratio to balance funding pressure and equity dilution risk. Additionally, it can expand funding sources through bond financing to meet different M&A needs.

Classification based on M&A attitude: Corporate mergers and acquisitions can be divided into friendly M&A and hostile M&A. Friendly M&A is achieved through friendly negotiation and consensus, with the M&A process proceeding according to mutually agreed-upon conditions and procedures. Hostile M&A, also known as a malicious takeover, involves making a takeover offer directly to shareholders without negotiating with the target company’s management. It is often accompanied by anti-takeover measures from the target company, such as poison pills or white knight strategies. The M&A process is often full of twists and turns and may even lead to legal disputes.

2.2. Basic process of corporate mergers and acquisitions

In the early stage of corporate mergers and acquisitions, companies need to clarify their M&A strategy, goals and assemble a professional M&A team consisting of internal executives, financial and legal personnel, as well as external investment banks, accounting firms, law firms, and other relevant personnel. Simultaneously, market research should be conducted to screen potential target companies, followed by due diligence covering various aspects such as finance and legal issues ^[4]. Afterwards, valuation methods like discounted cash flow should be employed to assess the value of the target company, determine a reasonable acquisition price range, and provide a reference for subsequent negotiations.

In the mid-stage of corporate mergers and acquisitions: Based on the results of due diligence and valuation, companies develop negotiation strategies, clarify key terms such as acquisition price, payment methods, and equity structure, and conduct multiple rounds of negotiations with the target company. After reaching an agreement, an M&A agreement is signed, stipulating transaction terms, delivery conditions, transitional arrangements, etc.

In the later stage of corporate mergers and acquisitions, following the signing of the M&A agreement, the company submits the M&A plan to the board of directors and shareholders’ meeting for review and approval according to internal decision-making procedures, ensuring alignment with the overall interests and development strategy of the company. If external procedures such as anti-monopoly review and industry regulatory approval are involved, an application needs to be submitted to the government authorities for approval. Meanwhile, a financing plan is developed based on the payment method and funding requirements, raising funds through internal fund allocation, bank loans, bond issuance, equity financing, and other means ^[5]. Finally, in the later stage of corporate mergers and acquisitions, asset delivery and debt undertaking are completed according to the M&A agreement, assets of the target company are inventoried and evaluated, and debts are sorted and integrated. Both parties’

businesses are integrated, processes are optimized, and resource sharing and synergistic effects are achieved. The organizational structure is adjusted based on the company's strategic planning and business needs, responsibilities and authorities are clarified, personnel are reasonably arranged, and operational efficiency is improved. Emphasis is placed on corporate culture integration, conflicts are resolved through communication and training, staff placement and incentives are implemented, the staff team is stabilized, and sustainable development of the company is ensured.

2.3. Synergistic effects of corporate mergers and acquisitions

One of the core motivations of corporate mergers and acquisitions is to achieve synergistic effects, which mainly cover three key aspects: Operating synergy, financial synergy, and management synergy. Taking *Midea Group's* acquisition of *Little Swan* as an example, the explanation is as follows.

Operating synergy: After corporate mergers and acquisitions, economies of scale can be achieved by expanding production scale ^[6]. After *Midea's* acquisition of *Little Swan*, the operating synergy effect was significant. In terms of manufacturing, production resources were integrated, the production line layout was optimized, economies of scale were achieved, and unit production costs were reduced. Simultaneously, utilizing *Midea's* extensive sales channels, the market coverage of *Little Swan* products was further expanded, increasing sales. In the research and development phase, technical teams from both sides exchanged and cooperated, accelerating the development speed of new products and launching more innovative products that meet consumer demands.

Financial synergy: Through mergers and acquisitions, companies can allocate funds reasonably. Relying on its strong financial strength and financing capabilities, *Midea* improved *Little Swan's* financial status and reduced its financing costs. By reasonably allocating funds, it improved fund usage efficiency and provided strong financial support for business expansion on both sides.

Management synergy: When a company with a higher management level acquires a company with relatively weak management, excellent management experience can be disseminated and shared ^[7]. *Midea* introduced mature and advanced management experience and operating models into *Little Swan*, optimizing its internal management processes, improving management efficiency, making various aspects of *Little Swan's* business operations more standardized and efficient, and significantly improving its overall operational level.

3. Common financial management issues in contemporary corporate mergers and acquisitions

3.1. Valuation and pricing challenges before mergers and acquisitions

Due to information asymmetry, it is difficult for the acquirer to fully understand the true financial status and potential risks of the target company, leading to valuation deviations ^[8]. The target company may mislead the acquirer by concealing debts, inflating assets, or other means, increasing the risk of mergers and acquisitions. Additionally, improper selection of valuation methods, such as the price-earnings ratio method being greatly affected by industry fluctuations or the discounted cash flow method relying on inaccurate predictions, can all lead to valuation deviations.

3.2. Dilemma of unreasonable financing structure

Corporate mergers and acquisitions often require significant financial support, and the choice of financing channels and financing structure directly affects the success or failure of mergers and acquisitions and financial stability ^[9]. Over-reliance on debt financing can increase the asset-liability ratio, leading to financial risks, while

over-reliance on equity financing can dilute the control of original shareholders, causing conflicts of interest and affecting the stable operation of the company. Furthermore, improper timing of financing, such as conducting debt financing when market interest rates are high, can also increase financing costs.

3.3. Risks of payment method selection

Although cash payment is simple and direct, it can increase financial pressure and affect liquidity. Equity payment, while avoiding cash outflow, can dilute equity, weaken the voice and decision-making power of original shareholders, and may even lead to battles for control. Mixed payment, while combining the advantages of cash and equity payments, can expose the drawbacks of both if the proportion of cash to equity is not properly balanced, increasing the risk of mergers and acquisitions ^[10].

3.4. Obstacles to financial integration

Financial integration after mergers and acquisitions is a key link to achieving synergistic effects involving various aspects such as accounting systems, financial management systems, and fund management. Inconsistent accounting policies and estimation methods among different companies may lead to a lack of comparability in financial data, affecting the financial analysis and decision-making of the company. In terms of fund management, if funds cannot be effectively integrated, problems such as fund dispersion and inefficient use may arise.

Corporate mergers and acquisitions involve complex tax issues, and reasonable tax planning can reduce merger and acquisition costs and improve merger and acquisition benefits. However, improper tax planning may lead to increased tax burdens or tax disputes ^[11]. For example, if the tax impact is not fully considered during the transaction structure design phase and a higher tax burden scheme is selected, or if the tax treatment in asset transfers, debt restructuring, and other aspects does not comply with relevant regulations, it may increase the tax risk of companies having to pay additional taxes, late fees, or even heavy fines.

3.5. Lack of risk management

There are various risks in the process of mergers and acquisitions, such as market risk, credit risk, and operational risk. If companies underestimate risks before mergers and acquisitions and lack effective risk management measures, it may lead to risk events and bring huge losses to the company.

4. Management strategies for financial management in contemporary corporate mergers and acquisitions

4.1. Strengthening due diligence and valuation management before mergers and acquisitions

To achieve accurate valuation and pricing, enterprises need to collect target enterprise information from all directions and channels ^[12]. In addition to consulting regular materials such as financial statements and audit reports, it is also necessary to deeply investigate the business operation details, market reputation and upstream and downstream partnerships of the target enterprise. You can communicate with the suppliers and customers of the target enterprise to understand its real operating conditions and latent risks. In the process of mergers and acquisitions, to ensure that the value evaluation of the target enterprise is scientific and reasonable, the comprehensive application of multiple value evaluation methods can effectively reduce the limitations of using a single method. At the same time, it is necessary to have a comprehensive and in-depth understanding of the financial status, operating results, and asset quality of the target enterprise. Carefully review the authenticity and accuracy of financial statements, verify the ownership of assets, investigate potential liabilities, and avoid falling into the trap of value assessment. In the financing process, it is crucial to reasonably determine the scale of

financing. Taking into account factors such as merger price and integration cost, accurately estimate the required financing amount to prevent excessive financing from increasing costs or insufficient financing leading to merger failure. In addition, it is also necessary to optimize the financing structure, and consider the ratio of debt financing to equity financing in combination with the company's own financial situation and market environment.

4.2. Optimizing the financing structure of enterprises

Enterprises should formulate scientific and reasonable financing plans according to their own financial situation, business objectives, and risk tolerance. Enterprises can broaden financing channels, rationally arrange financing structures, and reduce financing costs and risks ^[13]. On the other hand, the rational use of the tax shield effect of debt financing can reduce financing costs, but to avoid an excessive asset-liability ratio, a reasonable debt ceiling needs to be set to ensure that enterprises still have sufficient solvency in the face of operating fluctuations. On the other hand, it is necessary to use equity financing cautiously and fully evaluate the impact of equity dilution on existing shareholders' equity and corporate control. Diversified financing channels can be tried. In addition to bank loans and the issuance of stocks and bonds, strategic investors can also be considered. While obtaining funds, they can use their industry resources and management experience to help enterprises develop.

4.3. Reasonable choice of payment methods

When choosing M&A payment methods, enterprises should fully consider their own capital status, equity structure, and M&A goals. Cash payments are a good option if the company is well-funded and wants to maintain stable control, but ensure that it does not put too much pressure on subsequent operations. Equity payments can relieve capital pressure if the company's cash flow is tight and the acceptance of equity dilution is high. However, for most M&A transactions, hybrid payment methods are more flexible. Companies can flexibly adjust the proportion of payment instruments such as cash, equity and bonds according to the negotiation results and actual needs of the two parties to the acquisition.

To achieve accurate valuation pricing, companies need to collect comprehensive information about the target company through multiple channels. Besides reviewing financial statements, audit reports, and other routine materials, in-depth investigations into the target company's business operations, market reputation, and upstream and downstream partnerships are also required. Communications with the target company's suppliers and customers can provide insights into its true operating conditions and potential risks.

4.4. Deepening financial integration after mergers and acquisitions

After the completion of mergers and acquisitions, it is crucial to quickly unify the accounting system ^[14]. Firstly, a unified financial strategy and system should be established, and communication and integration between financial personnel should be actively promoted to enable both teams to work together. At the same time, clear and unified accounting policies and estimation methods should be established to ensure the consistency and comparability of financial data, laying a solid foundation for financial analysis and decision-making. In terms of fund management, a centralized fund management platform should be established, and the financial information system should be integrated to achieve real-time sharing of financial data. This allows corporate management to effectively monitor the capital situation and fully leverage financial synergies. Regarding financial system integration, the financial accounting system, approval process, and financial reporting system of both parties in the merger and acquisition should be unified to provide a unified standard for financial management and ensure the accuracy and consistency of financial information. Additionally, companies need to establish a financial risk monitoring mechanism, set warning lines for key financial indicators such as asset-liability ratio, current ratio, and net profit growth rate, and pay close attention to the company's financial situation in real-time. Once potential risks are identified, early

warning signals should be issued promptly. Furthermore, continuous evaluation of M&A performance is essential. Regular financial performance evaluations should be conducted on the merged company, and the results should be compared with the expected goals before the merger to identify deviations and adjust business strategies and financial management measures promptly to achieve the expected value of the merger.

4.5. Improving tax planning

Before the merger, the company should establish a professional tax team to study national and local tax policies, especially preferential policies and special provisions related to mergers and acquisitions^[15]. When designing the transaction structure for mergers and acquisitions, the tax impact of different options should be fully considered, and the option with the lightest tax burden should be selected^[16]. For example, by utilizing special tax treatment provisions, reasonable arrangements can be made for the transfer of assets and equity, deferring tax payment time and reducing the tax burden during the current period of the merger. In the integration process after the merger, continuous attention should be paid to changes in tax policies, and tax planning schemes should be adjusted promptly to ensure compliance with tax treatments and avoid tax risks.

The financial management issues in corporate mergers and acquisitions are complex and diverse, spanning various stages of the merger and acquisition process. Companies need to fully understand the importance of these issues, adopt effective management strategies, strengthen financial management in all links, reduce financial risks, achieve the expected goals of mergers and acquisitions, and enhance the comprehensive competitiveness and sustainable development capabilities of enterprises. In practice, companies should continuously adjust and improve their financial management strategies based on their own characteristics and market environment to adapt to the changing merger and acquisition environment.

Disclosure statement

The author declares no conflict of interest.

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Research on the Integration Strategy of Hainan Free Trade Port's International First-Class Convenient Business Environment System

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Abstract: With the development of global economic integration, building a world-class facilitating business environment has become an urgent need for Hainan Free Trade Port. To solve the existing problems in financial policies, legal supervision, and other aspects, this paper takes Hainan Free Trade Port as an example to analyze and study its institutional integration strategy for creating a world-class facilitating business environment. The specific integration strategies are summarized to promote the internationalization and facilitation of the business environment of Hainan Free Trade Port and promote the high development of the local economy.

Keywords: Hainan Free Trade Port; Business environment system; Integration strategy

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1. Introduction

Since the release of the Overall Plan for the Construction of Hainan Free Trade Port, Hainan Free Trade Port has been committed to achieving the grand goal of a “first-class business environment in China by 2025 and better business environment by 2035.” In this process, Hainan closely follows the spirit of the instructions of the Party Central Committee on the construction of a business environment and high-quality development of financial services of the Free Trade Port. It takes “creating a world-class business environment” as its core task and actively promotes the optimization of the business environment through institutional integration and innovation. At present, these efforts have achieved obvious results, reflected in a series of fruitful institutional innovations. However, how to define the world-class facilitating business environment, break through the existing barriers, and quickly build a top business environment that can support the smooth closure and operation of Hainan Free Trade Port is still a topic that needs in-depth discussion. Based on this paper, these issues are systematically studied, and theoretical and practical guidance is provided for the future development of Hainan Free Trade Port.

2. Analysis of the current business environment of Hainan Free Trade Port

2.1. Policy environment

The construction of the Hainan Free Trade Port, especially the optimization of its business environment, is seen as a key part of China's broader reform and opening-up strategy. According to multiple directives and plans of the Chinese central government, the Hainan Free Trade Port not only needs to play a leading role in the domestic market but also needs to demonstrate China's open attitude and efficient market operation capability internationally. In 2018, the Guiding Opinions of the CPC Central Committee and the State Council on Supporting Hainan in Comprehensively Deepening Reform and Opening Up clarified the strategic positioning of Hainan Free Trade Port, pointing out that it is necessary to comprehensively deepen reform and opening up and create a world-class business environment. Thereafter, the Overall Plan for the Construction of Hainan Free Trade Port issued in 2020 provided a detailed timetable and task book. It has set clear goals and phased results for the reform of Hainan's policy environment and regulatory framework. The report of the 20th National Congress of the Communist Party of China further emphasized the necessity of accelerating the construction of Hainan Free Trade Port, especially to create a market-oriented, law-based and international business environment that meets international standards, which reflects the great importance of the Chinese government to the reform of the business environment of Hainan Free Trade Port and its role in the global economy ^[1].

At present, the policy environment of Hainan Free Trade Port is still under active construction, and the main task is to integrate international best practices into local legal framework and administrative management to ensure policy transparency, consistency, and enforcement. The whole reform process needs to balance innovation and risk management and introduce international advanced experience and wisdom. To achieve the "rule of law, internationalization, facilitation" business environment standards, which is not only the central Committee of the directive task, but also the core requirements for the successful transformation of Hainan Free Trade Port. Through these policies and structural reforms, Hainan Free Trade Port aims to form a more mature business environment framework by 2025, lay a solid foundation for the scheduled closure operation, and thus form a good investment and economic activity center at home and abroad. This series of policy support and strategic deployment aims to ensure that Hainan Free Trade Port can meet the international first-class business environment standards as scheduled. To achieve China's broader strategic goals and promote the further development of the regional and even global economy ^[2].

2.2. Economic environment

The economic environment of Hainan Free Trade Port is built based on its highly open economic policy, which provides solid support for its creation of a world-class business facilitation environment. For a long time, Hainan's development strategy has not been clear, which has led to its relatively low development quality and level. However, with the strategic positioning of "three districts and one center" determined, committed to building a free trade port with the highest openness in the world, Hainan began to step into the track of high-quality development ^[3].

To achieve a high standard and high-level docking with internationally renowned free trade ports, Hainan has taken comprehensive consideration of its economic structure and foreign investment attraction. At present, Hainan has adopted various measures to optimize its industrial layout and promote the expansion of tourism, service and high-tech industries, which are easy to obtain international investment and integrate with the international market. By simplifying administrative procedures and optimizing the tax policy and regulatory environment, Hainan seeks to create a transparent and efficient business environment to enhance its competitive strength in the global economic system. In this practice, Hainan should not only imitate the model of other successful free trade zones, such as Singapore and Hong Kong, but should combine its own characteristics and practical situations, draw on and apply these experiences creatively ^[4], learn from Singapore's "one-stop" service mechanism, and streamline

business establishment and operation procedures by integrating various government services. At the same time, maintaining the efficient and transparent level of the government service system, adopting the tax strategy of the world-famous free trade port, such as adopting a more scientific and reasonable tax model, can improve the sustainable level of Hainan Free Trade Port's finance, and attract more foreign enterprises to invest capital. After completing the above strategic adjustments, stimulating Hainan Free Trade Port is expected to form a truly world-class business environment pattern and has obvious advantages in the economic environment ^[5].

2.3. Technology and innovation environment

In terms of the technology and innovation environment of Hainan Free Trade Port, as an economic region seeking to achieve the international first-class business environment standards, it is necessary to focus on improving its scientific and technological innovation ability and information infrastructure construction level. The allocation and utilization efficiency of the scientific and technological resources of Hainan Free Trade Port is one of the key pillars of its technological innovation. The concentration of scientific research institutions, the support of high-tech enterprises, and the degree of connection with the global innovation network are directly related to the transformation rate of innovation achievements and the pace of scientific and technological progress in the region. Cutting-edge information infrastructure, such as data centers, broadband network coverage, and cloud computing services, is the core component of modern enterprise operation. The construction level of such information infrastructure in Hainan Free Trade Port will directly affect its strength in attracting high-end technology enterprises at home and abroad, as well as the overall data processing and network communication efficiency of the port area. The implementation effect of policy support and incentive means is equally critical. The policy environment composed of tax incentives, research and development subsidies, intellectual property protection and other aspects jointly forms the overall framework foundation of the technological and innovation environment of Hainan Free Trade Port and plays a key role in promoting the rapid development of scientific and technological innovation and high-tech industry in the region ^[6].

3. There are problems in the business environment of Hainan Free Trade Port

As a major strategic platform for China's opening up to the outside world, Hainan Free Trade Port has taken many forward-looking steps in optimizing the business environment, but in the actual operation and governance process, the region still faces a series of complex challenges and constraints. First of all, although many local systems have been introduced to optimize the business environment, it is found in practice that these systems are often not mature and stereotypical, there are problems of fragmentation, low integration, and weak digital foundation, especially in the process of matching with the highest international economic and trade rules. The legal system in key areas such as intellectual property protection, closure operation, fair market competition, and risk avoidance is not yet complete, which limits the competitiveness and attractiveness of Hainan Free Trade Port in the international arena ^[7].

Secondly, Hainan Free Trade Port still faces great challenges in taking into account the interests of all parties and coordinating and regulating the operation behaviors and interest demands of market players. Market players often face rent-seeking behaviors of power, which further undermines industry rules and erodes business ethics, posing a serious threat to the business environment. Meanwhile, the unclear definition of the relationship between the government and the market is also a prominent problem. The boundary between government functions and market functions is chaotic, and it is impossible to ensure that the market plays a decisive role in resource allocation. In addition, talent shortage is also a key factor restricting the development of the Hainan Free Trade Port. Both the professional talents needed for the construction of the free trade port and the overall working quality

of government officials have problems such as insufficient quantity, low quality, and poor structure. Problems such as lazy work style, weak working ability, and low efficiency, which are prevalent in civil servants, further aggravate the impact of talent shortage^[8].

Finally, the complexity of the external environment has brought long-term uncertainties, the turbulence in the political and economic development of international trade caused by unilateralism and protectionism, as well as unpredictable major political risks, public emergencies, and natural ecological changes, all pose huge challenges to the stable development of Hainan Free Trade Port. In the context of the technological revolution in the information age, although Hainan has made certain progress by relying on the national quality infrastructure, a new nationwide system has not yet been formed in the process of optimizing the business environment, and the national quality infrastructure competitiveness index and efficiency evaluation system have not been effectively coupled with the optimization of the business environment. Finally, the implementation of “invite in” and “go out” strategies faces many challenges.

4. Hainan Free Trade Port to create a world-class facilitation business environment system integration innovation strategy

4.1. Policy formulation and optimization

In terms of the formulation and optimization of the Hainan Free Trade Port policy, an advisory committee consisting of experts, scholars, and industry leaders should be established at the beginning. The committee will monitor global economic dynamics, trends and adjust local policies based on this information to ensure that Hainan’s policies meet international standards and can quickly respond to changes in the global market. In this stage, policy formulation should highlight data-driven and result-oriented requirements, further collect and analyze a large number of economic, commercial and social data, with the support of these data, policy makers can more accurately identify problems, plan more effective policy measures, and implement regular policy evaluation measures to evaluate the effectiveness of existing policies. This continuous cycle of feedback and improvement is the key to improving policy adaptability and practical effectiveness. Hainan Free Trade Port should optimize the process of policy communication and implementation, ensure the efficient and transparent implementation of policies, reduce the redundancy of policy documents, clarify policy contents in clear and straightforward language, and further accelerate the popularization and implementation of policies with the help of digital measures, and take into account the coordination between regions. As a key example of special economic zone, Hainan Free Trade Port should not only meet the requirements of local development but also consider the interaction and effect with other regions in China and even the international market. By promoting policy coordination and overall planning, resource waste and policy conflicts can be prevented, and the comprehensive performance of policies can be expanded^[9].

4.2. Economic opening and market access

When building a reasonable strategy for economic opening and market access of Hainan Free Trade Port, two aspects should be focused on comprehensively reducing the entry threshold of foreign enterprises and building a fair competition environment. The government needs to re-integrate and streamline the existing administrative approval procedures to achieve efficient and transparent market access processes, including making all relevant approval processes of market access digital. To achieve one-stop seamless services, so that enterprises in the registration and business process of the time and operating costs to reduce, for specific related fields, such as finance, education and medical fields, can take the industry franchise approach, establish uniform standards and norms to ensure market supervision to encourage new enterprises to enter. Adjust the current trade restriction

regulations, weaken tariff barriers, break non-tariff barriers, such as quotas, licenses and other regulatory means, to ensure that domestic and foreign enterprises in the import and export links to obtain the same status, this measure will stimulate the international trade activities of Hainan Free Trade Port, enhance the dynamic vitality and competitiveness of the market, must further promote the negative list management mode. Accurately list the industries that are prohibited and restricted, fully liberalize the industries that are not included in the list, to minimize administrative interference and create a more relaxed and free business environment. A sound mechanism for enterprise complaints should be established to ensure that all participants entering the market can be timely and proper manner when facing market access problems. Establishing an independent regulatory body to conduct supervision and evaluation to ensure the fairness and effectiveness of policy implementation ^[10].

4.3. Technical support and innovation incentives

In creating a world-class business facilitation environment in Hainan Free Trade Port, technical support and innovation incentives play a core role. With the development of digital technology and the digital economy, the government should increase investment in the construction of basic digital infrastructure, ensure network coverage of the whole area, high speed and security, focus on the development of broadband and 5G networks, and form a wide coverage of high-speed communication networks. To provide stable and reliable data transmission services. Then, the government needs to formulate and implement a series of policies to promote the growth of high-tech enterprises, especially in frontier science and technology fields such as artificial intelligence, big data, and cloud computing. By providing tax incentives, research and development subsidies, innovation credit, and venture capital, the operating costs and market risks of innovative enterprises can be effectively reduced, and enterprises can be encouraged to increase technological innovation ^[11].

In terms of enabling digital technology, the government should build an intelligent government service platform, further expand the scope of a more comprehensive e-government system, realize the digitization of administrative approval, resource allocation, public services and data management, and reduce the time and economic cost of obtaining services for enterprises and the public. This platform can not only realize the function of online service but also reduce the time and economic cost of obtaining services ^[12]. It can also give real-time feedback on the processing status, strengthening the level of government transparency and response. To further promote the protection of enterprises' intellectual property rights, the government should use blockchain and other technologies to improve the safety and efficiency of the intellectual property registration, supervision, rights protection and transaction processes, build and complete intellectual property databases and online service systems, simplify the process of intellectual property application and rights protection, and ensure reliable protection of innovation achievements. The government also needs to make efforts to create an innovation-friendly legal environment, appropriately set the legal framework for technological innovation and application, revise and improve various laws and regulations related to the development of digital technology, ensure that it can promote the growth of technology, and successfully solve the legal troubles in the application of new technology, and provide a clear and stable legal environment for science and technology enterprises ^[13].

4.4. Regulatory simplification and transparency

In the process of promoting the simplification and transparency of regulations, it is necessary to conduct a comprehensive review of existing laws and regulations, screen out redundant, outdated, or contradictory provisions, and modify or abolish them, especially in the relevant aspects of enterprise registration and approval process. By merging multiple approval steps ^[14], a one-stop service mechanism can be adopted to reduce the start-up time and operating costs of enterprises. Opening up an e-government platform to enable online applications and

approvals will not only improve the overall efficiency but also enhance the transparency of processing operations. In terms of enhancing legal transparency, we should ensure that all laws, policies and other regulations are open and accessible to the public, and the terms are plain and easy to understand. We should release policy updates and interpretations through the official website following the established time to ensure timely and accurate information, assist enterprises and the public to better grasp the legal environment, and build a feedback bridge. Allow the public and enterprises to express opinions and suggestions on the existing regulations, improve the adaptation level of the legal framework, and promote the transparency of government work and the improvement of public trust ^[15].

5. Conclusion

In conclusion, as Hainan Free Trade Port continues to deepen the pace of opening up and reform, it is particularly critical to create a world-class business facilitation environment. By analyzing the current policy, economic, and technical environment, this paper puts forward a series of practical strategic suggestions. These strategies aim to comprehensively enhance the business environment of the Hainan Free Trade Port through various measures, such as policy formulation and optimization, wider opening of economic markets, simplification and transparency of regulations, and enhanced technical support and innovation incentives. Practice will prove that these integrated strategies, if effectively implemented, will greatly promote the international competitiveness of Hainan Free Trade Port and contribute new impetus to China's economic development. In the future, the development of Hainan Free Trade Port needs to constantly evaluate and adjust its strategies to ensure the synchronous progress with international standards while fostering a new era of openness and mutual prosperity.

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Financial Data Security Management in the Era of Big Data

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Abstract: In the era of big data, the financial industry is undergoing profound changes. By integrating multiple data sources such as transaction records, customer interactions, market trends, and regulatory requirements, big data technology has significantly improved the decision-making efficiency, customer insight, and risk management capabilities of financial institutions. The financial industry has become a pioneer in the application of big data technology, which is widely used in scenarios such as fraud detection, risk management, customer service optimization, and smart transactions. However, financial data security management also faces many challenges, including data breaches, privacy protection, compliance requirements, the complexity of emerging technologies, and the balance between data access and security. This article explores the major challenges of financial data security management, coping strategies, and the evolution of the regulatory environment, and it looks ahead to future trends, highlighting the important role of artificial intelligence and machine learning in financial data security.

Keywords: Big data; Artificial intelligence; Data security; Privacy protection

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1. Introduction

Big data refers to large amounts of structured and unstructured data generated at high speed from a variety of sources. In finance, this includes transaction records, customer interactions, market trends, and regulatory requirements. The integration of big data analytics with financial services improves decision-making processes, enhances customer insight, and develops more effective risk management strategies. Big data is transforming the financial industry, offering great potential to shape future research and applications^[1]. It has three key characteristics: large scale, high dimension, and complex structure, and it is pushing the boundaries of fundamental questions in various areas of finance, including corporate finance, market microstructure and asset pricing.

The financial sector has become one of the fastest growing adopters of big data technology, with banking, insurance, securities, and investment services leading the way^[2]. Big data analytics in the financial sector covers a wide range of applications, such as fraud detection, risk management, customer service optimization, and smart trading. The combination of big data with artificial intelligence (AI) has further transformed the industry

by changing the way data and information are generated, processed, and incorporated into the decision-making process ^[3].

In summary, big data has become a key asset in the financial sector, enabling more efficient contracting and risk-sharing among corporate stakeholders. As the field continues to evolve, researchers and professionals must combine expertise in the financial sector with state-of-the-art data analytics skills to take full advantage of the opportunities offered by big data and analytics tools. However, challenges remain, including data security, privacy concerns, and the need for advanced system architecture to handle the massive data and critical latency requirements in financial analytics ^[4].

2. Challenges for financial data security management

In the era of big data, financial data security management is faced with unprecedented complex challenges. As financial institutions increasingly rely on huge data sets for decision-making and operations, issues such as data breaches, privacy protection, compliance requirements, the complexity of emerging technologies, and the balance between data access and security are becoming more prominent. These challenges not only threaten the normal operations of financial institutions but can also have a serious impact on customer trust and industry reputation.

2.1. Data breaches and privacy

Financial institutions handle large amounts of sensitive information, including customers' personally identifiable information, transaction records, and financial data, which are highly attractive to cybercriminals. Big data platforms often store huge amounts of high-value information, which makes them prime targets for hackers ^[5]. Moreover, the highly interconnected nature of the financial data ecosystem further increases the possibility of unauthorized access, leading to a significant rise in the risk of privacy violations.

The complexity of managing personal information in the big data environment requires financial institutions to adopt strong data protection measures to uphold individual privacy rights and ensure ethical practices. However, as the volume of data continues to grow and the flow of data accelerates, traditional security measures have struggled to meet the demand. Financial institutions need to adopt more advanced technical means, such as encryption and multi-factor authentication, to deal with the threat of data breaches.

2.2. Compliance requirements

Financial institutions must also contend with increasingly stringent compliance requirements. Regulatory frameworks across the globe, such as the General Data Protection Regulation (GDPR) and the Gramm-Leach-Bliley Act (GLBA), have set higher standards for data protection ^[6]. These regulations require financial institutions to comply with strict legal requirements during data collection, storage, and processing to ensure the security of customer data.

However, navigating these complex regulatory frameworks is not easy task, especially among financial institutions operating in multiple jurisdictions. Legal requirements can vary across countries and regions, making it necessary for financial institutions to devote significant resources to ensuring compliance. This includes establishing comprehensive compliance strategies such as regular audits, staff training, and the implementation of best practices to ensure that data processing practices meet legal requirements.

2.3. Emerging threats and technological complexity

The dynamic nature of big data also presents challenges related to the speed and amount of information. The rapid generation and processing of data require flexible security solutions that can adapt to the ever-changing

threat landscape ^[7]. In addition, emerging technologies such as artificial intelligence (AI) and machine learning (ML) present both opportunities and challenges in the field of data security. On the one hand, these technologies can enhance threat detection and response capabilities, enabling financial institutions to identify and respond to potential security risks more quickly. On the other hand, the complexity of these technologies could also introduce new vulnerabilities. For example, AI and ML models could be subject to data poisoning attacks or algorithmic bias that could lead to security issues. Therefore, financial institutions need to take extra care when adopting these technologies to ensure that their implementation processes meet security standards ^[8].

2.4. Balance data access and security

Another major challenge in financial data security management is how to strike a balance between data accessibility and security. Financial institutions need to follow the principle of least privilege by granting users only access to the information ^[1] required for their role. This principle helps reduce the risk of unauthorized access, but it may face difficulties in practice.

2.5. Human factors

Human factors play a crucial role in financial data security management. Although technological means can significantly improve data security, human error is still one of the leading causes of data breaches. For example, employees may be targeted by phishing attacks due to a lack of security awareness, or sensitive data may be compromised due to operational errors.

3. Manage financial data security strategies

In the context of financial institutions, data security is of Paramount importance due to the sensitivity of the information being handled. Protecting customer data and financial transactions is essential not only for regulatory compliance but also for maintaining customer trust and confidence in the integrity of the institution. As financial services increasingly rely on digital platforms and big data analytics, the potential risks associated with data breaches are escalating, highlighting the need for robust security measures ^[3,5].

(1) Encryption: Encryption is a key defense mechanism that converts sensitive data into an unreadable format that requires a specific key to access ^[9,10]. Utilize strong encryption protocols, such as AES or RSA, to ensure that even if the data is intercepted, it remains secure and protected against unauthorized access. The technology is essential to protect stored data and information transmitted over the network.

(2) Multi-factor Authentication (MFA): Multi-factor authentication adds an extra layer of security by requiring multiple forms of verification before granting access to sensitive information. This approach significantly reduces the risk of unauthorized access because it ensures that even if one credential is compromised, the additional verification step remains valid.

Perform regular security audits. Regular security audits are critical to identifying gaps in your organization's data security framework. These audits should be performed by both internal teams and external experts to get a full picture of potential vulnerabilities. Routine assessments help organizations stay vigilant and address security vulnerabilities before they can be exploited.

(3) Staff training: Human error is still a significant factor in data breaches, which makes employee training an important aspect of data security. Regular training programs strengthen an organization's security posture against insider threats by educating employees on best practices, such as identifying phishing attempts and adopting strong password policies ^[7,11].

(4) Incident response plan: Having a clear incident response plan in place is critical to mitigating the impact

of a data breach. The plan should outline specific steps for detecting, responding to, and recovering from a security incident, ensuring that the organization can act quickly to minimize damage in the event of a breach.

(5) Third-party risk management: Because financial institutions often work with third-party vendors, managing third-party risk is critical. Organizations must ensure that their partners adhere to strict security standards to prevent potential breaches from outside sources. This includes a thorough review process and regular evaluations of third-party security practices.

(6) Compliance: Financial institutions must navigate the complex regulations that govern data security. Ensuring compliance with these regulations not only protects customer data but also reduces legal risk. Institutions should implement policies and frameworks that meet regulatory requirements to maintain compliance and enhance data security ^[12].

Take advantage of emerging technologies. Leveraging machine learning and artificial intelligence can enhance real-time detection of anomalies and potential security threats. By analyzing patterns in transaction data, these technologies can take proactive measures to protect against fraud and cyber threats ^[5,13].

4. Regulatory environment

The emergence of fintech and rapid advances in technology have created new regulatory challenges, particularly in the areas of data security and regulatory oversight ^[14]. Financial institutions must navigate complex regulatory webs while managing the risks associated with the rapid data dissemination and powerful covert nature of modern financial technologies.

The regulatory framework places particular emphasis on the protection of personally identifiable information and sensitive financial data. Banks and financial institutions face serious consequences if important information and data are compromised or lost, making compliance with data protection regulations their top priority ^[15]. In addition, with the deepening of the process of enterprise informatization, regulatory requirements are also paying more attention to the security of information systems. Financial institutions must establish strong internal control systems to comply with regulatory standards and guard against emerging security risks.

On the compliance side, financial institutions need to address the challenges of technology integration, including maintaining secure data storage and transmission systems, implementing effective risk prevention mechanisms, and ensuring proper integration of systems while maintaining security protocols. In addition, with the increasing internationalization of financial services, financial institutions must comply with the requirements of multiple jurisdictions. In the case of ICBC USA, for example, financial institutions are subject to both domestic and international regulatory standards.

5. Future trends in financial data security

The future of financial data security will be shaped by several transformative trends that reflect changing technology and regulatory requirements.

Increased adoption of AI and ML. AI and ML are becoming an integral part of financial institutions' data security strategies. These technologies enable organizations to analyze large amounts of data in real time, enabling them to quickly detect patterns and anomalies that could indicate a security breach. By leveraging AI-powered tools, financial entities can improve their threat detection capabilities, thereby enhancing their overall security posture against increasingly sophisticated cyber threats.

Blockchain technology. Blockchain technology is gaining popularity as a means of enhancing the security and integrity of data within the financial system. Its decentralized nature allows for more secure transactions and

reduces the risk of data tampering. As financial institutions explore the potential of blockchain, they aim to create a more transparent and secure environment for data management that fosters customer trust and compliance with regulatory frameworks.

The rise of quantum computing. Quantum computing is both a challenge and an opportunity for financial data security. While it has the potential to disrupt traditional encryption methods, advances in quantum-resistant algorithms are being developed to protect sensitive information. Financial institutions must stay ahead of these technological developments to protect their data from future threats posed by quantum computing power.

6. Conclusion

The rapid development of big data technology has brought unprecedented opportunities to the financial industry but also posed serious challenges. Financial data has become a key asset, but its security management is under pressure from multiple aspects, including data breaches, privacy protection, and compliance. Financial institutions need to remain flexible in a rapidly changing technological and regulatory environment, adopting advanced technological means such as artificial intelligence and machine learning to improve threat detection and response capabilities. In addition, financial institutions must establish comprehensive risk management systems that balance data accessibility with security to ensure the protection of sensitive data. The evolving regulatory environment requires financial institutions to remain compliant across multiple jurisdictions while addressing regulatory challenges posed by emerging technologies such as blockchain and the Internet of Things. In the future, financial data security will be more dependent on technological innovation and globalized regulatory cooperation. By continuously optimizing data governance and security strategies, financial institutions can fully leverage the potential of big data technology to drive the sustainable development of the industry while protecting data security.

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Study on the Impact of Strong Provincial Capitals on Regional Innovation Efficiency

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Abstract: Strong provincial capital is an important initiative for underdeveloped regions to realize rapid regional economic development through leading by point, which is related to the overall situation of China's economic high-quality development. This paper theoretically analyzes the internal mechanism of strong provincial capitals affecting regional innovation efficiency. The study finds that the policy of strong provincial capitals promotes the formation of the resource aggregation effect in the capital cities, attracts talents, technologies, policies, and capital and other factors, improves the efficiency and quality of innovation, and drives the development of neighboring regions. However, over-implementation of the policy will lead to a large number of "big enterprises," which will lead to rent-seeking, waste of resources, crowding out of government subsidies and congestion effects, inhibit innovation, and lead to the loss of innovation factors in peripheral cities, dragging down the innovation level of the whole province. Therefore, the relationship between strong provincial capitals and innovation is an inverted "U" shape, and this study is of great significance for understanding the double-edged sword effect of strong provincial capitals and formulating scientific regional innovation policies.

Keywords: Strong provincial capitals; Regional innovation efficiency; Technological progress; Resource allocation; Growth poles

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1. Introduction

In recent years, many provinces have chosen to implement the "strong provincial capital" strategy as a key initiative to promote regional economic development, according to statistics, Changsha, Shijiazhuang, Fuzhou and other 14 provincial capital cities (more than half of the national provinces, autonomous regions, provincial capitals, capital city) has put forward the strategy, aimed at creating a strong resource allocation center, enhance The strategy aims to enhance comprehensive competitiveness by creating a strong resource allocation center, improving urban discourse, and taking advantage of the capital city's political, economic, and cultural center status, as well as infrastructure and human resources, to serve as the core engine of provincial development, and then drive the province's economic synergistic development through the radiative effect to achieve common prosperity^[1-3].

Nowadays, innovation has become the core driving force for social progress and economic development and is also the core of China's new development concept, which is the key to promoting high-quality economic development. Therefore, in the context of the strategy of "strong provincial capitals," we cannot help but ask: Is the strategy of strong provincial capitals conducive to the promotion of innovative development? Can it effectively improve regional innovation efficiency? And how is the mechanism of strong provincial capitals' influence on regional innovation efficiency? These questions are not only related to the balanced development of China's regional economy, but also to China's position and prospects in global competition.

2. Literature review

2.1. Research on innovation

Innovative activities, unlike general production and business activities, are characterized by high inputs, long investment cycles, high risk of unstable investment results, and positive externalities of incomplete exclusivity of the results, but a large number of studies have concluded that innovation is an important source of economic growth. The endogenous growth theory suggests that technological innovation is a function of R&D funding and R&D personnel investment. However, innovation activities are not only affected by the innovation factors, i.e. R&D personnel and R&D inputs, but also by the innovation subjects, i.e. universities, research institutes, enterprises, etc., their characteristics, the market environment in which they are located and the government as a special economic unit ^[4,5].

Financing is the core problem of innovation activities, especially for innovation subjects such as universities, research institutions, and enterprises ^[6]. The limitations of internal financing make external financing critical. Through industrial policies such as R&D subsidies, tax breaks, and credits, the government not only provides direct resource support for enterprise innovation and reduces R&D costs but also attracts more investors with the help of the signaling effect, which enhances enterprises' confidence in innovation and the expected rate of return. However, government intervention may also bring problems such as information asymmetry, adverse selection, moral hazard and misaligned incentives, and even inhibit R&D investment and increase innovation costs due to the resource curse effect. In addition, the capital market, as another financing channel, expands financing channels through the allocation of financial assets by real enterprises, reduces information collection costs, and improves the efficiency of capital allocation. However, the market arbitrage motive may induce firms to neglect long-term R&D investment, weakening technological innovation capability. Market structure also affects innovation activities, with monopolistic firms and highly competitive market environments having their advantages. However, distorted factor markets can inhibit the rational allocation of resources, increase the cost of firms' access to innovation resources, distort the signaling mechanism of government subsidies, and make it more difficult for investors to identify firms with R&D potential. Finally, firm-level factors also have a profound impact on innovation activities, such as firm size, ownership, and corporate governance structure. Large monopolistic firms have an advantage in terms of R&D hardware due to their strength, while smaller firms may be more prone to technological breakthroughs due to organizational flexibility. In terms of corporate governance, the nature characteristics of the decision-making layer and management incentives determine whether firms are willing to carry out innovative activities with long-term value, which has a direct effect on encouraging managers to choose high-risk and long-cycle innovative activities and mitigating moral hazard ^[7-10].

To summarize, innovation activity is a complex process, which is subject to the joint effect of multiple factors such as innovation factors, market environment, government policies and enterprise characteristics. To promote innovation, it is necessary to consider these factors comprehensively, optimize the financing environment, improve the market structure, enhance the effectiveness and relevance of government policies, and at the same time

strengthen the construction of internal governance and incentive mechanisms of enterprises.

2.2. Research on strong provincial capitals

In the literature on strong provincial capitals, researchers mainly focus on their spillover and siphon effects to explore their impacts on the provincial capitals, neighboring cities, and the whole province. Strong provincial capitals, as agglomeration economies for provincial capitals, factor agglomeration may bring positive agglomeration effects, such as labor reservoirs, intermediate goods sharing, and knowledge and technology spillovers, but it may also produce crowding effects, leading to factor mismatch and rising production costs. For neighboring cities, it may produce spillover effects such as knowledge and technology diffusion and industry transfer or siphon effects such as talent and capital flight. For the whole province, the development of the provincial capital may either drive the province's development through radiation and diffusion or lead to unbalanced development due to policy and resource favoritism.

In terms of specific studies, Zhao *et al.* found that the industrial development of provincial capitals significantly drove the development of local cities, which manifested as a spillover effect. Wu *et al.* showed that the primacy of provincial capital cities has an “inverted U” effect on the level of economic development in the province. Fu *et al.* found that from the perspective of urban boundary expansion, in the long run, expansion has an inhibitory effect on the economic growth of the provincial capital. Wang *et al.* argue that the siphoning and spillover effects of provincial capitals vary in strength at different stages, and the timely implementation of the strategy of strong provincial capitals is conducive to narrowing the urban-rural income gap. Ding *et al.* found that in different primacy areas, city primacy has different effects on economic growth. In addition, scholars have studied the impact of strong provincial capitals on regional innovation capacity. Yang *et al.* found that strong provincial capitals have a significant role in promoting regional innovation performance, while Zhuang *et al.* found that the primacy of provincial capitals has an “inverted U-shaped” effect on the level of innovation development in the province, and a positive effect on the gap between the provincial capitals and non-provincial capitals in terms of innovation development ^[11-14].

In summary, the key to the study of strong provincial capitals lies in their spillover and siphoning effects, which have an impact on economic level, innovation level, and enterprise productivity. At the same time, to promote the development of the province as a growth pole, it is also necessary to consider the capacity of the neighboring regions, such as whether the overflow from the provincial capitals can be taken up by non-capital cities, and whether the excess factors will be attracted, etc., which are the issues that should be studied to realize regional development.

3. Analytical discussion

According to Schumpeter's hypothesis, large enterprises bear a larger proportion of the share of innovation, and the excess returns of innovation results also need certain market forces to ensure that the strong provincial capital is to build such “big enterprises” in the province. How to build such “big enterprises” in strong provinces? First, in terms of factor resources. The endogenous growth theory suggests that technological innovation is a function of R&D capital and R&D personnel input. Strong provinces will form a resource aggregation effect, attracting talent, technology, policy, and other factors to the provincial capital, forming a reservoir of labor, and attracting a large amount of capital to invest, providing sufficient factor reserves for innovation activities. In terms of capital factors, the policies of strong provincial capitals give more preferences to capital cities, such as R&D subsidies, tax breaks, relaxed credit and other policies to give more R&D funds to enterprises, easing their financing constraints; supplementing the resources needed for enterprise innovation, reducing the cost of private R&D, narrowing the

gap between the benefits brought by R&D activities to enterprises and the benefits to the society, raising the expected rate of return, and increasing the incentives for enterprises to innovate. In terms of R&D personnel, the economic agglomeration or industrial agglomeration brought about by strong provincial capitals creates a labor pool, improves the matching efficiency between enterprises and R&D personnel, and reduces the search cost brought about by information asymmetry. At the same time, the concentration of various talents provides researchers with opportunities for face-to-face exchanges, which contributes to the exchange and reorganization of tacit knowledge, i.e., the effective diffusion of knowledge and technology, leading to the rapid growth of R&D personnel's knowledge and skills, improving the quality of the workforce and accelerating the pace of innovation. A large amount of capital and high-quality labor force gathers in the provincial capital, which makes the provincial capital a "big enterprise" that becomes the innovation highland of the whole province and carries out innovation activities with higher efficiency and quality^[15,16].

However, the excessive reinforcement of provincial capitals, which makes "big enterprises" too large, will hurt the overall innovation efficiency, and as stated in Wu Yanbing's review of the relationship between firm size and innovation, the relationship between firm size and innovation capacity is not a simple linear relationship. Based on the resource curse effect, abundant resources are more likely to trigger rent-seeking activities and resource wastage, and rent-seeking costs may crowd out R&D investment. Further, government R&D subsidies, too, may have a crowding-out effect on firms' R&D investment. On the one hand, due to the positive externality of innovation, unsubsidized firms may have "free-riding" behavior, leading to a decrease in R&D investment in the whole industry; on the other hand, government intervention increases the demand for innovation factors, which leads to higher prices and higher innovation costs, and reduces the innovation activities of firms. Secondly, when factors are overly concentrated in provincial capitals, it will weaken the positive externality of agglomeration, and it will produce a crowding effect and inhibit innovation. If the supply of factors exceeds the demand of the industry, the marginal contribution rate of factors will decline; excessive agglomeration of industries will intensify market competition, making it difficult to fulfill the excess returns gained by enterprises through innovation and making enterprises lack the incentive to innovate. At the same time, as the growth rate of the supply of infrastructure and public products in the city is much lower than the growth rate of factors, it makes all kinds of environmental costs increase, and their prices deviate greatly from the value, which contributes to the confusion of resource allocation, and is not conducive to the development of innovative activities. In addition, from the perspective of the entire province, the innovation factors of the peripheral cities have flowed into the central region in large quantities, and they lack the necessary factors to undertake the overflow of knowledge and technology, failing to keep up with the development of the central cities and gradually disconnecting from the production and operation of the central region. The technology in the peripheral areas cannot be updated and will gradually be eliminated by the market, dragging down the innovation level of the province. Therefore, this paper concludes that there is an inverted U-shaped relationship between strong provincial capitals and innovation^[17,18].

4. Conclusions and recommendations

This paper explores in depth the impact mechanism of the strong provincial capital strategy on regional innovation efficiency and finds that the strategy significantly improves the regional innovation efficiency of provincial capital cities in the initial stage through the resource aggregation effect and policy preferences. Large firms play an important role in R&D activities by their economies of scale and diversification advantages, which reduce innovation risks and increase innovation success rates. However, as the strategy continues, the over-strengthening of provincial capitals may trigger a series of negative effects, such as resource congestion, policy crowding-out

effects, and weakening of the innovation capacity of neighboring regions, leading to an imbalance in regional development. As a result, the relationship between strong provincial capitals and innovation shows an inverted “U” shape, and the spillover effect to the surrounding areas is limited, and the marginal cities are difficult to keep up with the pace of development of the central cities due to the loss of innovation factors, which further affects the overall improvement of the province’s innovation level.

Based on the above findings, this paper puts forward the following suggestions to optimize the strategy of strong provincial capitals and enhance regional innovation efficiency:

First, the government should balance the distribution of resources to avoid the negative impact of over-agglomeration, focus on the rational allocation of resources when implementing the strategy of strong provincial capitals, guide the orderly flow of innovation factors through differentiated regional development policies, safeguard the needs of innovation and development in provincial capitals while taking into account the balanced development of neighboring regions, and alleviate congestion and policy crowding out effects. At the same time, it should strengthen policy coordination and management, reduce direct market intervention, improve the efficiency of resource utilization, and stimulate the innovation vitality of enterprises. In addition, the government should also promote regional cooperation, establish innovation alliances or cooperation platforms, promote the in-depth integration of industry, academia, and research, realize collaborative innovation, accelerate the transformation of scientific and technological achievements, and enhance regional innovation capacity and competitiveness. Optimizing the innovation environment, upgrading infrastructure and public services, formulating policies to attract talents, attracting high-end talents to innovate and start businesses, and providing solid support for regional innovation. Finally, strengthening supervision and evaluation to ensure the effectiveness of policies is an important guarantee for the implementation of the strategy of strong provincial capitals. The government should establish a perfect supervision and evaluation mechanism to regularly evaluate and provide feedback on the implementation effect of the strategy of strong provincial capitals. Based on the evaluation results, it should adjust the policy direction and strength promptly to ensure that the strategy of strong provincial capitals can continue to promote the improvement of regional innovation efficiency and inject new vitality into the economic development of the province and even the whole country.

Disclosure statement

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The Development of Large Language Models in the Financial Field

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Abstract: With the rapid development of natural language processing (NLP) and machine learning technology, applying large language models (LLMs) in the financial field shows a significant growth trend. This paper systematically reviews the development status, main applications, challenges, and future development direction of LLMs in the financial field. Financial Language models (FinLLMs) have been successfully applied to many scenarios, such as sentiment analysis, automated trading, risk assessment, etc., through deep learning architectures such as BERT, Llama, and domain data fine-tuning. However, issues such as data privacy, model interpretability, and ethical governance still pose constraints to their widespread application. Future research should focus on improving model performance, addressing bias issues, strengthening privacy protection, and establishing a sound regulatory framework to ensure the healthy development of LLMs in the financial sector.

Keywords: Large language model; Fintech; Natural language processing; Ethics of artificial intelligence

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1. Introduction

In recent years, with the rapid development of natural language processing (NLP) and machine learning technologies, large language models (LLMs) have demonstrated powerful text understanding and generation capabilities in many fields. The rise of LLMs began with breakthroughs in the field of NLP, especially the introduction of transformer architecture. Transformer uses a self-attention mechanism to enable the model to process long text and capture contextual information efficiently. Since the introduction of OpenAI's GPT series and Google's BERT, the application of LLM has expanded rapidly in various fields, and finance is no exception. As a data-intensive industry, finance has become one of the important scenarios for LLMs applications due to its demand for efficient data processing and intelligent decision making. From early probabilistic statistical models to today's deep neural network architectures, the capabilities of LLMs continue to grow, especially in text analysis, emotion recognition, and automated trading ^[1]. They have shown potential in stock price forecasting, automated document processing, research, information extraction, and customer service enhancement.

The diversity and complexity of the financial industry offer a wide range of applications for AI technologies.

Financial data comes from a wide range of sources, including market data, news reports, social media content, and company financial reports. However, implementing an LLM in the financial sector presents unique challenges, including the need for a domain-specific vocabulary and concerns about security and regulatory compliance ^[2]. LLMs, through their powerful natural language processing capabilities, can process this unstructured data efficiently, providing financial institutions with diverse support ranging from customer service to risk management. The advent of language models developed specifically for the financial sector, such as BloombergGPT and FinGPT ^[3], marks an important milestone in the application of LLMs in the financial industry. Through in-depth training and fine-tuning of financial professional data, these models can better understand financial language and specialized terminology, providing financial institutions with diverse support from customer service to risk management. However, with the wide application of LLMs, issues such as data privacy, model reliability, and ethical governance are emerging and need to be further studied and solved ^[4].

This paper aims to systematically review the development status of LLMs in the financial field, analyze its main application scenarios and challenges, and discuss the future development direction, to provide references for related research and practice.

2. The status quo of LLMs in the financial field

LLMs have made significant inroads in the financial sector, particularly through specialized Financial Language models (FinLLMs) ^[5]. These models are primarily built on open-source architectures such as BERT, Llama, and BLOOM, and are optimized for performance through the training of financial specialty datasets to meet the needs of specific financial scenarios ^[6]. For example, FinBERT has significantly improved the accuracy of sentiment analysis by fine-tuning financial news and market data, and BloombergGPT, which focuses on financial text generation and decision support, shows strong industry adaptability ^[3]. In addition, LLMs continue to grow in size and capability, with model parameters expanding from billions to hundreds of billions and training datasets expanding from general-purpose text to specialized financial datasets. This scale development allows LLMs to better capture complex semantic relationships in the financial sector, providing financial institutions with more accurate analysis and forecasting capabilities.

2.1. Model classification

General model: These are traditional LLMS, trained on broad data sets and designed to enable general knowledge discovery. They are the basis for a wide variety of applications, including finance, but lack domain-specific optimizations. Examples include GPT and BERT models that can be fine-tuned for financial use cases such as text summaries, Q&A, or market sentiment analysis ^[6].

Domain-specific expert model: These models are tailored for specific fields, such as finance. They combine expertise and datasets to perform tasks such as financial risk forecasting and financial data classification.

Personal or adaptive models: These are smaller, privacy-focused models designed to adapt to the needs of individual users. They can integrate personal preferences or localize financial data while keeping the data secure. These models are designed to provide real-time responses and personalized insights on mobile devices or personal computers.

2.2. Main applications

LLMs have a wide range of applications in the financial sector, covering the following key scenarios:

- (1) Sentiment analysis: Help institutions anticipate market volatility and develop investment strategies by interpreting financial news and market trends. For example, FinBERT excels in sentiment analysis tasks ^[7].

The applications of sentiment analysis are not limited to the stock market but include several areas such as the bond market, the foreign exchange market, and the cryptocurrency market.

- (2) Text summary: The automatic generation of summaries of financial reports and market analysis is an important function of LLM, which improves information processing efficiency. By analyzing large amounts of textual data, the LLM can extract key information and provide an overview, saving analysts' time.
- (3) Intelligent risk control: The LLM can analyze market data and news in real time, from which it can identify potential risks and provide early warning. This helps financial institutions take timely measures to guard against potential financial crises and losses.
- (4) Trading strategy generation: Based on the real-time dynamics of the market, the LLM can provide traders with trading recommendations. These models can be combined with technical analysis, fundamental analysis, and market sentiment to help investors make more informed trading decisions.
- (5) Knowledge graph construction: Through the analysis of large amounts of textual data, LLM can help build a financial knowledge graph, structuring information so that decision-makers can access key information. This process contributes to a deep understanding of the dynamics and interrelationships of financial markets.
- (6) Customer service: AI-powered chatbots and virtual assistants have significantly enhanced the customer experience by providing personalized support while reducing labor costs ^[8]. For example, a major bank implemented 24/7 customer support services by deploying ChatGPT-based chatbots, significantly reducing customer wait times.
- (7) Trading & portfolio management: Advanced LLMs optimize strategy execution and risk control in portfolio management by analyzing alternative datasets and historical data. For example, a hedge fund uses LLMs to analyze social media data to capture changes in market sentiment to optimize trading strategies.
- (8) Compliance and regulation: LLMs can quickly parse complex regulatory texts and assist financial institutions in completing compliance checks and risk assessments ^[9,10]. For example, a financial institution has significantly improved its compliance efficiency and reduced the risk of violations by deploying compliance chatbots.

3. Challenges and limitations

LLM shows great promise in the financial sector, but its deployment also brings significant challenges and limitations. Here is an overview of the main challenges and limitations:

3.1. Data-related challenges

- (1) Data quality and availability: Financial data is often fragmented, proprietary, or unstructured (e.g., earnings reports, news articles). Poor quality or incomplete data sets can result in poor model performance ^[11].
- (2) Domain-specific training: General LLMs require a lot of fine-tuning using domain-specific data to be effective in finance. This process requires a lot of resources and may still fail to capture subtle financial concepts.
- (3) Data bias: Financial data may contain inherent biases (for example, historical market conditions or the regulatory environment) that can lead to biases in the model's predictions or decisions ^[12].

3.2. Model complexity and scalability

- (1) High computational costs: Training and deploying large models require a lot of computational resources, so scaling is expensive for real-time financial applications ^[13].
- (2) Latency issues: In high-frequency trading or real-time risk assessment, the latency of large models can hinder their practical utility ^[1].
- (3) Overfitting risk: LLMS trained on specific financial datasets may overfit historical patterns, limiting their ability to adapt to new market conditions or black Swan events.

3.3. Ethical and regulatory issues

Lack of transparency: LLMS are like “black boxes” that struggle to interpret their predictions or decisions - this is particularly problematic in regulated industries, such as finance, where accountability is paramount ^[12].

Bias and fairness: Models can inadvertently perpetuate or amplify biases present in training data, leading to unfair outcomes in areas such as credit scoring or investment advice ^[12].

3.4. Risk of abuse

Fraudulent activity: Advanced LLM may be exploited to generate convincing phishing scams, fraudulent documents, or market manipulation tactics.

Over-reliance on automation: Over-reliance on LLMS to make decisions without human supervision can lead to systemic risk if the model fails under abnormal conditions.

3.5. Consistency and adaptability issues

Value alignment: Aligning the LLM with human preferences, values, and specific financial goals remains an ongoing challenge. Inconsistent models may produce outputs that are not aligned with organizational goals or ethics ^[12].

Adapt to rapid change: Financial markets are highly dynamic. Without frequent retraining, LLMS may have difficulty adapting quickly to sudden changes such as geopolitical events or economic crises.

3.6. Security breaches

Adversarial attacks: Malicious actors can exploit vulnerabilities in LLM by providing adversarial inputs designed to manipulate the output, such as misleading sentiment analysis ^[7].

Data privacy risks: The use of LLMS to process sensitive financial data raises concerns about data breaches and compliance with privacy regulations such as GDPR or CCPA ^[10].

3.7. Future prospect

The application of LLM in the financial field shows great potential and a wide range of application scenarios. With the continuous advancement of technology, possible future development directions include the following aspects:

- (1) Augmented learning and adaptive systems: Combined with reinforcement learning techniques, large language models can adjust themselves based on real-time market feedback. This approach can improve the model’s predictive accuracy, allowing financial institutions to better adapt to changes in the face of market volatility.
- (2) Integrate across domains: The combination of large language models with other machine learning techniques will make financial data analysis and decision support more complex and efficient. For example, big language models can be used for text analysis and sentiment analysis, while machine learning algorithms can be combined to predict market trends. Such cross-domain integration helps to

elevate the level of personalization and intelligence of financial services, providing deep insight into the design and risk control of financial products through the integration of multiple data types.

- (3) Policy and regulatory adaptability: As fintech evolves, the relevant policy and regulatory frameworks need to be constantly updated to accommodate the changes brought about by new technologies. In the process, regulatory mechanisms that are in line with the application of large language model technology can be established to ensure the safety and transparency of financial operations. For example, financial institutions need to strengthen compliance monitoring on the use of large language models to process customer data to avoid potential legal risks and data breach issues ^[13].
- (4) Intelligent investment decision and risk management: Large language models can assist investment decision-making and risk management by analyzing historical data and market dynamics. This includes processing financial text data and market information, predicting possible risk events, and making intelligent investment recommendations based on specific market conditions.
- (5) Personalized financial services: The application of large language models enables financial institutions to provide personalized customer service. By analyzing customers' trading behavior and exit data, the model can recommend the most suitable financial products for each customer, thereby improving customer satisfaction and loyalty. This personalized service is not only limited to recommendations but also includes the development of an intelligent customer service system, which enables customers to obtain relevant information and support at any time, further enhancing the user experience.
- (6) Technology infrastructure and data ecology construction: With the wide application of large language models, financial institutions need to build strong technical infrastructure, including high-performance computing capabilities, data storage and processing capabilities, and network transmission capabilities, to support large-scale data analysis and real-time decision-making.
- (7) Address ethical and regulatory challenges: As the LLM evolves, the financial sector must navigate the complexity of ethical codes and regulatory standards. Ensuring the responsible use of AI is critical, especially as new applications emerge in areas such as asset finance. This commitment to ethical practices will foster trust between consumers and stakeholders, thereby facilitating a smoother transition to AI-enhanced operations ^[14,15].

4. Conclusion

This paper comprehensively reviews the development, current situation and future trends of LLMs in the financial sector, emphasizing the need to prudently address its potential risks and challenges while making full use of the great opportunities brought by this technology. Future research should focus on improving model performance, enhancing explainability, strengthening data privacy protection, and establishing a sound ethical and regulatory framework to ensure the healthy and sustainable development of LLMs in the financial sector.

Disclosure statement

The authors declare no conflict of interest.

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Case Study Analysis of Integrated Marketing for DJI OSMO Pocket 3

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Abstract: With the rapid development of technology and fierce competition in the digital industry, integrated marketing plays a vital role in product promotion and sales. This article focuses on DJI OSMO Pocket 3, revealing the reasons for its fiery “out of the circle” and the problems and challenges it faces by analyzing its marketing environment and marketing strategies, to provide useful references for DJI and similar brands to expand their brand awareness and enhance their market competitiveness in the future.

Keywords: DJI OSMO Pocket 3; Integrated marketing; 4P marketing theory

Online publication: April 28, 2025

1. Introduction

DJI is a leading global drone manufacturer and technology company headquartered in Shenzhen, China. Since its founding in 2006, the company has gone from focusing on the development of flight control systems to entering the consumer market, launching the Phantom series of drones and the Osmo handheld gimbal camera to meet the needs of different users, and redefining China’s “smart” manufacturing with high-end products.

With the rise and development of social media software and short video platforms, the market demand for portable and high-quality impact devices has further increased. Released on October 25, 2023, the DJI OSMO Pocket 3 is a portable smart camera designed for content creators and photography enthusiasts. The product is centered on superior image stabilization and camera technology, and it carries a user-friendly interactive interface with an easy and portable design that has sparked a consumer following. More than a year after its release, and with “restore beauty” like live image and video effects bursting out of the circle, offline stores and the official website are “difficult to find a camera.”

2. SWOT analysis of marketing for DJI OSMO Pocket 3

SWOT analysis was first proposed by Albert Humphrey of Stanford University in the 1960s, aiming to analyze the causes of medium- and long-term failures of enterprises and to help them make long-term strategic planning and decision-making. Over time, the theoretical system of SWOT analysis has been gradually improved, mainly

including four key elements: Strengths, weaknesses, opportunities, and threats. Through the systematic analysis of these four aspects, enterprises can improve the scientific nature of decision-making, optimize resource allocation through the development of more targeted strategies, and ultimately achieve the purpose of enhancing market competitiveness.

SWOT analysis can help DJI OSMO Pocket 3 fully understand its strengths and weaknesses to develop a more targeted marketing strategy. SWOT analysis can help companies seize the growth potential of emerging markets, and through a comprehensive assessment of the internal and external environments, it can provide DJI with a systematic framework for thinking and help DJI maintain its flexibility and adaptability in the competitive market to achieve long-term sustainable development and adaptability, thus realizing long-term sustainable development.

2.1. Strength analysis: Technological innovation and strong brand reputation

Technical innovation is the core competitiveness of DJI OSMO Pocket 3 as a smart camera. This time, DJI OSMO Pocket 3 continues to innovate in technology. It is equipped with an advanced 3-axis mechanically stabilized gimbal, which is capable of shooting smooth and fluid videos under various motion conditions. Its internal 1-inch CMOS image sensor, support for 4K 120P video recording, and HDR function ensure that every frame is clear and detailed. This time, DJI OSMO Pocket 3 upgrades the sensor to one-inch, the increase in sensor size brings a larger light-sensitive area, improving the camera's ability to capture light and enhancing the camera's dark-light image quality and photo texture. In addition, the DJI OSMO Pocket 3's display has been upgraded by 4.7 times, and the 2-inch display screen improves the user's touch experience and viewing effect.

Good brand reputation is the link of trust between DJI OSMO Pocket 3 and users. Since its inception, the company has been known for its high-quality products, utilizing high-quality materials and advanced technology to ensure that the device is durable and lightweight. The product development of DJI has a deep insight into the needs of consumers, and the DJI OSMO Pocket 3, as a portable pocket camera, brings a different experience to users with its user-friendly interaction and portable body design. The company's technology-based, user-centered, and straight-to-the-point market pain-point image has brought DJI products and users closer together, forming a better brand reputation and word-of-mouth.

2.2. Weaknesses analysis: Insufficient production capacity and limited user base

Lack of production capacity is the biggest disadvantage faced by the DJI OSMO Pocket 3 at present. Both the online website and offline stores are out of stock, and the official store has not received a clear notice of replenishment. On third-party platforms, the DJI OSMO Pocket 3 is sold at a premium. The product supply of the DJI OSMO Pocket 3 is unable to meet the market demand, which may lead to a loss of customers and affect brand loyalty. In addition, products that cannot be purchased at the original price are sold at a premium in third-party websites may also damage the brand image and affect the consumer experience. At the same time, the problem of insufficient production capacity also reflects the company's supply chain and production level from the side, which will affect the company's development plan in new product development and market expansion.

DJI OSMO Pocket 3 relies on a specific consumer user group and has high user education costs, which limits the market for the product. The target user group of the product is mainly oriented to specific users such as photography enthusiasts and content creators, who have the foundation of film and video cameras and have more requirements on image effect and shooting quality, and thus will choose the product. However, for ordinary consumers, getting started in photography and learning camera functions require a certain amount of time and economic costs, and high education costs will affect potential consumers' purchasing decisions. Meanwhile,

consumers who lack the habit of shooting and recording may tend to favor lower-cost alternatives due to concerns about the effectiveness of the equipment's use and have little adhesion to the product.

2.3. Opportunities analysis: The rise of content creation trends and the promotion of the beauty economy

The rise of the content creation trend provides ample conditions for the promotion of DJI OSMO Pocket 3. With the popularization of cell phones and imaging devices, shooting daily life, editing videos and publishing and sharing have become more and more popular. In recent years, the scale of the pan-web audiovisual industry has grown 7.18 times, the scale of the short video industry has grown 153 times, and its share has grown 17.8 times, which has become the main engine of the development of the big audiovisual industry ^[1]. With the rise of social media such as Jittery, B station, and other short video platforms, the speed of information dissemination has increased, and the number has risen exponentially. Through the algorithmic recommendation mechanism as well as the promotion of the platforms, more viewers are attracted, forming a larger potential consumer group.

The beauty economy provides an excellent selling point for the promotion of DJI OSMO Pocket 3. Equipped with unique algorithms, DJI OSMO Pocket 3 has in-flight technologies such as intelligent beauty and natural skin-brightening, which produce images with natural beauty effects that are favored by users. This function follows the trend of the beauty economy, attracting more female users and young groups for DJI OSMO Pocket 3 and expanding the target consumers.

2.4. Threats analysis: Intense market competition and international policy restrictions

The highly competitive market for electronic devices is the biggest threat facing the DJI OSMO Pocket 3. Several existing well-known camera brands in the market have shelved similar portable devices to dominate the market and compete directly with the DJI OSMO Pocket 3 in all aspects. At the same time, the consumer market for electronic devices is becoming saturated with the increase in the number of brands and products, leaving limited room for growth. Therefore, DJI must utilize its ability of technological innovation to develop new products that are responsive to the development of the times.

DJI's market is spread all over the world, yet it has been repeatedly suppressed by unilateralism in its development. Western countries, led by the United States, have repeatedly suppressed DJI and put it on the sanctions list. Increasing tariffs and restricting trade will increase the cost of DJI's products, limiting its sales in overseas markets and reducing its market share. Meanwhile, some of the policy restrictions on data privacy will lead to a decrease in overseas consumers' trust in the DJI brand.

To summarize, driven by the trend of vlog video production and short video live streaming, new imaging needs have emerged, and DJI OSMO Pocket 3 is facing great market opportunities as a portable pocket camera. At the same time, the update of competitors of the same type of products and the restriction of relevant national policies require DJI enterprises to continuously realize the differentiated production of products through technological innovation to maintain a more favorable competitive advantage.

3. Analysis of marketing strategies for DJI OSMO Pocket 3

3.1. Analysis of integrated marketing strategies for DJI OSMO Pocket 3 in the Chinese market

One of the influential theories in marketing is the 4P marketing theory put forward by American scholar Jerome McCarthy in 1960 in his book Basic Marketing. The content of the 4P marketing theory is to carry out marketing research through the four dimensions of product, price, channel, and promotion. The 4P marketing theory

provides a systematized framework for enterprises to help them formulate marketing strategies by considering the interrelationship of each key element to improve the competitiveness of enterprises.

3.1.1. Product strategy

Accurate positioning, multiple use scenarios to meet different needs. DJI OSMO Pocket 3 is positioned as a portable gimbal camera with a lightweight and compact body design that is easy to carry and shoot as you go. In the current trend of Vlog shooting and short video creation, whether it's for daily life or outdoor sports, the DJI OSMO Pocket 3 can be flexibly used in a variety of scenarios with its compact shape to meet the different needs of users.

Optimized design, convenient interactive operation, and user-friendly functions. DJI OSMO Pocket 3 display has changed from the previous small and dull, and instead adopts the interaction design of the rotating screen, binding the rotating screen and the device startup to each other, with smooth operation and upgraded user experience. In addition, DJI OSMO Pocket 3 has a simple, functional interface that can be operated with one hand, making it easy for users to get started and expanding the consumer base.

3.1.2. Pricing strategy

Affordable price point with tiered pricing. According to the official website data, the DJI OSMO Pocket 3 standard version of 3499 yuan, the all-around set of 4499 yuan, and another configuration of different Vlog set prices range from 3798 yuan to 5998 yuan. Compared with professional DSLR cameras and microsingle cameras that can easily cost thousands or even tens of thousands of dollars, DJI OSMO Pocket 3 is cheap and does not require the purchase of a stabilizer, which is good for shooting and low cost; compared with the same type of competitors, DJI has a high degree of brand awareness, and the DJI OSMO Pocket 3 is highly adaptable, has a wide range of applications and high quality of presentation, which makes it a more cost-effective product overall.

3.1.3. Channel strategy

Channel integration, online and offline omni-channel sales. A clever channel strategy will give the company's goods better access to the market and improve its brand influence. Consumers can learn detailed product information and purchase goods through the official website, and they can also go to the offline official experience stores to try and experience the products in person. Meanwhile, DJI has also opened official flagship stores on major e-commerce platforms, with sales channels set up on Tmall, Taobao, Jingdong, and other platforms. In addition, DJI also has a well-established distribution channel, and through its network of agents and dealers, it can expand the market coverage of its products and increase the penetration rate of the brand.

3.1.4. Promotion strategy

KOL marketing differentiation, multi-form and multi-channel dissemination. KOL refers to people who express opinions in specific fields and have a certain influence. In social media marketing, KOL marketing has become one of the most favored marketing methods for brands at present. Research shows that 49% of consumers will make consumption decisions based on KOL's recommendations^[2]. Taking Xiaohongshu as an example, firstly, if you search for "DJI OSMO Pocket 3 Celebrity Model" on the platform, screenshots of many celebrities holding DJI OSMO Pocket 3 in variety shows or roadshows will appear, and the influence of the celebrities will provide hotness for the discussion of DJI OSMO Pocket 3^[3]. Secondly, many bloggers in the photography area conducted comprehensive reviews and experiences of DJI OSMO Pocket 3 on the Xiaohongshu platform, explaining it to viewers from a professional perspective and boosting their trust in the product and the brand. In addition, video content creators in different areas shared their daily lives through videos shot by DJI OSMO Pocket 3, indirectly

demonstrating its high image quality and triggering more discussions and attention to the product.

Meet the demand for social interaction and provide positive emotional value. To objectively and fully understand the product situation, consumers will often search for themselves and refer to the feedback of past consumers, so user-generated content plays an important role in consumer purchasing behavior. The mechanism of emotional marketing is based on the insight and awakening of the emotions of the user group and transforming consumer emotions into consumption behavior ^[4]. In the official release of DJI OSMO Pocket 3, Zhang Xiaonan, Senior Corporate Strategy Director and Spokesperson of DJI, said, “DJI expects more users to use Osmo Pocket 3 to capture the fleeting beauty of life.” The mode of emotional interaction in the new media era extends emotional communication to interpersonal communication and group communication, realizing the dissemination of information between individual consumers and individuals, and even the dissemination of emotions between individual consumers and other consumer groups with a common sense of belonging. As a gimbal camera with documentary function, DJI OSMO Pocket 3 focuses on the publicity orientation of ready access and recording of good life in its publicity, and various bloggers use the product to shoot travel and tourism, trendy stores, daily life and other contents for publication, which triggers the audience to feel the emotion of “longing for life” for the contents they shoot. This triggers the audience to feel the emotion of “yearning for life” for the content of their photos, which in turn triggers the urge to consume.

4. Issues with the marketing strategies of DJI OSMO Pocket 3 and countermeasures

4.1. Existing issues

In traditional marketing without feedback, product experience is missing. Traditional marketing means focus on product distribution and distribution, while the new media era of information dissemination is beyond the limitations of traditional marketing, so that the dissemination of information is no longer the leading factor in determining consumer spending. Through the behavior of experience, potential consumers can directly obtain the knowledge of the product itself from both rational and emotional aspects. From the rational level, consumers directly feel the details of the product, imaging, functionality and other practical feedback and evaluation of the product, which directly affects their final decision to buy or not; from the emotional level, consumers interact with the product and thus generate emotional feedback also largely determines the consumer’s choice.

The private domain operation bundle is weak, and the brand stickiness of users is low. Private traffic is a relative perspective of public traffic, referring to the traffic pool on a closed platform based on a trust relationship, and merchants need a carrier to receive this user traffic and to maintain and operate it. The limitations of new media communication and promotion are reflected in the growth of online traffic with the saturation of the public traffic pool as a whole tends to be slow, and the cost of quality audience precision delivery has risen, audience stickiness is low, stability is weak. Neglecting the maintenance and operation of private traffic will likely produce a high user turnover rate, while the potential value of the user cannot be fully tapped, in the long run will not be conducive to the sustainable development of the enterprise.

Lack of differentiated publicity, weak adaptability to the international market. Marketing emphasizes effective communication with the audience. Due to the differentiation of consumers in different countries and regions in terms of habits and cultural perceptions, brands need to fully market research and adopt different marketing strategies in the international market. At the same time, the adaptability of the international market is also reflected in the degree of difference in brand awareness. Due to the influence of policies and media publicity, international consumers may not have enough trust in brands and products, and brands need to publicize more to enhance awareness and reputation.

4.2. Countermeasures

Enhancing brand word-of-mouth marketing and emphasizing consumer satisfaction. Niu Xiaojing (2020) pointed out in her study on the influence mechanism of content marketing on consumers' brand communication willingness in the context of social media that informational content, emotional content and entertainment, and interactive content significantly affect brand communication willingness^[5-10]. Consumers' willingness to buy is determined by online content marketing and user feedback, which is, in essence, the pursuit of product quality and brand quality service. DJI should insist on technological innovation and product quality as the core of development, and continue to provide high-quality products for the market and inject new vitality. At the same time, pre-sales and after-sales services are also conducive to improving brand reputation. DJI can provide more diversified channel support, establish user feedback mechanisms, and improve the quality of after-sales service.

Enhance the value of user participation and establish strong brand intimacy. The essence of private traffic is SCRM, and the core of maintaining private traffic is to improve the utilization rate of stock users^[11-16]. The shift from a "customer mindset" to a "customer retention mindset" requires companies to realize a strong connection between the end customer and the company through retention, activation, and conversion. DJI can enhance the association between the brand and consumers by strengthening the construction of community networks and improving the membership growth system, increasing the brand stickiness and establishing intimacy with consumers by maintaining long-term relationships with them during the stock period.

Based on the base of science and technology innovation, improve the marketing system. Innovation is a technology company and digital products in the market to maintain the competitiveness of the foothold, DJI Innovation Technology Co., Ltd. wants to maintain a long-term competitive advantage in the domestic and international markets must continue to innovate and keep pace with the times to develop new products to meet the needs of consumers and the development of the times. At the same time, before publicity, the enterprise should also clarify the market characteristics and consumer demand through market research. Through market research to understand in detail the local market consumption habits and consumer purchasing power, for the differentiation of communication to lay a practical foundation.

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Analysis of Internal Legal Risk Prevention and Control in Enterprises from the Perspective of Financial Law

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Abstract: Under the background of increasingly complex global economic development and financial markets, the legal risks faced by enterprises are increasingly intensified. As an important legal norm to adjust financial activities, financial law has put forward higher requirements for the operation and risk management of enterprises. Therefore, the article will start from the concept of internal legal risk prevention and control under the financial perspective, study and analyze the common internal legal risks and the causes of risks, and put forward the specific measures of prevention and control of internal legal risks.

Keywords: Financial law; Internal enterprise; Legal risk prevention and control

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1. Introduction

With the development of financial globalization, the complexity and diversity of various kinds of financial transactions have increased significantly, and the corresponding legal risks also rise. As an important legal framework to regulate financial activities, the function of financial law is not only reflected in the supervision of financial transactions but also in providing compliance paths and norms for enterprises. In this context, while pursuing profit maximization, enterprises must face the major economic losses and reputation damage that may be caused by legal risks. Especially in the current economic situation, compliance operation has become a necessary condition for the development of enterprises.

2. The concept of internal legal risk prevention and control in enterprises from the financial perspective

In the financial domain, corporate operations and financial activities are deeply intertwined, which highlights the growing importance of internal legal risk management within companies. Internal legal risk management is a systematic management activity aimed at ensuring lawful and compliant business operations and preventing

losses due to legal issues. From the perspective of legal risk generation, if companies lack accurate understanding of and adherence to laws and regulations during financial management processes, they are highly likely to fall into legal predicaments^[1]. In activities such as financial transactions, fund operations, and investment decisions, if companies are unaware of relevant laws and regulations, including financial regulatory laws, contract law, and securities law, and fail to operate legally, they may encounter various legal risks. For example, during the signing of financial lending contracts, if the legal implications of contract terms are not clearly understood and the rights and obligations of both parties are not explicitly defined, disputes may arise regarding repayment periods and interest calculations, exposing the company to default risks and high compensation liabilities. Alternatively, when companies engage in securities issuance or the sale of investment products, if they are unfamiliar with laws and regulations, such as securities law and financial product sales management measures, and operate in violation, they may face severe penalties from regulatory authorities, including administrative fines and business restrictions. In serious cases, they might even be held criminally responsible for crimes like illegal fundraising or financial fraud. The core of internal legal risk management lies in fostering a strong awareness of legal risk prevention. All levels of corporate decision-making, management, and employees must deeply recognize the significant impact of legal risks on the survival and development of the company.

3. Common corporate internal legal risks

3.1. Financial-related legal risks in the process of enterprise establishment

When establishing a company, if the initiators have flaws in their financial qualifications or obligations, it may lead to serious consequences. Many businesses in the financial industry require specific licenses or permits. If the initiators lack the necessary qualifications but attempt to set up a financial company, the establishment of the company will face the risk of failure. The initial investment of funds and human resources could be wasted, causing significant economic losses. When setting up an internet finance company, if the initiators do not meet the regulatory requirements regarding capital strength, technical security, and senior executives' experience in the financial sector, the company will not only fail to establish successfully but also find it difficult to recover the preparatory funds already invested. Additionally, there is a possibility of facing regulatory penalties for non-compliant preparations.

3.2. Legal risks of financial contracts in the conclusion and performance of the contract

In financial business, contract is the key carrier of transaction, and contract-related legal risks occur frequently. Financial contracts involve complex financial terms, trading rules, and regulatory requirements. If enterprises lack professional legal knowledge, they can easily get into difficulties in the process of signing, modifying, performing and termination of contracts. When signing a financial derivatives trading contract, I do not understand the product pricing, risk disclosure, stop loss provisions and other contents in the contract. Once the market fluctuates, it may face huge losses or breach the contract due to failure to timely perform the contractual obligations, and bear the liability for breach of contract. The unclear terms of the contract may also cause disputes, affect the capital turnover and credit rating of the enterprise, and bring financial and reputation losses to the enterprise.

3.3. Financial and legal risks in the capital operation of enterprises

The capital operations of enterprises, such as mergers and acquisitions, restructuring, and listings, carry significant legal risks from a financial perspective. Corporate M&A involves complex financial transactions and legal procedures; insufficient investigation into the target company's financial status, debt disputes, and compliance with financial regulations can lead to substantial financial liabilities or regulatory penalties after the merger.

During the restructuring and listing process of state-owned enterprises, issues related to the valuation and trading of state assets arise. Violating state asset management laws and financial regulatory rules by engaging in illegal transactions of state assets not only results in the loss of state assets but also exposes responsible individuals to criminal legal risks ^[2]. For listed companies, failing to disclose financial information legally or conducting unauthorized financial activities, such as manipulating stock prices or insider trading, can result in penalties from securities regulators, the risk of delisting, and legal litigation against company executives, causing severe consequences for both the company and individuals.

3.4. Financial strategic and legal risks in major business decisions

Major investment, strategic transformation, major purchase and sales decisions is closely related to financial activities, legal risk should not be ignored, in a major financial investment decisions, such as investment financial products, participate in the financial market transactions, if not fully assess the legal risk, legal compliance, the legal effect of investment contract lack of in-depth study, once the investment failure or legal disputes, will bring significant economic losses to the enterprise. The major strategic transformation involves the reallocation of financial resources and the adjustment of business structure. If it does not conform to the financial regulatory policies and laws and regulations, the transformation may be blocked, the enterprise capital chain will be broken, and endanger the survival and development.

3.5. Financial and legal risks in financial and human resources and litigation

In terms of finance, the enterprise's financial taxation risk, conceal financial business income, false profits, off-account capital circulation, tax evasion and illegal disclosure of financial information, a serious violation of financial and fiscal laws and regulations, enterprises will face the punishment of the tax authorities, financial regulatory investigation, may even cause criminal proceedings. In terms of human resource management, financial enterprises violate labor laws and regulations in employee recruitment, salary and welfare, and labor contract signing and termination, which may cause labor disputes, affect the normal operation of enterprises, and increase labor costs and legal risks.

4. Analysis of the causes of internal legal risks in enterprises from the financial perspective

4.1. Weak awareness of prevention and control and short-sighted strategy

The insufficient awareness of legal risk prevention and control among business managers, along with their short-sighted strategic vision, is a significant cause of internal legal risks. In the financial sector, corporate operations involve numerous financial regulations, supervisory policies, and complex contract terms, which place high demands on the legal literacy of managers. However, most business managers in China today do not have a background in law, leading to a lack of legal knowledge and limited ability to identify financial-related legal risks. When participating in financial transactions, due to a lack of deep understanding of financial contract terms, they fail to detect potential legal pitfalls, potentially plunging the company into unfavorable legal disputes. In financial derivatives trading, if managers are unaware of relevant trading rules and risk disclosure clauses, they may suffer substantial losses exceeding expectations during market fluctuations. In decision-making processes, they focus solely on whether capital can be quickly converted into direct returns, paying little attention to potential legal consequences. When making financial investments, they prioritize short-term return rates without thoroughly reviewing the legal compliance of investment targets. Once legal issues arise with the investment target, the company will face dual challenges of investment losses and legal liabilities, sowing seeds for long-term

development problems^[3].

4.2. Loopholes in the internal management system

The imperfections, inadequacies, and unscientific nature of internal management systems within enterprises are the institutional roots of legal risks. From a financial perspective, these systems encompass multiple aspects, such as financial business processes, financial management, and human resource management. However, many enterprises in China have chaotic internal management systems with numerous loopholes. Some companies lack clear norms and standards for their financial business processes, leading to arbitrary operations that can easily trigger compliance risks. In terms of financial management, an incomplete financial system may result in violations in financial and tax handling, such as tax evasion and improper disclosure of financial information, thereby facing legal penalties. The lack of effective supervision and regulatory mechanisms during the implementation of internal management systems makes it difficult to enforce these systems effectively. In financial operations, even if there are comprehensive risk control systems in place, without strict supervision and enforcement, it is impossible to effectively prevent legal risks.

5. Internal legal risk prevention and control measures of enterprises under the financial perspective

5.1. Strengthening the legal awareness and personnel quality training

Enterprise leadership as the core decision-making, the legal risk control consciousness has a profound influence on enterprise development direction, in the financial sector, policy and market environment, if enterprise leaders only by experience, feeling and courage to manage enterprises, lack of prospective understanding of legal risk, even in the short term enterprise due to accidental factors thriving, also difficult to resist policy changes, market fluctuations, the impact of or litigation. When financial regulatory policy adjustment, enterprise are not familiar with the new laws and regulations and irregularities, may face huge fines and limited business, so business leaders must be deeply realized in the society under the rule of law, law is the cornerstone of enterprise management, itself is not only to become the knowledge, law-abiding, usage, dealing with enterprise affairs, also need to actively promote enterprise staff legal literacy. At the same time, the use of publicity column, advertising column, posters, such as propaganda positions, in the form of plain legal knowledge and typical cases, enhance employees' legal cognition, and with the help of enterprise portal to open "Legal Column" "Franco-Prussian Classroom," provide online legal learning resources, convenient employees to learn financial legal knowledge, through a full range of the enterprise law the Franco-Prussian education, formed within the law, obey the law, reduce the enterprise legal risk from the source. When employees are dealing with financial business, they should operate according to legal regulations to avoid legal disputes caused by ignorance.

5.2. Establishing a professional legal affairs system and a risk early-warning mechanism

Establishing a robust legal department is crucial for managing legal risks. The legal department plays a vital role in the company, generating value far beyond its setup costs and personnel expenses. A professional legal department should consist of legal professionals with deep expertise and proficient practical skills, as well as accounting or auditing personnel who are adept at finance. They should comprehensively review the company's operations from both legal and financial perspectives, providing comprehensive legal support. The head of the legal department should be directly responsible to the chairman or general manager to ensure their significant position in corporate decision-making. The legal department staff should deeply engage in company operations, having the right to be informed, participate, and vote on major activities, and to follow up and supervise afterward.

In addition to handling daily legal disputes, the core responsibility of the legal department is to manage legal risks throughout the entire process. In financial investment projects, legal personnel should intervene early to review the legal compliance of the project, assess potential legal risks, and provide professional legal advice for decision-making; during contract signing, they should strictly review contract terms to avoid legal loopholes. Furthermore, the legal department must conduct a comprehensive identification and investigation of internal and external legal risks. Internally, it evaluates the legality and effectiveness of management institutions and processes, identifying and assessing risks for major decisions and daily business activities; externally, it monitors changes in financial regulatory policies, market dynamics, competitors, and legal actions, promptly identifying potential legal risks. Based on scientific analysis, argumentation, and prediction from both internal and external sources, it issues early warnings for possible risks.

5.3. Building a scientific and reasonable institutional system

Enterprise business activities in the field of financial wide, professional, build a set of scientific and reasonable system is the basis of the risk prevention and control of law, enterprises should according to the chapter by the management, scientific management, democratic management, closely combined with their actual situation and development needs, with safe development as the top priority, the people, goods, resource allocation of rationalization and scientific as the key, follow the principle of responsibility, right, relationship clear, comprehensively improve and perfect all kinds of management system. In terms of organization and management system, the responsibilities and authority of each department in the financial business process should be defined, legal risks caused by unclear responsibilities should be avoided, the responsibilities of risk management departments and business departments in financial investment decision-making should be clearly defined, to prevent legal responsibility prevarication caused by decision-making errors ^[4]. Personnel management system should standardize the financial talent recruitment, appointment, examination and incentive mechanism, to ensure that employees have corresponding professional quality and legal consciousness, reduce the legal risk caused by personnel factors, in the recruitment of financial legal personnel, strict audit its professional qualifications and experience, ensure that it can effectively deal with the financial legal affairs. The financial management system is particularly critical in the financial perspective, and the financial accounting, capital operation and tax treatment should be strictly standardized. Ensure the authenticity and accuracy of financial statements and avoid the legal risks caused by financial fraud, illegal fund operation, or illegal tax behaviors. Therefore, enterprises should, following the requirements of financial regulation, establish and improve the financial internal control system, strengthen the supervision and management of financial activities, protect financial product innovation, brand identity and other intellectual property rights, prevent infringement disputes to bring legal losses, and encourage employees on the premise of legal compliance in financial business innovation, clear innovation process and legal boundary, ensure the smooth progress of innovation activities.

5.4. Strengthening inspection and assessment and enhance the implementation of the system

System vitality lies in the execution, to ensure that the enterprise each rules and regulations play an effective role in the prevention and control of legal risk, enterprises cannot only satisfied with the system, more to focus on the implementation of the system, the regular implementation of the system to conduct a comprehensive, in-depth inspection, timely discover the problems existing in the execution process and loopholes, further check whether financial business operation strictly follow the relevant system process, financial reimbursement is in line with the requirements of the financial management system, etc. At the same time, commend and reward departments and individuals who strictly implement the system and effectively prevent and control legal risks, stimulate

the enthusiasm of employees to observe the system, strictly follow the risk prevention and control system and successfully avoid major legal risks in the financial business, form an effective restraint mechanism, and punish employees who operate financial funds against the rules, give disciplinary action and economic punishment by the regulations ^[5]. By rewarding the good and punishing the bad, create a good atmosphere of system implementation, so that all employees consciously abide by the system, improve the implementation of the system, to effectively prevent and control the internal legal risks of the enterprise, and ensure the steady development of the enterprise in the financial perspective.

6. Conclusion

In the context of financial law, companies need to strengthen legal risk prevention through multi-dimensional strategies and significantly enhance the legal risk awareness of all employees. In particular, management must deeply understand the importance of financial law in business operations, intensify learning and training on financial legal knowledge, and foster a positive atmosphere where everyone abides by the law and operates legally. At the same time, a scientific and reasonable system should be established, covering organizational management, personnel management, financial management, and risk prevention. A specialized legal department should be set up to leverage its critical role in identifying, assessing, warning against, and responding to legal risks. This will enhance competitiveness in the financial market and improve risk resistance capabilities, ensuring the long-term stable development of the company.

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Research on the Current Situation and Problems of Financing for Small and Medium-sized Enterprises in Haikou

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Abstract: The establishment of Hainan Free Trade Port provides a new opportunity for the financing of small and medium-sized enterprises. In the process of the country continuously promoting the development of a free trade port, the financing environment of small and medium-sized enterprises has gradually improved, and the financing environment has been greatly improved. But the small and medium-sized enterprises “financing difficult” “financing expensive” problem still exists. The problems of difficult and expensive financing of small and medium-sized enterprises in Haikou city have their reasons as well as the influence of external environmental factors. Therefore, to better solve the financing problems of small and medium-sized enterprises in Haikou, this paper analyzes the reasons for the difficulty and expensive financing of small and medium-sized enterprises according to the existing research results and summarizes the financing experience of small and medium-sized enterprises at home and abroad. This article finds that the financing systems for small and medium-sized enterprises (SMEs) in developed countries are relatively well-established, and both the government and society offer significant support to SMEs. Therefore, this paper believes that the government should adjust the business strategy to improve the financing ecological environment and enhance the financing ability of SMEs. The government should take the lead in perfecting the guarantee system, continuously improving the credit information system of enterprises and various financial service institutions, promoting the opening and institutionalization of private credit, and developing Internet finance ^[1].

Keywords: Haikou; Small and medium-sized enterprises; Financing situation

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1. Introduction

Under the background of “free trade port with Chinese characteristics,” the development of small and medium-sized enterprises in Hainan is facing unprecedented opportunities. At the same time, the financing difficulties and expensive problems of small and medium-sized enterprises in Hainan Free Trade Port have become increasingly prominent. This is not only related to Hainan’s financial environment but also deeply affected by the level of SMEs’ internal control of financing constraints, which is the result of comprehensive internal and external factors.

With the development of Hainan Free Trade Port, the financial service capacity provided by financial opening and financial innovation for the free trade Port has also continued to rise. Therefore, whether the Hainan Free Trade Port can develop sustainably and healthily and how to solve the financing problems of small and medium-sized enterprises are particularly critical ^[2]. Based on this research background, this paper analyzes the current situation of development and financing of SMEs in Hainan and puts forward new insights on the choice of financing channels for SMEs in Hainan. It also makes the government departments realize the importance of the development of SMEs and provides references for formulating more favorable financing policies for SMEs in the future ^[3].

2. Analysis of current situation and causes of financing of SMEs in Haikou City

2.1. Development status of SMEs in Hainan

In the process of reform and opening up, small and medium-sized enterprises (SMEs) in Hainan have sprung up like mushrooms, thus continuously promoting the economic development of Hainan. During this period, local reform initiatives often played a leading role, and breakthrough results were achieved before they were formally adopted as national policies. For example, in the early 1980s, the Haikou municipal government had begun to promote and support the growth of individuals and private entrepreneurs, which became a core part of Haikou's economy at the time. In recent years, Haikou's government has implemented stronger support measures for small and medium-sized enterprises. Haikou has put specific funds into development, which has reduced the financing expenditure of small and medium-sized enterprises. In addition, the government has introduced incentives such as tax cuts and entrepreneurial skills training to help SMEs grow steadily. Haikou is working hard to promote the process and innovation of brush digitalization. Haikou has been selected as one of the country's first cities to conduct digital transformation trials. To improve the operation quality of SMEs, Haikou City to strengthen the industrial economy through twenty measures, Haikou City small and medium-sized Enterprise development special fund management measures (2024 revision), Hainan Province high-quality small and medium-sized enterprises gradient cultivation management implementation rules. In recent years, Hainan Province and Haikou City have introduced a "package" supporting policies to support the whole life cycle of enterprises from supporting the transformation and upgrading of SMEs, supporting the construction of SMEs' public service system ^[4], and improving the financing environment of SMEs.

2.2. The role of SMEs

2.2.1. To promote employment

Employment has always been a key factor affecting socio-economic growth and promoting social harmony. A large number of small and medium-sized enterprises bring huge jobs, and most of the small and medium-sized enterprises are concentrated in labor-intensive industries, so they can provide a large number of employment opportunities. In the whole industrial field, the number of employees of small and medium-sized enterprises accounts for a large proportion. In recent years, the employment opportunities provided by small and medium-sized enterprises in the secondary and tertiary industries in Hainan Province have accounted for more than 95 percent of the total enterprise employment opportunities, becoming the main way to solve the problem of labor employment in the province.

2.2.2. To drive innovation

Many SMEs are flexible, responsive, and able to make breakthroughs in certain market segments or innovative products. They often try and innovate in technology, business models and management methods to inject new

vitality into the economy.

2.2.3. To promote economic diversification

The development of small and medium-sized enterprises helps to promote the diversification of industries, reduce dependence on a single industry or large enterprises, and enhance the resilience of the economy.

2.2.4. To support local economies

Most small and medium-sized enterprises are local enterprises. Their development has directly promoted the growth of the local economy, enhanced the vitality of the regional economy, and improved the living standards of local people.

2.2.5. To promote the development of social services

Some small and medium-sized enterprises not only have a foothold in the manufacturing industry but also play an important role in the service industry, cultural industry, and creative industry, which has promoted the vigorous development of the social service industry.

2.3. Current financing situation of SMEs

2.3.1. Single financing channels

Small and medium-sized enterprises in Hainan have relatively single financing channels, mainly bank loans. However, due to the small scale and relatively high risk of SMEs, banks are usually reluctant to provide sufficient loan support considering the risk factors, which makes it difficult for these enterprises to obtain funds through traditional bank loans. The difficulty of external financing and bank loans leads to the high financing constraints faced by SMEs.

2.3.2. High financing cost

Even if they can get bank loans, SMEs usually need to pay higher loan interest due to credit and collateral problems, which increases the financing cost of enterprises. In addition, due to the lack of sufficient collateral, these enterprises often need to pay higher guarantee fees, further increasing financing costs. As a result, financing costs for SMEs are relatively high.

2.3.3. Limited financing scale

Small and medium-sized enterprises in Hainan are generally small in scale, and their operating income is limited, so their internal financing capacity is relatively weak. This means that it is difficult for these enterprises to meet their financing needs through their accumulation, and they must rely on external financing support.

2.3.4. Insufficient policy support

Although the government has introduced some policies to support SME financing, the implementation of these policies has not been obvious. For example, some policies have made it difficult for SMEs to enjoy the benefits of these policies due to asymmetric information, cumbersome approval procedures, and high application costs. Risk prevention mechanisms are inadequate, with larger enterprises accounting for less than 1 percent of the total nationwide, but their accounts receivable balance has reached nearly 50 percent, compared with less than 25 percent for SMEs that contribute more than 50 percent of GDP. This shows that the investment of small and medium-sized enterprises is grossly disproportionate to the financial support they receive ^[5].

3. The experience of domestic and foreign regions in solving the financing difficulties of SMEs

3.1. The US Government provides a favorable external development environment for small and medium-sized enterprises

American SMEs are not only engines of economic growth but also major providers of technological innovation and job opportunities. However, they also appear vulnerable in the face of economic uncertainty and need continued government support to maintain their competitiveness and vitality.

- (1) Improve relevant laws and regulations: The Basic Law of Small and Medium-sized Enterprises in the United States, promulgated in 1953, is the Small Business Act, which provides specific provisions on the financial system, stock system, business scope, legal protection, and other aspects of small and medium-sized enterprises.
- (2) Loan guarantee: Through cooperation with commercial banks, the SBA provides loan guarantees for SMEs to reduce the risk of bank loans to SMEs. Common loan programs include 7(a) loans, 504 loans, and microloans, among others.
- (3) Small Business Investment Companies (SBIC): The SBA provides equity financing to small and medium-sized businesses by partnering with private investment firms to help businesses expand production or enter new markets.
- (4) Tax breaks: For example, the Small Business Jobs Act, implemented in the United States, provides tax breaks for eligible small businesses, including accelerated depreciation on capital investments and tax incentives for first-time asset purchases, among others.
- (5) R&D tax credit: This tax credit allows eligible small and medium-sized businesses to enjoy tax credits for innovative research and development, encouraging companies to innovate in technology.
- (6) Improving the support mechanism for finance: In the United States, the interest rate for small business loans is comparable to that for commercial credit. The US has created a risk-sharing mechanism involving government-guaranteed agencies, financial entities, and small and medium-sized enterprises. The financial assistance system for SMEs in the US includes two aspects: Internal management and external financing. As for the lending behavior of banks and other financial institutions to SMEs, the small business administration assumes the responsibility to ensure that the rights and interests of these financial institutions are reasonably protected and has the right to recover the arrears of SMEs.

3.2. The government of the Republic of Korea has established a sound financial system

3.2.1. Financing support and loan concessions

The government of the Republic of Korea provides low-interest loans to SMEs through institutions such as the SME Bank to help them solve financing problems. In addition, the Republic of Korea has provided financial support to eligible small enterprises through the SME Financial Support program, including start-up loans, export loans, and technology innovation loans, which has eased the financial pressure on enterprises.

3.2.2. Tax incentives and subsidies

the Republic of Korea offers a series of tax breaks to small and medium-sized enterprises to encourage their innovation and growth. For example, the Research and Development Tax Credit policy provides tax incentives for enterprises to invest in research and development, helping enterprises to reduce innovation costs. In addition, the government provides tax breaks and incentives, especially in supporting local small and medium-sized enterprises and the development of green technologies.

3.2.3. Technological innovation and export support

The Korean government encourages SMEs to make technological innovations and expand overseas markets through the Technology Innovation Support Program and the SME Internationalization Program. In particular, the SME Technology Innovation Fund provides financial support to help companies conduct research and development and technological transformation. At the same time, the Republic of Korea is also helping small and medium-sized enterprises (SMEs) gain access to international markets and enhance their international competitiveness through measures such as export credit guarantees.

3.3. Financing measures in Zhejiang Province

Zhejiang Province actively promotes the financing innovation of small and medium-sized enterprises and has made brilliant achievements. To sum up its financing experience, it mainly includes the following aspects ^[6]:

Looking for new ways to raise funds. To promote the legal progress of equity pledge financing more strategically, Zhejiang Province promulgated the first local regulation in the country, the Guiding Opinions on Equity Pledge Loans in Zhejiang Province. The release of this new legal provision not only provides a clear legal support for equity pledge financing but also opens up a new solution for small and medium-sized companies in financing difficulties and high costs ^[7].

Promoting the innovation of banks in the implementation of credit mechanisms. To improve the efficiency of loan approval for SMEs, it is proposed to establish an examination body specifically responsible for the credit market promotion and approval process and assign the responsibility of loan authorization to its subordinate units to effectively improve the quality of approval and loan quality ^[8].

Actively research and innovate various credit products and their models. Given the current financial climate, many banks across the province are trying to innovate their credit instruments and strategies to cater to the diverse needs faced by all types of businesses and individuals.

Gradually improve the credit guarantee system ^[9]. The credit guarantee organizations in Zhejiang Province have gradually diversified from the three directions of policy guarantee, commercial guarantee, and mutual guarantee. This diversified structure helps to meet the financing needs of different enterprises and industries and improves the coverage and flexibility of the credit guarantee system ^[10].

4. Inspiration to the financing of small and medium-sized enterprises in Zhejiang Province

4.1. Increasing financing support and innovating loan tools

Many foreign countries, such as the United States and the Republic of Korea, provide SMEs with various financing supports such as low-interest loans, credit guarantees, and venture capital through special banks, guarantee funds, and loan guarantee schemes, thus solving the problem of difficult and expensive financing for SMEs ^[11].

Hainan can provide low-interest government loans by setting up a special SME financing guarantee fund, or strengthen cooperation with financial institutions to provide customized financial services for SMEs of different sizes and industries. In addition, innovative financing tools from abroad, such as export credits and loans for technological innovation, can be borrowed to promote innovation and the internationalization of SMEs ^[12].

4.2. Improving tax policies and incentives for innovation

Hainan can introduce more flexible preferential tax policies, especially for R&D investment of high-tech, small, medium and micro enterprises, and implement tax deduction or tax reduction policies. Enterprises should be encouraged to increase research and development and innovation in smart manufacturing, green technology, and

information construction. In addition, more support can be given to small and medium-sized technology-based enterprises, and more innovation support and incentives can be provided to them ^[13].

4.3. Government procurement and market development opportunities

Hainan can develop more explicit policies to prioritize a certain percentage of government procurement budget to local small and medium-sized enterprises to help them secure a solid market foundation. At the same time, the government can help Hainan SMEs go global, especially countries along the Belt and Road, by setting up an export credit guarantee fund, supporting participation in international exhibitions, and providing training for market exploration, etc., to enhance their international competitiveness ^[14].

Through in-depth discussion and analysis of the experience of supporting SMEs' financing in advanced areas at home and abroad, it is found that there is a gap between Haikou City and developed areas at home and abroad in terms of government support for SMEs' financing. Their experience is worth thinking and referencing. It has important reference value for Haikou to support the financing of small and medium-sized enterprises and is worth learning from Haikou ^[15].

Disclosure statement

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Transforming to Digitalization of Financial Management in Selected Banking Industry in Jinan, Shandong Province, China

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Abstract: This study aims to explore the relationship between the driving factors, implementation measures, and effects of financial management digital transformation in the banking industry in Jinan, Shandong Province, China. Faced with intense competition driven by advancements in financial technology, evolving customer demands, and policy support, digital transformation has become a critical strategy for enhancing operational efficiency and market competitiveness. Leveraging the researcher's extensive professional experience and employing scientific research methods and tools, the study conducted an online survey across multiple banking institutions in Jinan, collecting 305 valid responses from senior management, financial department heads, IT personnel, middle management, and financial and audit staff. The questionnaire was designed around key dimensions of financial management digital transformation, including driving factors, implementation measures, and effect evaluation, covering variables such as technology adoption, process optimization, employee training, data security, and organizational adjustments. Quantitative analysis methods, including reliability analysis, validity analysis, descriptive analysis, regression analysis, and chi-square independence tests, were used to ensure data quality and uncover inherent patterns. The findings reveal significant relationships between driving factors (e.g., financial technology advancements, market demand, and policy support) and transformation effects (e.g., operational efficiency, resource allocation, and customer experience), with notable differences in implementation outcomes across different types of banks. Based on these insights, the study provides strategic recommendations for optimizing digital transformation in Jinan's banking industry, aiming to enhance operational efficiency, improve financial service quality, and support sustainable industry development.

Keywords: Jinan banking industry; Financial management digital transformation; Driving factors; Implementation measures; Transformation effects

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1. Introduction

1.1. Research background

The rapid growth of the global digital economy has driven unprecedented transformation in the field of financial management in the banking sector, particularly in Jinan, a key hub of China's digital economy. Faced with increasing market complexity and efficiency demands, traditional financial management models can no longer meet current needs, prompting banks to adopt advanced technologies such as artificial intelligence, big data, and blockchain to enhance operational efficiency, optimize processes, and improve customer experience. Despite strong policy support and market demand, challenges such as outdated systems, skill gaps, integration issues, and data security concerns hinder progress^[1]. This study explores the digital transformation of financial management in Jinan's banking sector, analyzing its current status, challenges, and strategies, aiming to provide valuable insights for banking institutions, policymakers, fintech companies, and researchers to promote sustainable development in the financial industry.

1.2. Research purpose

This study aims to explore the relationship between the driving factors, implementation measures, and effects of digital transformation in the financial management of the banking sector in Jinan, Shandong Province, China, and to propose strategic recommendations for optimizing digital transformation. By deeply analyzing the key factors of digital transformation, this study provides specific implementation paths and strategies for banks to maintain a leading position in the fiercely competitive market^[2].

1.3. Research significance

By thoroughly analyzing the current status and challenges of digital transformation in Jinan's banking sector, this study not only provides strategic guidance for banking institutions but also offers rich case data and empirical analysis for policymakers, fintech companies, and academia, promoting the industry's shift toward digitalization and intelligence^[3]. Additionally, this study serves as a reference for digital transformation in banking sectors in other regions, offering broad practical and theoretical value.

2. Literature review

2.1. Theoretical foundation

This study is based on transaction cost theory, strategic management theory, and synergy theory to explore the driving factors, implementation measures, and effects of digital transformation. The transaction cost theory explains how digital transformation reduces transaction and internal regulatory costs, the strategic management theory emphasizes the importance of market positioning, resource allocation, and technological innovation in digital transformation, and the synergy theory further analyzes the interactions and synergistic effects among different factors^[4].

2.2. Conceptual framework

Guided by the theories and concepts stated above, the study was guided by the research paradigm below. The core of this study is to explore the driving factors, implementation measures, and the relationship between the digital transformation of financial management in the banking industry and the transformation effects^[5]. The research aims to comprehensively analyze and empirically verify these factors, reveal their interrelationships and overall impact on the transformation of the banking industry, and provide an optimized digital transformation strategic framework for the banking industry.

The input information includes: Respondents' age, sex, job position, years of experience, and educational attainment; Evaluation variables for digital transformation (e.g., driving factors, implementation measures,

impacts); Challenge factors for digital transformation (e.g., technology integration, data security risks, employee adaptability), etc.

Process analysis involves collecting data from respondents, analyzing the evaluation of digital transformation and its relationship with demographic information, assessing the challenges faced in digital transformation, testing the significance of the relationship between digital transformation and its challenge factors, and building an optimization model based on findings.

The output includes: Demographic profile report; Digital transformation evaluation and significance difference report; Strategic model for optimizing the digital transformation of financial management in Jinan Bank (Figure 1.)

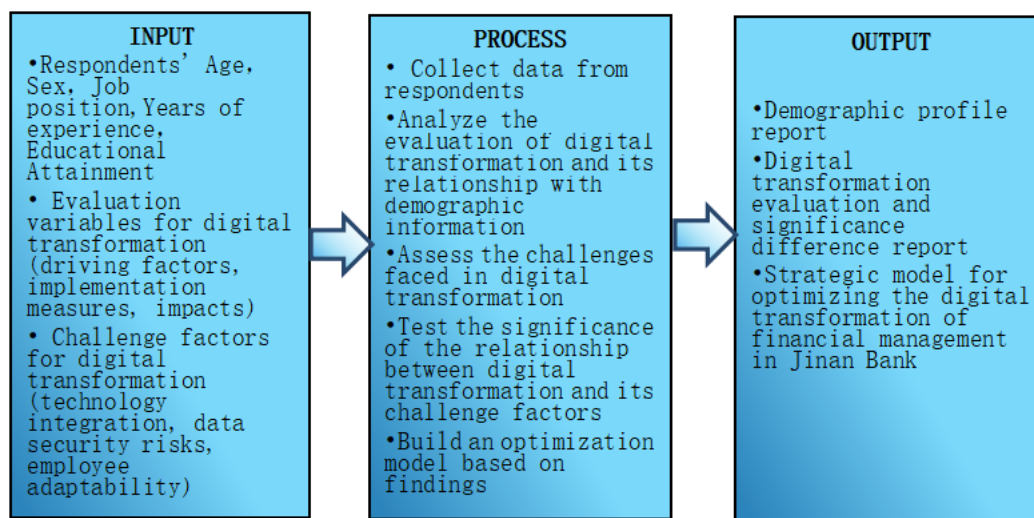


Figure 1. Framework for evaluating and optimizing digital transformation in financial management

2.3. Driving factors

The main driving factors for digital transformation in the banking sector include advancements in financial technology, customer demands, policy support, market competition pressure, and technological progress ^[6]. The application of technologies such as artificial intelligence, big data, and blockchain has enhanced efficiency and risk management in banking, while customer demands for convenience and personalized services, government policy support, and the rise of fintech companies have accelerated this process ^[7]. Specifically, advancements in fintech enable banks to improve operational efficiency through automated tools and intelligent systems, diversified customer demands drive banks to offer more personalized and convenient services, policy support provides banks with funding and innovation momentum, market competition pressure forces banks to continuously optimize their business processes and service models, and technological progress offers more opportunities for innovation ^[8].

2.4. Implementation measures

Implementation measures for digital transformation include technology adoption (e.g., deep integration of artificial intelligence, big data analytics, and blockchain), process optimization (e.g., improving business process efficiency through automation tools), employee training (e.g., enhancing employees' digital skills and technical application capabilities), data security (e.g., establishing robust data encryption mechanisms and cybersecurity protection systems), and organizational adjustments (e.g., optimizing organizational structures to meet digital demands) ^[9]. Technology adoption is the core of digital transformation, as banks need to introduce advanced technologies to enhance their business capabilities and competitiveness. Process optimization reduces manual operations

and improves the speed and accuracy of business processing through automation tools and intelligent systems. Employee training is crucial for the success of digital transformation, as banks need to systematically enhance employees' digital literacy and technical application capabilities ^[10]. Data security is the foundation of digital transformation, requiring banks to establish comprehensive data protection mechanisms to ensure the security of customer information and transaction data. Organizational adjustments are necessary to meet the demands of digital transformation, enabling banks to improve overall operational efficiency by optimizing organizational structures and business processes ^[11].

2.5. Transformation effects

Digital transformation has significantly improved operational efficiency and resource allocation rationality, enhanced customer experience and service quality, and reduced operational costs, achieving refined management. Through digital transformation, banks can process business more efficiently, reduce human errors, and shorten processing times, thereby improving overall operational efficiency ^[12]. Optimizing resource allocation allows banks to more accurately identify high-value customers and potential risk points, offering more personalized financial products and services. Enhanced customer experience is achieved through digital channels and personalized services, enabling customers to conduct transactions and manage accounts anytime, anywhere via mobile and online platforms ^[13]. Cost control is optimized through automated systems and intelligent tools, reducing labor costs and operational risks, thereby achieving refined management.

3. Research methodology

3.1. Research design

This study adopts a quantitative research method, collecting data through questionnaires. The research subjects are 305 employees from major banks in Jinan, including senior managers, financial department heads, IT personnel, and middle managers. Through the questionnaire survey, this study comprehensively understands the current status, challenges, and effects of digital transformation in the banking sector, providing data support for subsequent analysis ^[14].

3.2. Data collection and analysis

Data were collected through online questionnaires and analyzed using SPSS software. Descriptive statistics, correlation analysis, and regression analysis were used to verify the relationships between driving factors, implementation measures, and transformation effects ^[15]. Descriptive statistics summarized respondents' basic information and evaluations of digital transformation, correlation analysis explored the relationships between different variables, and regression analysis verified the impact of driving factors and implementation measures on transformation effects ^[16].

4. Results and discussion

4.1. Demographic profile of respondents

Most respondents were aged 35–44 (28.85%), with females accounting for 54.75%. Senior managers made up 27.87%, and most respondents had over 10 years of work experience (25.25%) and a financial management background (61.31%). These results indicate that the employee structure in Jinan's banking sector is relatively young and experienced, providing a solid foundation for digital transformation.

4.2. Evaluation of digital transformation

Technological advancements and market competition were the main driving factors, with an overall weighted average of 3.94 (high). Data security received the highest score (4.21), with an overall weighted average of 4.16 (high). Resource allocation and cost control scored the highest (4.17), with an overall weighted average of 4.13 (high). These results indicate that technological advancements and market competition are the primary drivers of digital transformation, while data security and cost control are key focus areas for banks.

4.3. Challenges of digital transformation

The high cost of technology integration was the main obstacle, with an overall weighted average of 4.21 (very high). Transparency and minimizing errors in data security risks were major issues, with an overall weighted average of 4.32 (very high). Employee adaptability, participation, and transparency were critical, with an overall weighted average of 4.16 (high). These results indicate that technology integration and data security are the main challenges in digital transformation, while employee adaptability is a key factor affecting transformation outcomes.

4.4. Demographic differences

Respondents aged 25–34 had higher evaluations of transformation effects, male respondents' evaluations were higher than females', senior managers' evaluations were higher than other groups, respondents with 1–3 years of work experience had higher evaluations, and respondents with IT-related backgrounds had higher evaluations. These results indicate significant differences in evaluations of digital transformation among employees of different ages, genders, positions, and work experiences, suggesting that banks need to develop differentiated transformation strategies based on employee characteristics.

4.5. Relationship between digital transformation and challenges

Technology integration, data security risks, and employee adaptability showed significant positive correlations with digital transformation, which are 0.89, 0.78, and 0.52, respectively. These results indicate that technology integration and data security are key factors affecting digital transformation outcomes, while employee adaptability is crucial for ensuring successful transformation.

5. Strategic plan for digital transformation

5.1. Strategic goals

The strategic goals of digital transformation include ensuring continuous updates and optimization of digital systems, improving operational efficiency through technology integration and process optimization, and enhancing customer experience through personalized services and digital channels ^[12]. Banks need to continuously innovate and optimize processes to enhance their business capabilities and competitiveness while improving customer experience through personalized services and digital channels to maintain a leading position in the competitive market ^[17].

5.2. Key measures

Key measures include adopting advanced technologies such as artificial intelligence, big data, and blockchain, optimizing business processes through automation tools, strengthening employee training in digital skills, establishing robust data encryption and cybersecurity protection systems, and optimizing organizational structures to meet digital transformation demands ^[18]. Banks need to adopt advanced technologies and optimize business

processes to enhance their operational capabilities and efficiency while ensuring successful digital transformation through employee training and organizational optimization.

6. Conclusion and recommendations

6.1. Research conclusion

Advancements in financial technology, customer demands, policy support, and market competition are the main driving factors of digital transformation. Technology adoption, process optimization, employee training, and data security are key to successful transformation. Digital transformation has significantly improved operational efficiency, customer experience, and cost control, but technology integration, data security risks, and employee adaptability remain major challenges ^[19].

6.2. Recommendations

To ensure the success of digital transformation, banks should maintain gender balance, value feedback from frontline employees, strengthen data security, optimize organizational structures, and maintain industry leadership through technological and business model innovation ^[20]. Banks need to continuously innovate and optimize processes to enhance their business capabilities and competitiveness while ensuring successful digital transformation through employee training and organizational optimization.

Disclosure statement

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Digital Operation Management Implementation Strategies Based on the Concept of Business-Finance Integration

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Abstract: In the digital age, digital operation management has become a key strategy for enterprises to enhance their core competitiveness. This paper explores in depth the implementation strategy of digital operation management based on the concept of financial integration. First, it analyzes the connotation and mutual relationship between financial integration and digital operation management and points out that financial integration provides the basis for data and business collaboration for digital operation management, and digital operation management is an important means to further promote financial integration. Then, from building a unified data platform, strengthening real-time data sharing and analysis, optimizing resource allocation models, strengthening cost control, and improving enterprise incentive mechanisms, it provides reference and reference for enterprises to realize efficient operation management based on the concept of financial integration in the process of digital transformation.

Keywords: Digitalization; Management and operation; Financial integration

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1. Introduction

Against the backdrop of the high-quality development of information technology and economic globalization, digital operation management is one of the important symbols of the management transformation of Chinese enterprises^[1]. By promoting digital operation management and facilitating the close integration of business management and financial management, the scientific nature of the management model can be ensured, the quality of financial management can be effectively improved, and jointly safeguard the high-quality operation management and development of enterprises^[2].

Operation management refers to the process in which managers, centering around business objectives, effectively utilize various resources, organize, plan, control, and improve the operation system during the operation process, provide customers with the required products and services, and achieve value added in the value chain. Business-finance integration means the in-depth integration between the financial management and business management of an enterprise to achieve the goal of information sharing while rationally optimizing the existing

resource allocation ^[3].

During the implementation of digital operation management in an enterprise, the role of financial management will undergo corresponding changes. Traditional financial management mainly involves recording and reporting, while financial management under the business-finance integration model is more inclined to strategic participation, emphasizing the organic combination of financial data analysis and business decision-making ^[4]. On the one hand, it is necessary to ensure the timely and high-quality production of products that meet consumer needs and complete the transformation of materials. On the other hand, resources should be rationally utilized to create a process of product value added at the lowest cost, thereby improving the overall operational efficiency of the enterprise.

2. The necessity of digital transformation based on the concept of business-finance integration

To cope with the increasingly fierce market competition and the continuous changes in the external environment, implementing the digital transformation of business-finance integration can effectively promote the refinement of enterprise internal management and improve the enterprise's response speed to external environmental changes. Through the implementation of business-finance integration, enterprises can achieve the real-time update of financial information, enabling enterprise management to formulate more scientific and reasonable business decisions based on financial data. It also helps to promote information flow across departments, break the information silo phenomenon, and establish a comprehensive and dynamic management information system. In specific work, enterprises need to continuously innovate financial management methods and tools and use advanced information technologies, including big data analysis, cloud computing, etc., to conduct in-depth analysis of financial data and maximize the value of financial information. In the long run, business-finance integration is a key path for enterprises to adapt to the economic development needs of the new era and improve their management level, and it has a profound impact on the long-term development of enterprises ^[5]. By deepening the practice of business-finance integration, enterprises can better grasp the modernization direction of financial management, which is of great significance for promoting the high-quality development of enterprises ^[6].

First of all, it is conducive to improving the deficiencies of traditional finance. By analyzing the traditional financial management mode, traditional finance has many weaknesses and blank points. For example, the application of manual methods leads to low data search efficiency, which is not conducive to the realization of the goal of data sharing. Moreover, paper documents take up a large amount of space and are difficult to store. The time and energy invested by financial personnel can only be used to complete basic tasks such as auditing bills and data statistics, and they cannot fully engage in financial management work. In addition, traditional finance attaches great importance to numbers themselves, ignoring the importance of management and service, resulting in a serious imbalance in the relationship between accounting, management, and service ^[7]. In economic activities, some financial managers only focus on post-event supervision and do not implement pre-event control, making it difficult for enterprises to accurately judge and predict potential financial risks. Through the digital transformation of finance, the above-mentioned phenomena of human resource consumption can be avoided, mistakes can be prevented, and the utilization efficiency of human resources can be improved. Moreover, the relationship between accounting, management, and service can be balanced, effectively improving the deficiencies in traditional financial management ^[8].

Secondly, it is conducive to the improvement of enterprise competitiveness. At present, the market competition situation is becoming increasingly fierce. Accurate financial data can provide strong support for enterprise business decisions, and digitalization plays an important role in the collection and processing of financial

data. By building a digital platform for financial management, enterprises can have an in-depth understanding of the use of funds, clarify the procurement, production, etc. processes, and continuously improve the deficiencies in their own operation and management processes. In addition, it can also achieve the smooth acquisition of relevant market data, enabling enterprises to better understand consumer preferences, provide a strong basis for the adjustment of production and operation, reflect the pertinence of product research and development, strive to meet consumer needs, and thus obtain more market share. Of course, it can also help enterprises accurately analyze the differences between themselves and their competitors, learn from others' strengths to make up for their weaknesses, and thus provide support for managers to make correct decisions.

Finally, it improves the enterprise's risk prevention and control ability. The deep integration of financial information and business decisions provides enterprises with a more comprehensive and real-time decision-support system, thereby enhancing their competitive advantage. In practice, the forward-looking nature of financial management is strengthened, and it has a good early-warning function. Enterprises can promptly discover potential financial risks and formulate reasonable and feasible countermeasures to avoid blindness in business decisions. Through business-finance integration, enterprises can more accurately grasp the dynamic changes in costs and revenues, optimize resource allocation, and comprehensively improve the efficiency of capital use, thereby gaining a corresponding competitive advantage in the fierce market competition. In addition, business-finance integration can also play an important role in promoting the creation of a good business culture in the enterprise, prompting all departments and employees to pay more attention to financial performance and business results, thereby stimulating innovation vitality and enhancing the overall competitiveness of the enterprise. By deeply analyzing the correlation between financial data and business operations, enterprises can foresee potential risk factors earlier. Common risk factors include market fluctuations, credit risks, etc., and then promptly take corresponding preventive or mitigation measures to minimize possible negative impacts. In addition, since business-finance integration plays an important role in promoting communication and collaboration across departments in the enterprise, it can significantly enhance the speed and breadth of information flow, making risk management no longer the sole task of the financial department but a process jointly participated in by all members of the enterprise. This comprehensive risk management model can significantly improve the efficiency of enterprise risk response and effectively support the optimization of enterprise internal management ^[9].

3. Measures to promote enterprise digital operation management based on business-finance integration

3.1. Improving the top-level design of the digital information platform and optimizing the architecture of the digital integrated information platform

An enterprise's possession of a complete operation management information system is the key to the efficient integration of business and financial tools. Based on business-finance integration, and in combination with its business strategy and development plan, an enterprise should formulate a complete construction plan for the information system of the integrated information platform, achieving real-time data sharing and process automation, to support the enterprise in carrying out refined operation management efficiently ^[10].

First of all, improve the top-level design of the operation management information system. A complete, digital integrated information platform should meet the following requirements: First, comprehensive sharing. Break down information barriers within the enterprise, rely on a highly integrated IT platform to achieve the automation of data processes, ensure the seamless connection of business and financial data, and guarantee the accuracy, integrity, and timeliness of data, improving the efficiency and precision of operation management. Second, in-depth integration. Under the premise of unified systems, processes, and standards, strengthen the

connection between the financial system and the business system, and achieve the in-depth inter-communication and high-efficiency collaboration of internal business and finance in the enterprise. Third, data empowerment. The information integration platform shares all-domain data. Through data cleaning, algorithm construction, and analysis model building, it excavates the financial and business data resources accumulated and uses data empowerment to drive business growth and risk compliance control ^[11].

Secondly, conduct a comprehensive assessment and optimization of the existing information system, and fill in the missing information integration modules. In actual work, for the scientific implementation of an integrated information system, an enterprise needs to establish a more open and collaborative organizational culture, encourage active information exchange among departments, and enable team members with different backgrounds and professional knowledge to participate in the decision-making process, thereby enhancing the breadth and depth of decision-making. The integration of business systems can provide the financial shared service center with a richer business scenario, making financial analysis and reports closer to the business reality, enhancing the business relevance of financial data, and overall improving the enterprise's decision-support ability. Such system integration is conducive to significantly improving the efficiency of cross-departmental collaboration within the enterprise. Breaking down information barriers, it promotes the effective integration of the financial perspective and the business perspective, helping the enterprise make more accurate and rapid decisions in a complex and changeable market environment. In this process, the enterprise needs to comprehensively evaluate the existing information system and take targeted optimization measures to ensure that the system architecture can support the connection of business and financial data and at the same time ensure the accuracy and integrity of the data ^[12].

3.2. Strengthening the business-finance operation analysis ability and focus on the targets of lean management

Accurate, objective, and scientific operation analysis can provide multi-dimensional and comprehensive “useful data” for the strategic, operational, and business levels of the enterprise, provide data-based decision-support for enterprise managers, and at the same time provide a solid data foundation for the evaluation of departments, business groups, and individuals. Strengthen the application of analysis results to boost the improvement of enterprise operation efficiency and management ability.

In the actual transformation process, based on the concept of big data, analyze various contents such as budgets, financing, and investment, and combine the comprehensive budget management model to improve the enterprise's fund management ability. To improve the financial data analysis ability, it is necessary to establish a special operation analysis team composed of members from various departments, such as finance, sales, and production, responsible for data collection and sharing. Through the cooperation of various departments, information sharing becomes more convenient, giving full play to the role of the financial information platform and solving the problem of “information silos” ^[13].

First of all, based on strategic goals and implementation feasibility, setting operation analysis indicators at different levels is the basis for strengthening operation analysis. For example, at the overall enterprise level, set up profit-return indicators, etc.; at the business level, set up cost-benefit analysis indicators for high-value assets, the scheduling and utilization of public assets, etc.; in budget execution analysis, dynamically monitor budget execution to provide more basis for resource allocation; in investment management, first conduct predictive analysis, evaluate the risk level and take effective preventive measures. Strengthen control during the process, analyze the generated investment results, and use the information platform to provide timely feedback. If necessary, technologies such as big data, AI, and expert systems can be used to establish a data analysis model, import data for intelligent analysis, predict results, and conduct comprehensive evaluations, providing more basis

for management to make decisions.

Through the real-time monitoring of the information system, financial management is more closely integrated with the daily operations and strategic decisions of the enterprise. Improve the accuracy and depth of financial analysis to provide more accurate and comprehensive decision support for management.

At the same time, improving cross-field business understanding and analysis ability is also the key to improving the efficiency of department integration. Financial personnel should have an in-depth understanding of the enterprise's business processes and market environment to play a more active role in the integration of financial management and business decision-making. Through regular cross-departmental training, promote the interaction between financial personnel and other business departments. In this way, information barriers can be effectively broken, trust among teams can be enhanced, and the overall collaboration efficiency can be improved.

3.3. Optimizing the resource allocation model, strengthening cost control, and continuously optimizing the economic structure

By effectively tracking key indicators such as business income and costs, budgets, and asset utilization rates, and at the same time conducting comprehensive analysis in combination with business data, identify potential risks, accurately grasp development opportunities, and on this basis, formulate forward-looking financial plans. An integrated information system for optimizing cost, budget, and cash-flow management can more effectively track and manage key financial indicators such as costs, budgets, and cash-flows, and at the same time conduct comprehensive analysis in combination with business data. Enhance risk identification and the forward-looking nature of financial planning to identify potential risks and opportunities and achieve more flexible and forward-looking resource allocation ^[14].

In terms of strengthening contract management, conduct an in-depth analysis of contract plan requirements to reasonably formulate a fund management plan to ensure the rationality and scientificity of fund allocation. To achieve the desired implementation effect, start from the collection progress. Department leaders need to strictly approve fund payments to ensure the smooth payment of funds and the proper implementation of contracts. Finally, for group enterprises, they should pay more attention to the enterprise's capital situation, review project funds comprehensively and from multiple perspectives, and continuously improve the level of budget management. In addition, after the preparation of financial statements, in-depth analysis and comparison of the differences between the budget and the actual execution should be carried out, and the financial report should be continuously adjusted to facilitate the enterprise to make accurate decisions.

In terms of strengthening internal control and risk management, it reduces the risks of errors and fraud through automated processes and real-time monitoring and ensures the security and reliability of business and financial information. The high-efficiency integration of business tools and financial tools not only supports the refinement of financial management but also enhances the enterprise's adaptability and competitiveness, providing support for sustainable development.

3.4. Building a performance appraisal system and improving the enterprise incentive mechanism

Building a performance appraisal system and improving the enterprise incentive mechanism is a systematic and complex process. It needs to be closely combined with the enterprise's strategic goals, cultural characteristics, and employees' specific job responsibilities, and is of great significance for enhancing employees' enthusiasm, improving work efficiency, and the overall performance of the enterprise.

The following steps can be taken: (1) Combine strategic goals, design performance appraisal indicators by combining quantification and qualitative assessment, and clarify the performance appraisal goals of each position.

(2) Set a reasonable assessment cycle: According to the actual situation of the enterprise and assessment goals, set different assessment cycles such as monthly, quarterly, and annual. Ensure that the assessment cycle matches the business cycle, which is convenient for identifying problems and adjusting strategies. (3) Use the information integration platform to standardize the assessment process, achieve real-time data monitoring and timely feedback of results, and improve the efficiency and transparency of assessment management. (4) Link the assessment results with salary adjustments, job promotions, training and development, etc., to form an effective incentive and restraint mechanism. Analyze the assessment results, identify problems, and formulate improvement measures. (5) Establish a feedback and communication mechanism: Conduct regular performance interviews, give timely feedback to employees, and point out their strengths and weaknesses. Encourage employees to put forward opinions and suggestions and jointly improve the performance appraisal system^[15].

Through the above steps, an enterprise can build a scientific, fair, and effective performance appraisal system, stimulate employees' enthusiasm and creativity, promote the close connection between employees and the organization, and promote the overall performance improvement of the enterprise.

4. Conclusion

In a complex and changeable market environment, the application of digitalization has laid a good foundation for achieving the goal of data resource sharing. It can help enterprises achieve the refinement of financial management, effectively improve the level of centralized financial management, contribute to the smooth transformation and upgrading of enterprise financial management, and provide solid support for the sustainable development of enterprises. The above is the author's analysis of enterprise operation management in the digital context based on practical work experience, hoping to provide some inspiration for further promoting the optimization and implementation of financial management work.

Disclosure statement

The author declares no conflict of interest.

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Research on the Development of Creative Agriculture in Qinhuangdao City: Integration Path of Strategic Innovation and Marketing Retail

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Abstract: This article first comprehensively analyzes the current development status of creative agriculture in Qinhuangdao City, pointing out that it has unique advantages in terms of resource endowments and cultural heritage. Although it has achieved certain results in recent years, it still faces challenges such as low brand awareness, single marketing channels, and insufficient innovation in retail models. In terms of marketing strategy innovation, this article proposes innovative ideas such as digital marketing, cultural IP marketing, and experiential marketing. Regarding retail model innovation, this article explores models such as online and offline integration, community group buying, and live streaming sales. This article presents an outlook for the future development of creative agriculture in Qinhuangdao City based on the research findings. It is believed that with technological advancements and consumption upgrades, creative agriculture has broad prospects.

Keywords: Qinhuangdao City; Creative agriculture; Marketing strategy innovation; Retail model innovation introduction

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1. Introduction

In the context of accelerated global agricultural modernization and increasingly diversified consumer demands, creative agriculture, as an emerging industry that deeply integrates agriculture with multiple fields such as culture, technology, and art, is gradually becoming an important force to promote agricultural transformation and upgrading and rural economic prosperity ^[1]. Qinhuangdao City, a city that integrates natural scenery and historical culture, not only possesses unique natural resources and rich cultural heritage but also has distinct advantages for developing creative agriculture.

In recent years, with the in-depth implementation of the national rural revitalization strategy ^[2], Qinhuangdao City has actively responded to the call, explored the development path of creative agriculture, and strived to transform traditional agriculture into a composite industry integrating production, ecology, and life through

innovation-driven approaches. However, faced with fierce market competition and constantly changing consumer demands, Qinhuangdao's creative agriculture also encounters numerous challenges in its development process, such as unclear strategic planning, single marketing means, and lagging retail models. Therefore, conducting in-depth research on the current development status of creative agriculture in Qinhuangdao City and exploring optimization paths for its strategic innovation, marketing strategies, and retail models is of great significance for promoting the high-quality development of agriculture in Qinhuangdao City.

2. Analysis of the current development status of creative agriculture in Qinhuangdao City

2.1. Development foundation and advantages

Qinhuangdao City has formed ten characteristic industrial clusters, including grain and oil, vegetables, edible fungi, chestnuts, fruits, Chinese medicinal materials, livestock and poultry, aquatic products, fur, and leisure agriculture, relying on the latitude advantage of "the golden latitude of agricultural production at 40 degrees north latitude," the resource advantages of "mountains, hills, plains, beaches, and oceans," the location advantage of "one-hour fresh agricultural products circulation in Beijing, Tianjin, and Qinhuangdao," the transportation advantage of "sea, land, and air intersection," and the talent advantage of gathering universities and research institutes ^[3]. For example, Lulong County has been rated as "the hometown of sweet potatoes in China," Qinglong chestnuts have become the first "Hema County" in China with chestnuts as the main supply product, Changli County is a national characteristic agricultural product advantage area, and the Jieshi Mountain production area has been known as "the East Bordeaux" ^[4]. These characteristic industries have laid a solid material foundation for the development of creative agriculture.

2.2. Initial success in industrial integration

Based on characteristic agriculture, Qinhuangdao City is actively exploring the development path of creative agriculture. On the one hand, by holding various agricultural festivals and activities, such as the Shanhaiguan Cherry Festival and the Qinglong Chestnut Industry Development Conference ^[5,6], agriculture is combined with cultural tourism, enhancing the cultural connotation and market influence of agricultural products. On the other hand, some agricultural enterprises have begun to focus on brand building and product innovation. For example, Hebei Liuqing Fungi Industry Co., Ltd. exports shiitake mushroom sticks to the ASEAN market, expanding international market space. In addition, Qinhuangdao City has also vigorously developed leisure agriculture, identifying 57 eco-leisure agriculture demonstration sites, and 28 seasonal leisure agriculture scenic routes have been promoted at the provincial level, promoting the deep integration of agriculture and tourism ^[7].

2.3. Challenges and problems faced

Although the development of creative agriculture in Qinhuangdao City has achieved certain results, it still faces many challenges. Firstly, the development of new agricultural business entities is lagging, and problems such as capital shortages, backward business philosophy, and narrow business areas restrict the large-scale and modern development of creative agriculture. Secondly, the added value of creative agricultural products is low, and there is a lack of brands and products with market competitiveness. Thirdly, the marketing methods are single, and traditional wholesale markets are still the main channel for agricultural products to enter the market, while modern circulation methods such as e-commerce and supermarket docking are insufficiently applied. Finally, the retail model is lagging, online and offline integration is not tight enough, and the consumer experience needs to be improved.

2.4. Policy environment and support

To promote the development of creative agriculture, Qinhuangdao City has introduced a series of policy measures. For example, in terms of attracting investment, the city signed 31 agricultural projects with a total investment of 13.776 billion yuan in 2024, undertaking nine projects transferred from Beijing and Tianjin with a signed investment of 3.95 billion yuan. In terms of brand building, Qinhuangdao City actively taps into local characteristic resources, strengthens brand planning and promotion, and seven products such as Changli cucumber and Qinglong chestnut have been selected into provincial characteristic agricultural product advantage areas, and ten products such as Changli fur and Shanhaiguan cherry have been rated as “regional public brands in Hebei Province”^[8]. In addition, Qinhuangdao City also focuses on technological innovation and talent cultivation, cooperating with agriculture-related universities and research institutes to enhance the technological innovation capability of characteristic agricultural industries.

The development of creative agriculture in Qinhuangdao City has a certain foundation and advantages, but continuous innovation is still needed in industrial integration, brand building, marketing strategies, and retail models to promote the high-quality development of creative agriculture.

3. Designing of strategic innovation path for creative agriculture in Qinhuangdao City

3.1. Differentiated competition strategy

Creative agriculture in Qinhuangdao City should leverage local unique resources to develop distinctive agricultural products. For instance, by utilizing the advantage of being located at the “golden latitude of 40 degrees north for agricultural production,” the city can focus on creating high-quality fruits, vegetables, and other specialty agricultural products. Taking Shanhaiguan cherries as an example, further segmentation of varieties can be carried out to introduce cherry varieties with different sweetness, acidity, and fruit texture based on the taste preferences of different consumer groups. Simultaneously, combining modern biotechnology, deep processing of agricultural products can be conducted to develop a series of products such as cherry jam, cherry juice, and cherry wine, extending the industrial chain and increasing product value-added. Additionally, the cultural connotations of agricultural products can be explored by integrating them with local historical culture and folk customs. For instance, agricultural product packaging featuring Gu Zhu culture and Great Wall culture can be introduced, making the products not only edible but also carriers of cultural inheritance^[9].

In terms of services, creative agriculture in Qinhuangdao City can provide personalized agricultural experience services^[10]. For example, farming culture experience activities can be organized to allow visitors to participate in crop planting, picking, processing, and other aspects, experiencing the charm of farming culture. Diversified experience projects can be designed for tourists of different age groups and consumption levels, such as agricultural science popularization classes for children to learn about agricultural knowledge through fun explanations and interactive games, and agricultural entrepreneurship experience projects for adults to realize their entrepreneurial dreams in the agricultural field. Furthermore, customized agricultural product delivery services can be provided to deliver fresh agricultural products to consumers’ homes regularly based on their needs, satisfying consumers’ demand for healthy and green food.

3.2. Sustainable development strategy

The development of creative agriculture in Qinhuangdao City should adhere to the principle of ecological priority and strengthen agricultural ecological environmental protection. Green prevention and control technologies should be promoted to reduce the use of chemical pesticides and fertilizers, adopting green prevention and control methods such as biological control and physical control to ensure the quality and safety of agricultural products.

Simultaneously, resource utilization of agricultural waste should be strengthened, such as fermenting crop straws to make organic fertilizers, turning agricultural waste into valuable resources. Additionally, clean energy sources like solar and wind power can be utilized to provide power for agricultural production, reducing energy consumption and environmental pollution ^[11].

Promoting the coordinated development of creative agriculture and related industries can form industrial cluster effects. Strengthening integration with the tourism industry, agricultural tourism routes can be developed by combining agricultural sightseeing, leisure vacations, and folklore experiences to create distinctive agricultural tourism brands. For example, an “agricultural tourism route of mountains, sea, and countryside” can be developed, incorporating Qinhuangdao’s natural scenery and historical cultural relics, allowing tourists to experience the joy of agricultural production while admiring the natural beauty. Furthermore, cooperation with the cultural and creative industries can be enhanced to explore agricultural cultural connotations and develop agricultural cultural and creative products, such as agricultural-themed anime, games, film, and television works, expanding the development space of creative agriculture.

3.3. Technology-driven strategy

Increasing research and application efforts in digital agricultural technology can enhance the intelligent level of agricultural production. Utilizing technologies such as the Internet of Things, big data, and artificial intelligence, real-time monitoring and precise regulation of the agricultural production environment can be achieved. For example, sensors can be installed in farmland to collect real-time data on soil moisture, temperature, nutrient content, etc. Based on data analysis results, automatic control of irrigation, fertilization, and other equipment can be achieved for precision agriculture. Simultaneously, drones can be utilized for farmland patrols and pest monitoring, improving the efficiency and quality of agricultural production ^[12].

Strengthening the construction of agricultural science and technology innovation platforms, integrating scientific research resources, and enhancing agricultural science and technology innovation capabilities are crucial. Establishing platforms such as agricultural science and technology research and development centers and agricultural science and technology transformation centers, strengthening cooperation with universities and research institutes, and carrying out key agricultural technology research and scientific and technological achievements transformation are essential. For instance, collaborating with agriculture-related universities to conduct research on deep processing technologies for agricultural products, developing agricultural product processing technologies and equipment with independent intellectual property rights, and enhancing the added value and market competitiveness of agricultural products.

4. Marketing strategy innovations for creative agriculture in Qinhuangdao City

4.1. Digital marketing innovations

In the digital era, social media has become a crucial platform for information dissemination and marketing promotion. Creative agriculture in Qinhuangdao City can fully utilize social media platforms such as Weibo, WeChat, and Douyin (TikTok’s Chinese version) to conduct agricultural product marketing activities. For instance, establishing official Weibo and WeChat accounts dedicated to agricultural products, regularly publishing information about the cultivation process, growth environment, and nutritional value of agricultural products, can enhance consumers’ understanding and trust in these products. Meanwhile, creating lively and interesting short videos showcasing the unique features and advantages of agricultural products, and disseminating them through platforms like Douyin, can attract more consumer attention. Additionally, social media interaction activities such as agricultural product photography competitions and agricultural knowledge quizzes can increase consumer

engagement and brand loyalty

E-commerce platforms provide a broader market space for the sale of agricultural products. Creative agriculture in Qinhuangdao City should actively establish a presence on major e-commerce platforms such as Taobao, JD, and Pinduoduo, opening flagship stores to expand sales channels. In e-commerce platform marketing, emphasis should be placed on product display and page design, highlighting the unique features and advantages of agricultural products to enhance their attractiveness. Simultaneously, utilizing marketing tools such as Zhitongche and Zuanshan on e-commerce platforms can facilitate precise promotion, increasing product exposure and sales volume ^[13]. Furthermore, e-commerce live streaming activities can be conducted, inviting popular anchors or agricultural experts to recommend and explain products, answer consumers' questions in real-time, and promote product sales.

4.2. Cultural IP marketing innovations

Qinhuangdao City is rich in historical and cultural resources, including Gu Zhu culture, Great Wall culture, and ocean culture. Creative agriculture can deeply explore these regional cultural elements, combining them with agricultural products to create culturally enriched agricultural product brands. For example, developing a series of Great Wall-themed agricultural products such as Great Wall wine and Great Wall chestnuts, integrating Great Wall elements into product packaging and promotion, can highlight the regional characteristics and cultural heritage of the products. By creating cultural IPs, the brand value and market competitiveness of agricultural products can be enhanced.

Combining creative agriculture with cultural tourism can create distinctive cultural tourism brands ^[14]. For instance, organizing agricultural culture festivals, agricultural product picking festivals, and other activities can attract tourists to experience agricultural production and rural culture. During event planning, emphasis should be placed on integrating cultural elements, such as conducting folk performances, handicraft production, and other activities, allowing tourists to experience the local cultural charm while participating in the activities. Simultaneously, developing cultural tourism souvenirs such as agricultural product models and cultural handicrafts can extend the tourism industry chain and increase tourism income.

4.3. Experiential marketing innovations

Constructing agricultural experience parks that integrate agricultural production, sightseeing, experience, and leisure can provide consumers with opportunities to personally participate in agricultural production ^[15]. Within these parks, functional areas such as planting zones, picking zones, and breeding zones can be established, enabling consumers to engage in activities like crop planting, picking, and breeding, thereby experiencing the joy of agricultural production. Additionally, professional agricultural technicians can be equipped to provide technical guidance and training to consumers, enhancing their participation experience.

Diversified thematic experience activities can be carried out according to different seasons and consumer demands. For example, during spring, activities like "Flower Appreciation and Picking Experience" can be organized, allowing tourists to enjoy the beautiful flower fields while experiencing the joy of fruit picking. In autumn, "Harvest Festival and Agricultural Product Processing Experience" activities can be arranged, enabling tourists to participate in the processing and production of agricultural products and understand their production processes. Through thematic experience activities, the interaction and emotional connection between consumers and agricultural products can be strengthened, increasing consumers' willingness to purchase.

5. Innovation in retail models for creative agriculture in Qinhuangdao City

5.1. Online and offline integrated retail model innovations

Creative agriculture in Qinhuangdao City should actively establish online sales platforms, such as building official websites and joining renowned e-commerce platforms^[16]. The official website can serve as a window to showcase agricultural product information, brand image, and corporate culture, providing detailed product introductions, cultivation process demonstrations, user evaluations, and other content to enhance consumers' trust in agricultural products. Simultaneously, utilizing the large traffic advantages of e-commerce platforms can expand the sales scope of agricultural products. In terms of platform operation, emphasis should be placed on user experience, optimizing page design, and improving website loading speed and ease of use. For instance, setting up a clear navigation bar can facilitate consumers to quickly find the desired products, and providing multiple payment methods can meet the payment needs of different consumers. Additionally, utilizing big data analysis technology to understand consumers' purchasing behaviors and preferences can enable precision marketing, pushing personalized product recommendations and promotional information.

Offline experience stores serve as an important bridge connecting online and offline channels^[17]. Qinhuangdao City can open agricultural product experience stores in city centers, commercial districts, tourist attractions, and other locations, allowing consumers to personally experience the quality and characteristics of agricultural products. These experience stores can be equipped with functional areas such as product display zones, tasting zones, and interactive experience zones. In the product display zone, various agricultural products can be exhibited in an exquisite manner, highlighting their appearance and quality. The tasting zone can offer fresh agricultural products for consumers to sample, enabling them to intuitively experience the taste and flavor of the products. The interactive experience zone can host activities such as agricultural product processing and agricultural knowledge popularization, increasing consumer interaction and engagement with agricultural products. By establishing offline experience stores, consumers can be attracted to experience the products in-store, thereby promoting online sales.

5.2. Community group purchase retail model

Community group purchase is a new retail model that has emerged in recent years, offering advantages such as low cost, high efficiency, and fast dissemination^[18]. Creative agriculture in Qinhuangdao City can actively recruit community leaders, who can be residents within the community, convenience store owners, etc. Provide professional training to the recruited community leaders, covering agricultural product knowledge, marketing skills, customer service, and other aspects. Through training, enhance the business capabilities and service levels of community leaders, enabling them to better promote and sell agricultural products.

Regularly plan community group purchase activities, introducing special agricultural product group purchase packages based on different seasons and consumer demands. For example, launch a fruit gift box group purchase activity during the fruit harvest season, and introduce a combined agricultural product package group purchase activity during holidays. In the process of implementing the activities, ensure the quality and stable supply of agricultural products, and promptly handle consumer orders and after-sales issues. Simultaneously, utilize social media, community bulletin boards, and other channels for activity promotion, increasing the visibility and participation of the activities.

5.3. Live streaming retail model

Establish a professional live streaming team consisting of anchors, operational staff, and customer service personnel. Anchors should have good communication skills and product knowledge, capable of vividly introducing the characteristics and advantages of agricultural products. Provide regular training to the live streaming team,

learning live streaming skills, marketing strategies, interaction methods, etc., to improve the effectiveness of live streaming sales.

Carefully plan live streaming content, combining the cultivation process, growth environment, nutritional value, and other aspects of agricultural products to create interesting and informative live streaming content ^[19]. For example, conduct agricultural product traceability live streams, allowing consumers to intuitively understand the production process of agricultural products, and invite agricultural experts to provide live explanations, offering professional agricultural knowledge and purchase suggestions to consumers. Simultaneously, utilize multiple channels for live streaming promotion, such as social media, short video platforms, and e-commerce platforms, to attract more viewers into the live streaming room.

6. Countermeasures and suggestions for the development of creative agriculture in Qinhuangdao City

To promote the sustainable development of creative agriculture in Qinhuangdao City, this article proposes the following countermeasures and suggestions: In terms of policy support, the government should formulate specific support policies for the development of creative agriculture, including financial subsidies, tax incentives, and land use support. For example, a certain percentage of investment subsidies can be provided for creative agriculture projects, or related taxes and fees can be reduced or exempted to lower the entrepreneurial costs for operators.

Talent cultivation is key to the development of creative agriculture. Qinhuangdao City should strengthen the cultivation and introduction of professional talents in creative agriculture and establish a cooperation mechanism between industry, academia, and research. For instance, it can collaborate with local universities like Hebei Normal University of Science and Technology to offer creative agriculture-related courses and cultivate compound talents, while introducing advanced creative agriculture management experience and marketing concepts.

Infrastructure construction cannot be ignored. Qinhuangdao City should improve the transportation, communication, water and electricity infrastructure of the creative agriculture park, and enhance its reception capacity. For example, it can improve road conditions leading to major creative agriculture parks and add a tourism signage system; improve WiFi coverage in the park to facilitate visitors' sharing of experiences.

A quality supervision system needs to be established and improved. Qinhuangdao City should formulate quality standards for creative agricultural products, strengthen quality supervision and brand protection. For example, a "Qinhuangdao Creative Agriculture" certification system can be established, and certification marks can be awarded to products that meet the standards to enhance the market recognition of the products.

7. Conclusion and future prospects

Qinhuangdao's creative agriculture possesses unique advantages in terms of resource endowment and cultural heritage. Despite achieving certain development results in recent years, it still faces many challenges, such as low brand awareness, a single marketing channel, and insufficient innovation in retail models. In terms of marketing strategy innovation, digital marketing, cultural IP marketing, and experiential marketing provide new development ideas for creative agriculture in Qinhuangdao City, helping to enhance the market competitiveness and brand influence of agricultural products. Regarding retail model innovation, online and offline integration, community group purchases, and live streaming sales have opened up broader spaces for agricultural product sales, better meeting the diverse shopping needs of consumers.

The development prospects of creative agriculture in Qinhuangdao City are broad. With continuous technological advancements and upgrading consumer demands, creative agriculture will usher in more

development opportunities. In terms of marketing strategies, the application of digital marketing should be further deepened, utilizing technologies such as big data and artificial intelligence to achieve precision marketing. Simultaneously, the deep exploration and creation of cultural IPs should be strengthened to form a brand image with stronger recognition and attractiveness. Regarding retail models, continuously optimize the online and offline integration model, improve the service quality and user experience of community group purchases and live streaming sales, and explore more innovative retail models. Furthermore, the government, enterprises, and all sectors of society should form a joint effort to promote the development of creative agriculture in Qinhuangdao City. The government continues to increase policy support and improve industrial supporting facilities; enterprises strengthen their own innovation capabilities and improve product quality and service levels; all sectors of society actively participate to create a good development atmosphere. It is believed that with the joint efforts of all parties, creative agriculture in Qinhuangdao City will achieve high-quality development, becoming an important force driving local economic growth and rural revitalization ^[20].

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Research on the Financing of Affordable Talent Rental Housing Based on the REITs Model

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Abstract: This article through the domestic and foreign literature research in this field, related concepts and theoretical review, as well as the analysis of our country's security talent rental housing and REITS development situation, discuss the prospect and development direction of our country's security talent rental housing public REITs, and put forward suggestions.

Keywords: REITs; Rental housing; Financing

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1. Introduction

This paper makes an in-depth discussion of the development of the affordable rental housing and REITs in our country, and probes into the necessity of developing the affordable rental housing^[1]. At the same time, it will point out the practical problems faced in promoting affordable rental housing in our country. From the practical point of view, it analyzes the advantage of the REITs model in the financing and development of affordable talent rental housing and puts forward some relevant suggestions.

2. The development situation of affordable talent rental housing in our country

REITs (Real Estate Investment Trusts) are financial instruments that securitize real estate assets, allowing investors to invest indirectly in the real estate market by purchasing fund shares and share rental income and capital appreciation. In many countries and regions around the world, REITs have become an important capital market tool, but the introduction and development process in China is tortuous and challenging^[2].

In 2003, China Securities Regulatory Commission (CSRC) proposed to study the securitization of real estate and began to explore the relevant laws and regulations of real estate investment trusts (REITs). At that time, China's capital market was still in the early stage of development, and the real estate market was also growing rapidly, but the legal framework and regulatory system of REITs were still immature, and the speed of promotion was slow^[3].

In 2005, the CSRC released a research report on real estate securitization and proposed the feasibility of REITs products. However, due to the imperfect market environment, legal system and financial supervision at that time, REITs did not gain policy support in China and failed to enter the substantive implementation stage.

In 2014, the Chinese government began to attach importance to the capital market and financial innovation, and in this context, REITs were put back on the policy agenda. The State Council made clear its support for real estate securitization in *Several Opinions on Accelerating the Development of Modern Insurance Service Industry*, while the China Securities Regulatory Commission also released a *Research Report on Policies related to real estate Securitization in 2014*, which provided a policy foundation for the pilot of REITs products. At this stage, the CSRC conducted some preliminary explorations in the pilot areas, mainly to test the feasibility of REITs in China and meanwhile accumulate experience for improving relevant regulations, market mechanisms, and regulatory frameworks.

Since 2015, the CSRC has officially launched the pilot work of REITs and selected some regions and specific industries for the pilot. During this period, the introduction of REITs focused on the infrastructure sector, such as transportation, warehousing, and other fields of asset securitization, and some local governments also began to promote the securitization of land, commercial real estate, and other real estate. In August 2018, the State Council issued the *Opinions on Further Making Good Use of Foreign Capital*, which proposed to promote the pilot work of REITs. Since 2019, China's securities market has gradually improved, and REITs have become an important part of the capital market reform. The government has issued several policy documents paving the way for the legalization and marketization of REITs. At the same time, the market's attention to REITs has increased significantly, and more enterprises and investors have begun to study the REITs model and explore how to finance real estate assets through securitization. At this stage, the product design, laws and regulations and market environment of REITs were gradually improved, and although China's REITs market was still in the pilot stage, the market's recognition of it gradually increased ^[4].

In June 2020, the China Securities Regulatory Commission (CSRC) officially approved the pilot of infrastructure REITs, and the first batch of infrastructure REITs products were successfully listed on the A-share market. This marked the official opening of China's REITs market.

Since 2021, the REITs market has ushered in rapid development opportunities in China. With the successful listing of the first batch of infrastructure REITs products, more and more enterprises have begun to pay attention to this market, and REITs have gradually been accepted and expanded as part of the capital market. More REITs launch: In 2021, more REITs will be launched one after another, covering not only infrastructure but also commercial real estate, industrial real estate, and many other sectors. These products have begun to attract more investor participation while also promoting the continuous improvement of relevant laws and regulations.

3. The construction mode of rental housing for the guarantee talents in China

In China, there are four main business models in the process of project development, which include: government-led, market-oriented cooperation model and enterprise participation model ^[5].

3.1. Government-led model

In this model, the government takes the lead in the construction and operation of low-income rental housing through policy guidance, financial support, land supply, and other means, and the government assumes the main responsibility. The main features include:

- (1) Policy guidance and capital input: The government has set aside land specifically for rental housing for talents in urban planning and has provided special financial support to reduce the burden on development

enterprises. The government can adopt the form of public construction or private or public construction public, and cooperate with real estate development enterprises or property companies. The government provides land and financial support, and the development enterprises carry out construction and management, or the government directly builds and operates.

- (2) Preferential policies: Provide tax relief and preferential land transfer policies for development enterprises to reduce construction costs and improve the attractiveness of rental housing. For example, Shenzhen, through a government-led way, has built some affordable talent rental housing projects in specific areas, giving priority to high-end talents, talents in short supply, and innovative talents. The government provides support in terms of land transfer, fiscal and tax subsidies, etc., to ensure the low cost and relatively favorable rent of the projects.

3.2. Market-based cooperation model

The market-oriented cooperation model is mainly to attract social capital and enterprises to participate in the construction of talent rental housing under the guidance and policy support of the government. In this model, the government does not directly participate in the development of residential buildings but promotes the participation of market forces through policies, financial support, and tax incentives. The government cooperates with enterprises. The government provides land, policy support, or financial subsidies to attract real estate developers or enterprises to participate in the construction. At the same time, the enterprises can obtain stable profits through the long-term rent guarantee provided by the government. Rent control and market-oriented operation: In this model, the government will supervise and control the rent to a certain extent, but the operation and management mode depends more on the market-oriented mechanism, and professional property companies or real estate enterprises are responsible for the management and operation ^[6].

Social capital is introduced to guide the investment of social capital through the public-private partnership (PPP) model. The government will share the development proceeds through long-term leases or equity partnerships. For example, Beijing and Shanghai.

3.3. Enterprise participation model

Under the enterprise participation mode, some large enterprises or innovative enterprises themselves will participate in the construction of affordable talent rental housing. By providing housing security for employees, enterprises can attract and retain core talents and help the government ease the pressure on talent housing.

Enterprises build their housing. Some large enterprises, such as high-tech companies, internet companies, and manufacturing companies, provide their employees with special affordable rental housing, which usually includes temporary accommodation and long-term rental ^[7].

In cooperative development, enterprises can cooperate with the government or real estate developers to jointly build housing that meets the needs of talents. Enterprises are responsible for a certain amount of capital input and project management, while the government provides land or policy support. For example, Alibaba, Tencent, and others. These enterprises use their resources to build rental housing for talents in major cities, especially in cities where talents are concentrated, not only to meet the housing needs of their employees but also to enhance their attractiveness and competitiveness.

4. The development of affordable talent rental housing in China

Affordable rental housing is an important work put forward in the field of real estate in China ^[8]. Since all localities actively responded to the unified deployment of the country, they have formulated corresponding construction

plans and plan to launch a large number of affordable housing units for talents.

At present, the layout of talent rental projects around China mainly focuses on the first and second-tier hot cities, which have a large demand for talents and relatively high population inflow. To attract more talents to live here, these projects are usually located in areas with convenient transportation and complete supporting facilities. As a result, the purchase cost of the affordable talent rental project is high, and a lot of capital needs to be invested. Because these projects are for public welfare, the rent is generally lower than that of ordinary apartments in the surrounding areas. As a result, these projects face considerable difficulties in financing, requiring the support of long-term, low-cost, and large funds.

Affordable talent rental housing has been launched in many cities in China, and the following are some major cities^[9].

In recent years, Beijing has intensified its efforts to attract high-end talent, and the affordable talent rental housing project has gradually increased. For example, “Beijing Talent Apartment” is a rental housing for newly introduced high-level talents and innovative talents. Through policy support, the Beijing municipal government encourages developers to build talent apartments and ensures the reasonableness of rents through market-based leasing.

Shanghai has also adopted talent apartment and rental housing projects. As an international metropolis, Shanghai has a huge demand for talent, and affordable rental housing is seen as an important way to enhance its talent appeal. Shanghai’s “talent apartments” mainly cater to outstanding talents with high education, high technology, and high skills, offering them housing options with relatively low rents and longer rental terms. Shenzhen has been one of the most active cities in the construction of affordable rental housing for talented people in recent years. Guangzhou and Hangzhou have also actively rolled out relevant policies to promote the construction of affordable rental housing for talented people^[10].

5. Prospect of public offering REITs for affordable talent rental housing in China

5.1. Providing credit enhancement support

The government may, according to the actual conditions of REITs, provide appropriate operational subsidies to their operators to enhance their daily profitability; At the same time, the original stakeholders should, according to the specific conditions of the project, implement credit enhancement strategies such as rent compensation arrangement, credit rating upgrade buyback program to reduce the investment risk of the REITs project. The adoption of a credit enhancement mechanism can help to adjust the rate of return of affordable housing products more accurately, meet the requirements of open market REITs and the expectations of investors, and attract investment funds more effectively^[11].

5.2. Providing relevant support to reduce the cost of asset acquisition

To improve the operating profit of low-income rental housing, reducing the cost of asset acquisition is regarded as an extremely important part. Among the various expenses involved in ensuring the construction and operation, and maintenance of rental housing, land expenditure occupies the most important share. From the perspective of land. First, administrative agencies can continuously increase the supply of land for rental talent housing projects to ensure the maximum utilization of land resources; Secondly, it is necessary to improve the quality of land and provide land with good location and convenient transportation for the construction of rental housing for talents, to ensure that the supply of rental housing for talents can meet the actual needs. In addition, the price of land transfer should be properly planned, and appropriate compensation and financial policy support should be provided to the party who purchases land^[12].

5.3. Reasonable operation of underlying assets to improve operational capacity

To better meet the needs of investors, real estate investment trust (REITs) products need to provide a satisfactory rate of return and have a stable and reliable cash flow. To ensure this, companies operating rental housing need to be committed to improving their business, relying on efficient operations and management to control costs, and constantly improving product quality^[13].

5.4. Improving the management mechanism and internal control mechanism and training new management talents

At present, the transaction structure of real estate investment trusts (REITs) is relatively complicated, including more market participants. Therefore, on the one hand, investors need to clearly define the allocation of management responsibilities and hierarchical relationship between special plan managers, fund managers and underlying asset operators, and clarify the details and regulations of due diligence, management responsibilities and fees, to truly, comprehensively, accurately and timely reflect the operation status of REITs products and ensure their healthy operation. On the other hand, given the unclear rights and responsibilities between the fund host and the operator, it is necessary to clearly define the boundary of rights and responsibilities, improve the overall ability of managers, and cultivate comprehensive asset management professionals who are both familiar with the operation of the financial market and have the ability to manage rental projects to ensure its benign operation^[14].

5.5. Improving special legislation and introducing preferential tax policies

China's REITs development is limited by two main aspects, namely insufficient legislation and strict tax policy. To solve this problem, special legislation needs to be perfected. A sound system of laws and regulations should be established to ensure the orderly operation of affordable talent rental housing financing under the REITS model, and to clarify the rights, responsibilities and obligations of all parties and relevant institutional arrangements; Standardize the order of the talent rental housing market, and establish the leasing and transaction access system to ensure the healthy and orderly operation of the market; At the same time, strengthen the supervision of relevant institutions and subjects of affordable talent rental housing financing under the REITS model to ensure that they carry out activities according to law and compliance^[15]. Appropriate tax policies will be formulated to promote their sound development.

Disclosure statement

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A Study on the Impact of Data Assetization on Supply Chain Resilience of SRDI SMEs and the Mechanism of Its Role

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Abstract: This paper selects the data of China's specialized, special and new "small giants" listed companies from 2011 to 2021, and starts from the key production factor and strategic asset of data assets, empirically examines the impact of data assetization on the supply chain resilience of SRDI SMEs, and examines the impact of data assetization on the supply chain resilience of SRDI SMEs using the role of the mechanism model. Through the mechanism model, the mediating effects of financing constraints and technological innovation are examined, and a path of action is drawn, which provides theoretical evidence and policy recommendations for promoting the digital transformation of SRDI SMEs and improving supply chain resilience.

Keywords: Data assetization; Supply chain resilience; Financing constraints; Technological innovation; SRDI SMEs

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1. Introduction

With the deepening integration of the digital economy and the real economy, specialized, refined, differential, and innovative SMEs (SRDI SMEs) have emerged as pivotal forces in driving innovation and fostering new economic paradigms. However, these enterprises face significant challenges in supply chain management, particularly in adapting to market uncertainties. Against the backdrop of accelerating national data assetization policies, this study addresses a critical question: How can data assetization enhance supply chain resilience for SRDI SMEs? Existing research predominantly examines the financial implications of data assetization or isolated supply chain optimization strategies, overlooking its systemic role in resilience building. To bridge this gap, this paper constructs a novel theoretical framework linking data assetization with supply chain resilience, addressing two core issues: (1) the mechanisms of technological empowerment and value reconstruction, and (2) the heterogeneity of enterprise characteristics and external environments. The possible marginal contributions of this paper are: (1) Theoretical integration: Extending beyond financing-focused studies, this research systematically examines how data assetization integrates internal and external resources to strengthen supply chain resilience. (2) Mechanistic insights: By validating the dual mediating roles of technological innovation and financing constraints,

we reveal how data-driven production processes enhance resource utilization and risk response capabilities. (3) Methodological refinement: A three-tier analytical model incorporating regional marketization, policy support, and industry-specific factors is developed to assess the contextual impacts of data assets on resilience.

2. Literature review

2.1. Data assetization

Data assets are data that have application scenarios and have been used repeatedly or continuously for more than one year in the production process. Compared with traditional assets, data assets are characterized by strong versatility, non-consumability, dynamism, and diversity of value creation forms.

Hannila found that integrating IoT data with other data assets (e.g., product, transactional, and interaction data) helps maximize the value of data and supports management decisions ^[1]. Li *et al.* showed that companies using data assets perform better on ESG metrics ^[2], with the impact being stronger for firms with low asset turnover, weak market power, high agency costs, missing ESG disclosures, and IT-savvy CEOs. Zhai *et al.* demonstrated that data assetization enhances firms' risk-taking ability and helps them address challenges in business ethics, industry competition, and internal issues ^[3].

2.2. Supply chain resilience

In economics, “resilience” refers to the ability to withstand and adapt to recover from external risks, as well as the ability of an enterprise to reorganize and transform, and upgrade using internal and external resources. Supply chain resilience refers to the ability to prepare for, respond to, or recover from disruptions in a timely and effective manner to move to a more optimal operating state after the disruption.

Li *et al.* identified six key antecedents in the “supply chain resilience” framework ^[4], including dynamic capabilities and organizational initiatives, and explored their impact on resilience through factors like resource integration and organizational flexibility. Liang *et al.* found that the three dimensions of supply chain resilience—readiness, alertness, and agility—significantly affect firm financial performance ^[5]. Sharma Satyendra Kumar *et al.* highlighted those factors like supply chain efficiency ^[6], collaboration, information technology, complexity, and supplier concentration are key drivers of resilience.

2.3. Research review

Despite the growing interest in “data assetization” and “supply chain resilience,” research at their intersection remains limited. Data assetization in China is still in its early stages, with most studies focusing on macro statistics and value assessment rather than on how it can enhance supply chain resilience. Similarly, supply chain resilience research often emphasizes traditional management strategies, overlooking the potential of data assets. Given that SRDI SMEs are vital to China's economy, understanding how data assetization impacts their supply chain resilience can fill existing research gaps and provide practical solutions for improving resilience in the digital economy, fostering high-quality development.

3. Research hypotheses

Data assetization removes time and space constraints, enabling efficient flow and integration of critical resources such as information, knowledge, and technology within SRDI SMEs' supply chains. By effectively utilizing data assets, companies can access real-time insights on market dynamics, customer demand, and inventory, facilitating comprehensive monitoring and accurate forecasting. This accelerates information transfer, promotes collaboration,

and enables resource sharing across the supply chain. As data assetization progresses, enterprise boundaries expand, forming a new value creation model based on data. Sharing data assets fosters collaboration and co-innovation, creating a strategically integrated ecosystem. In this ecosystem, enterprises can quickly identify and leverage complementary resources, building a stable supply chain that responds effectively to market changes and external risks. Based on this, the paper proposes the following hypothesis:

H1: Data assetization helps enhance the supply chain resilience of SRDI SMEs.

Data assetization, a key component of the digital economy, boosts enterprise innovation and supports real economy growth. By transforming data into valuable assets through analysis, orchestration, and governance, it provides clearer usage scenarios and market insights. This process reduces development costs and enhances the adoption of technologies like cloud computing, IoT, and AI, improving operational efficiency and fostering innovation for SRDI SMEs. Data assetization also facilitates collaborative innovation, enabling data sharing across supply chains, improving early warning systems, and reducing disruption losses. Based on this, the paper proposes the following hypothesis:

H2: Data assetization can improve the technological innovation vitality of enterprises, and then enhance the supply chain resilience of SRDI SMEs.

Data assets have significant positive externalities, enabling enterprises to access creditor information at lower costs, enhance trust, and alleviate financing issues for technological innovation. Digital finance has expanded financial services, improved capital utilization, and alleviated enterprise financing constraints. Data assetization boosts transparency, optimizes the information flow between enterprises and capital providers, and breaks data silos. This improves resource allocation, profitability, and financial support, which strengthens supply chain management, production efficiency, and resilience. Based on this, the paper proposes the following hypothesis:

H3: Data assetization can alleviate financing constraints and thus enhance the supply chain resilience of SRDI SMEs.

4. Study design

4.1. Sample selection and data sources

This paper uses data from A-share and New Third Board “small giants” listed companies (2011–2021). The SRDI concept was introduced in the 2011 “Report on China’s Industrial Development and Industrial Policy,” marking 2011 as the sample’s starting point. Based on He *et al.* ^[7], 786 “small giant” firms were identified, with further sample screening excluding financial industry firms, ST and ST firms, and those with missing data. The final sample includes 398 companies and 1,635 firm-year observations. To address outliers, the paper applies 1% winsorization to continuous variables, using financial data from the CSMAR database.

4.2. Definition of variables

4.2.1. Explained variable: Supply chain resilience (SCR)

This paper measures supply chain resilience using two indicators: supply chain relationship stability (SCRe) and supply chain resistance (SCRn). SCRe, based on Cull *et al.* ^[8], is the natural logarithm of the ratio of accounts receivable to revenue, where lower values indicate stronger supply chain relationships. SCRn, following Wang *et al.* ^[9], is calculated using the Herfindahl index, which measures a firm’s dependence on its top five customers. Higher values suggest greater exposure to customer churn risks. The supply chain resilience (SCR) index is calculated as $SCR = 0.5 \times SCRe + 0.5 \times SCRn$.

4.2.2. Core explanatory variable: Degree of enterprise data assetization (DA)

Based on the existing studies, this paper takes the texts of laws and regulations related to data assets as the corpus, and uses “information,” “network,” “digital” and “data” as the seed words to construct the similar word sets of these four seed words using Word2Vec neural network model and deep learning technology. “data” as the seed vocabulary, using Word2Vec neural network model and deep learning technology to construct the similar words of these four seed vocabulary words, and referring to the study of He *et al.* ^[2], we classify the data assets into own-use data assets (ODA) and transactional data assets (DDA) according to the specific use, so that we can analyze the enterprise data assets more deeply, and then we can analyze the data assets more deeply, so that we can analyze the enterprise data assets more deeply. Thus, the value of enterprise data assets can be analyzed more deeply.

4.2.3. Control variable

Referring to Zhang *et al.* ^[10], this paper selects the following characteristic variables to further control the potential factors affecting firms’ supply chain resilience. These include: firm size (size, natural logarithm of total assets at the end of the year), firm age (EstAge, years of establishment), gearing ratio (LEV, total liabilities /total assets), growth (Growth, growth in total assets at the end of the year/total assets at the beginning of the year), net cash flow (OCF, net cash flow from operating activities/total assets), and return on total assets (ROA), net profit/total assets.

4.3. Model construction

To test the impact of data assetization on the supply chain resilience of SRDI SMEs, the benchmark regression model of this paper is set as follows:

$$SCR_{it} = \beta_0 + \beta_1 DA + \beta_2 Controls_{it} + \varepsilon_{it} \quad (1)$$

In Eq. (2), i and t denote enterprise and time, respectively; the explanatory variable SCR represents supply chain resilience; the explanatory variable DA represents the degree of data assetization, and the coefficient β_1 denotes the degree of DA’s influence on supply chain resilience; controls are an enterprise-level control variable. All regressions control for industry fixed effects (Ind) and year fixed effects (Year).

To test H2 and H3, this paper refers to the mediation effect research method of Jiang ^[11], and simplifies the mediation effect three-step test model to a two-step method. Set up model (2) to examine the impact of the technological innovation role mechanism, and set up model (3) to examine the impact of the financing constraints role mechanism:

$$InTen_{it} = \beta_0 + \beta_1 DA + \beta_2 Controls_{it} + \varepsilon_{it} \quad (2)$$

$$FC_{it} = \beta_0 + \beta_1 DA + \beta_2 Controls_{it} + \varepsilon_{it} \quad (3)$$

Following Shi *et al.* ^[12], we measure corporate technological innovation (InTen) using the ratio of R&D investment to operating income. For financing constraints (FC), we adopt Li *et al.*’s approach, constructing an index from six indicators: cash ratio, firm size (log of total assets), age, liquidity ratio, fixed assets ratio, and accounts receivable ratio. The index is standardized after summation. All other variables align with Model (1).

5. Empirical results and analysis

5.1. Descriptive statistical results

Table 1 shows the results of descriptive statistics of the main research variables. From the overall sample, the standard deviation of supply chain resilience is 9.8785, the maximum value is 49.505, and the minimum value is 0.565, indicating that there are large differences in supply chain resilience among different enterprises; the mean

value of “data assets” is 3.3322, the maximum value is 6.3682, and the minimum value is 0, which indicates that the level of data assets of the sample enterprises is generally not high. The data asset level is not high in general.

Table 1. Summary statistics

	<i>N</i>	Mean	Standard deviation	Median	Min	Max
SCR	1635	17.86	9.8785	15.6925	0.565	49.505
DA	1635	3.4149	0.5899	3.3322	0	6.3682
ODA	1635	3.3834	0.5648	3.3322	0	6.3333
DDA	1635	0.506	0.8033	0	0	4.8903
Size	1635	12.0454	0.6771	11.9959	10.5238	14.2978
EstAge	1635	17.1584	5.0967	17	2	45
LEV	1635	0.2954	0.1582	0.2704	0.0467	0.7522
Growth	1635	0.1706	0.2586	0.109	-0.2115	1.5304
OCF	1635	0.0432	0.0609	0.0439	-0.1364	0.2032
ROA	1635	0.0505	0.0594	0.0501	-0.1882	0.2177

5.2. Data assetization and supply chain resilience for SRDI SMEs

The regression results of model (1) are shown in **Table 2**. From column (1), the regression coefficient of DA is significantly negative at the 1% level, indicating that data assetization helps to promote the supply chain resilience of SRDI SMEs. The results in columns (2) and (3) show that the regression coefficients of ODA are significantly negative at the 5% level, and the regression coefficients of DDA are significantly negative at the 1% level, which shows that both data assets for personal use and transactional data assets can help to improve the supply chain resilience of SRDI SMEs, and H1 has been verified. H1 is validated.

Table 2. Results of the benchmark regression analysis

Variable	(1)	(2)	(3)
	SCR	SCR	SCR
DA	-1.3404*** (-2.7125)		
ODA		-1.3149** (-2.5356)	
DDA			-1.1536*** (-3.6710)
cv	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
N	1635	1635	1635
adj. R^2	0.1106	0.1101	0.1128

Note: *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively, with *t* statistics in parentheses, as in the table below.

5.3. Examinations of the mechanism of data assetization and supply chain resilience of SRDI SMEs

The regression results of model (2) and model (3) are shown in **Table 3**. The regression results in **Table 3** show that data assets (DA, ODA, DDA) significantly enhance technological innovation and supply chain resilience at the 1% level (columns 1–3). Technological innovation improves adaptability, helping businesses better manage supply chain uncertainties, thus verifying H2. Columns (4)–(6) demonstrate that data assets significantly alleviate financing constraints, with DA, ODA, and DDA having negative coefficients at the 1% and 10% levels. By easing financing constraints, data assets enable firms to secure the financial support needed for smooth supply chain operations, verifying H3.

Table 3. Mechanism analysis

Variable	Technological innovation			Financing constraints		
	(1)	(2)	(3)	(4)	(5)	(6)
DA	0.0040*** (4.4165)			-0.0123*** (-3.4631)		
ODA		0.0040*** (4.2157)			-0.0123*** (-3.3141)	
DDA			0.0027*** (4.1282)			-0.0049* (-1.8965)
cv	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
N	1635	1635	1635	1635	1635	1635
adj. R^2	0.1838	0.1828	0.1822	0.5704	0.5702	0.5686

5.4. Robustness tests

5.4.1. Endogeneity test

Since disclosing the top five customer or supplier information is optional, some firms may not disclose it, causing potential self-selection bias. To address this, the paper applies the Heckman two-stage model, with the first stage using disclosure (Discl) as the dependent variable. The results in **Table 4** show that the IMR coefficients are significant, and the coefficients for DA, ODA, and DDA remain significantly positive at the 1% level.

Table 4. Heckman's two-stage regression results

	Stage 1	Stage 2
DA	-1.3240*** (-2.6699)	
ODA		-1.2944** (-2.4868)
DDA		-1.1743*** (-3.7289)

Table 1 (Continued)

	Stage 1		Stage 2	
IMR		-0.0128*	-0.1153**	-0.5646**
		(-1.9069)	(-2.2076)	(-2.3073)
cv	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	1592	1592	1592	1592
R ²	0.1068	0.1228	0.1224	0.1254

5.4.2. Exclusion of alternative interpretations

(1) The Ministry of Industry and Information Technology (MIIT) released the first batch of “small giants” enterprises with specialties and specialties in 2019, so the post-2019 samples are excluded from the regression, and the results of Column (2) As shown in column (2) of **Table 5**, the regression coefficient of DA is still significantly negative at the 1% level, suggesting that data assetization still enhances supply chain resilience during periods of weak policy support. (2) Related studies have pointed out that digital transformation can improve supply chain resilience^[13,14]. We introduce two control variables in the baseline model: the share of digitization technology in intangible assets (DCG1) and the composite index of digital transformation in the CSMAR database (DCG2). Columns (3)–(4) of **Table 5** show that the coefficients of DA are significantly negative at the 5% and 10% levels, respectively, after controlling for the digitization process, confirming that the uplift effect of data assetization is independent of digital transformation factors.

Table 5. Results of robustness test

	(2) SCR	(3) SCR	(4) SCR
DA	-2.5863***	-1.0948**	-0.8462*
	(-4.1536)	(-2.2521)	(-1.6550)
DCG1		-4.0232**	
		(-2.2927)	
DCG2			-0.0093***
			(-3.6671)
cv	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
N	767	1620	1620
R ²	0.1003	0.1136	0.1181

6. Further analysis: Heterogeneity test

6.1. Nature of enterprise

- (1) In grouping firms by size, regression results from columns (1)–(2) of **Table 6** show that data assetization significantly enhances supply chain resilience in larger firms but has no significant effect in smaller

ones. Larger firms benefit from more advanced data capabilities, greater access to resources such as talent and capital, and a central role in the supply chain, allowing them to integrate data into R&D and manufacturing more effectively.

- (2) In terms of industry, the analysis in columns (3)–(4) reveals that data assetization’s impact on supply chain resilience is more pronounced in manufacturing firms. These firms typically have strong technological foundations (e.g., smart factories, industrial internet), enabling them to incorporate data assets efficiently into supply chain management, which often involves longer chains and external supplier networks. This leads to enhanced transparency and efficiency, strengthening overall supply chain resilience.

Table 6. Results of heterogeneity analysis of firm characteristics

	(1) Large enterprise size	(2) Small enterprise size	(3) Manufacturing	(4) Non-manufacturing
DA	-1.6700*** (-2.6911)	-0.7766 (-0.9609)	-1.7547*** (-3.2979)	-0.8030 (-0.5791)
cv	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
<i>N</i>	814	806	1465	155
adj. <i>R</i> ²	0.1392	0.0967	0.1159	0.0663

6.2. External environment

- (1) Using the Economic Policy Uncertainty (EPU) index, this study measures the impact of economic policy uncertainty on supply chain resilience. As shown in columns (1)–(2) of **Table 7**, data assets significantly enhance supply chain resilience in high-policy-uncertainty environments. In such conditions, businesses face greater risks and inefficiencies, but data assets help analyze complex information and utilize tacit knowledge, allowing companies to adapt and collaborate more effectively to manage risks.
- (2) Based on the marketization index from Wang *et al.* ^[15], the study divides firms into high and low marketization groups. The results in columns (3)–(4) of Table 8 indicate that in low-marketization regions, data assets have a stronger impact on supply chain resilience. Firms here rely more on data to manage information asymmetry and competition, benefiting from more time and policy support for data asset investments.

Table 7. Results of heterogeneity analysis of the external environment

	(1) High economic policy uncertainty	(2) Low economic policy uncertainty	(3) High level of marketization	(4) Low level of marketization
DA	-2.7836*** (-3.7686)	-0.7371 (-1.2113)	-0.6611 (-0.9400)	-2.5776*** (-3.4358)
control variables	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
<i>N</i>	531	1089	770	850
adj. <i>R</i> ²	0.0735	0.1244	0.1085	0.1525

7. Conclusion and policy implications

This study demonstrates that data assetization improves supply chain resilience in Chinese SRDI SMEs by reducing financing constraints and boosting innovation. The effect is stronger in large firms, manufacturing sectors, regions with high economic policy uncertainty, and low marketization levels.

The findings offer the following policy implications: (1) Integrate data assets into supply chain management. Governments should refine data accounting standards under the Data Element X Three-Year Action Plan (2024–2026) ^[16]. Firms need cross-department data governance frameworks to enhance transparency. Manufacturing SMEs could adopt IoT and blockchain through targeted subsidies. (2) Enhance data-driven financial services. Regulators can leverage the Fintech Development Plan (2022–2025) to promote bank-SME data sharing and expand blockchain-based data collateral pilots ^[17]. Financial institutions should develop real-time transaction-driven supply chain finance tools. (3) Foster data-enabled innovation ecosystems. Local governments should build industry-specific data spaces and incentivize AI-driven forecasting models. Tax breaks for R&D data utilization can further stimulate innovation.

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Research on the Development Path of Precision Agriculture Based on Big Data Application

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Abstract: With the continuous advancement of big data technology, its application in precision agriculture is becoming more and more extensive, which provides a new path for agricultural modernization. Based on the background of big data technology, this paper discusses the development path of precision agriculture. The research shows that the application of big data technology in precision agriculture is mainly reflected in crop growth monitoring and prediction, soil fertility assessment and regulation, water resources management and optimization, agricultural product traceability and origin tracing, and agricultural product supply chain management and risk control. However, the application of big data technology in the agricultural field still encounters numerous challenges, such as data collection and processing, data analysis and application, and privacy protection and security. To this end, this paper puts forward countermeasures, including strengthening infrastructure construction and establishing data sharing and management mechanisms.

Keywords: Big data; Precision agriculture; Development path

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1. Overview of the application of big data in precision agriculture in the Zhejiang Province of China

1.1. Big data infrastructure construction

Through the construction of the smart agriculture cloud platform and rural brain, Zhejiang Province has realized the efficient integration and application of agricultural data. The smart agriculture cloud platform integrates agriculture-related resources at all levels of provinces, cities and counties ^[1], forming a framework of “one platform, one center, and N applications,” covering data in multiple fields such as agricultural industry, Internet of Things, plant protection, agricultural machinery, and animal husbandry. In addition, the “11153” core framework has been built by the Rural Brain, which has achieved full integration at the provincial, municipal, and county levels, with an average daily visit of more than 1.2 million times.

Focusing on agricultural intelligence, rural intelligent governance ^[2], and farmers’ prosperity, we use digital technology to integrate computing power, data, algorithms, models, intelligent modules and other resources, build one warehouse, one map, one code, five libraries, three capabilities and 16 intelligent series of multi-cross

application scenarios, and collect 1.6 billion pieces of data on agriculture, rural economies, and rural areas, which has effectively boosted the scientific decision-making [3], precise governance, and efficient service of agricultural and rural departments at all levels.

1.2. Precision agricultural production driven by big data

Through the combination of big data and Internet of Things technology, Zhejiang Province has promoted the wide application of precision agriculture (Figure 1) [4]. For example, in the “Tian Cube” Future Farm in Linping District, real-time field data is collected through intelligent equipment such as water quality sensors, insect monitors, and weather stations to provide accurate decision-making support for agricultural production. In addition, Zhejiang has also promoted new planting technologies such as “aeroponics,” and used big data analysis to optimize the growth environment of fruits and vegetables, which significantly improved yield and resource utilization efficiency.

In terms of grain output, from 6.21 million tons in 2022 to 6.502 million tons in 2024, the growth has achieved a qualitative leap.

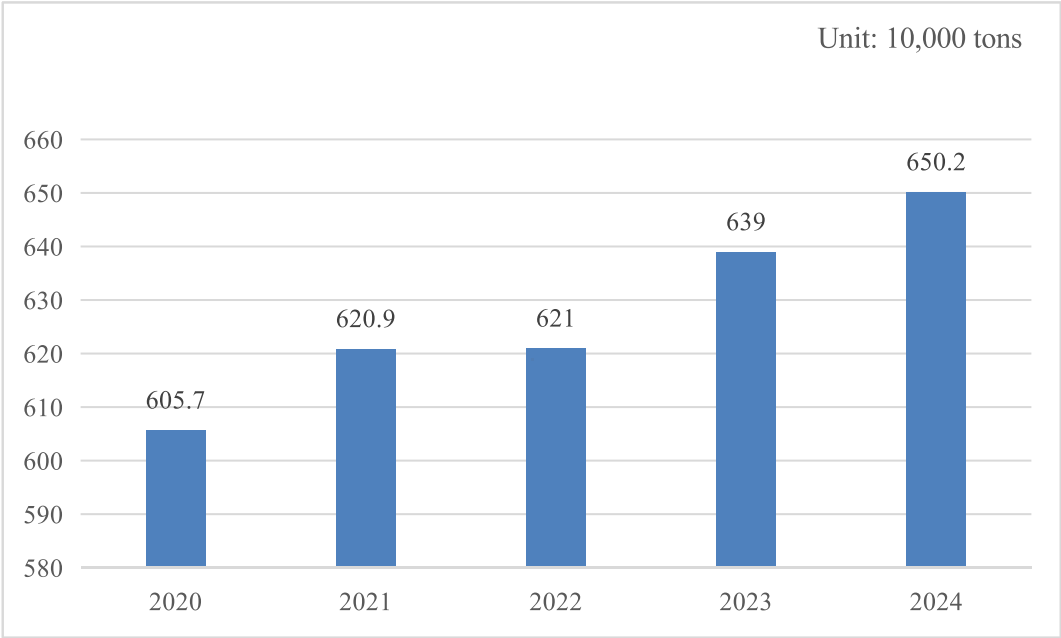


Figure 1. Total grain production in Zhejiang Province, China (2020-2024)

To demonstrate that the application of big data drives the development of precision agriculture, we collected data on the yield of 14 regions in Zhejiang Province before and after the use of digital farms. The following analysis uses hypothesis testing to make a point:

Formulate hypotheses:

$$H_0\colon \mu_1 \geq \mu_2$$

(The use of digital farms has no significant impact on the increase of food production)

$$H_0\colon \mu_1 < \mu_2$$

(The use of digital farms has a significant impact on the increase of food production)

Argumentation process:

Conclusion: $P = 0.35 < \alpha = 0.05$ can be seen from the analysis (Table 1). Based on the results obtained, the following judgment can be made: The P -value falls into the rejection domain. Therefore, there is no good reason for the null hypothesis to be true; it can be assumed that the use of digital farms has a significant impact on the increase in food production.

Table 1. Hypothesis paired samples test by SPSS analysis

	Mean	Std deviation	Std error mean	Lower	Upper	t	df	Sig
Before using digital After using digital farming	8464.17857	13458.19002	16234.70614	16234.70614	693.65100	2353	13	0.035

1.3. Optimizing resource allocation to achieve sustainable development

Zhejiang Province has achieved the efficient allocation of agricultural resources through digital tools ^[5]. For example, the smart agriculture cloud platform and the “Zhejiang Agricultural Code.” In addition, as a digital ID card for agricultural subjects and agricultural products, the “Zhejiang Agricultural Code” realizes the resource optimization of the whole chain of agricultural production through data integration and sharing. The Internet of Things (IOT), big data, and artificial intelligence (AI) technologies are widely used in precision agriculture to promote sustainable agricultural development ^[6]. At the same time, the intelligent irrigation system automatically adjusts the amount of irrigation according to soil moisture and crop water demand, saving water resources.

2. Problems in precision agriculture with big data applications

2.1. Data sharing and integration

There are many challenges in the sharing and integration of big data in precision agriculture. On the one hand, there are obstacles to data sharing, as data owners are unwilling or unable to share data due to security and privacy concerns, unclear distribution of benefits, differences in standards and norms, and insufficient legal protection. On the other hand, data integration is difficult, data sources are scattered in multiple departments and fields, making them hard to collect, technical obstacles are brought about by the inconsistency of technical platforms in various places, and the quality of data is uneven due to complex terrain.

2.2. Data quality and standards issues

Big data helps precision agriculture face the dual dilemma of data quality and standards. On the other hand, the complex terrain and diversified agricultural industries make it difficult to ensure the accuracy of data collection, the timeliness of update is poor, and the operation of some farmers is not standardized, leading to frequent errors, missing data, or lags in soil, climate, and crop growth data, which cannot provide a reliable basis for agricultural decision-making. On the other hand, the equipment used by agricultural operators in the province varies greatly, the data formats and units are inconsistent, and the classification of agricultural data is not clearly defined, this leads to the difficulty of data aggregation and integration, which greatly restricts the in-depth application of big data in precision agriculture and hindering its progression to a higher stage of development.

2.3. The development of major digital agriculture regions is unbalanced

In Zhejiang Province, the application of big data to precision agriculture has an obvious problem of unbalanced regional development (**Figure 2**) ^[7]. On the one hand, Hangzhou, Jiaxing, and other regions with relatively developed economies and concentrated scientific and technological resources have made remarkable achievements in the construction of digital agricultural factories and future farms by their abundant capital, technology and talent advantages. On the other hand, some economically underdeveloped areas such as Lishui and Quzhou are located in mountainous areas, limited by factors such as insufficient capital investment, lack of professional talents, and weak infrastructure, the development of big data precision agriculture lags, agricultural production still relies more on traditional experience, less application of intelligent equipment, poor data collection and processing capabilities, and the gap between regions significantly hinders the overall coordinated promotion of precision agriculture in

Zhejiang Province.

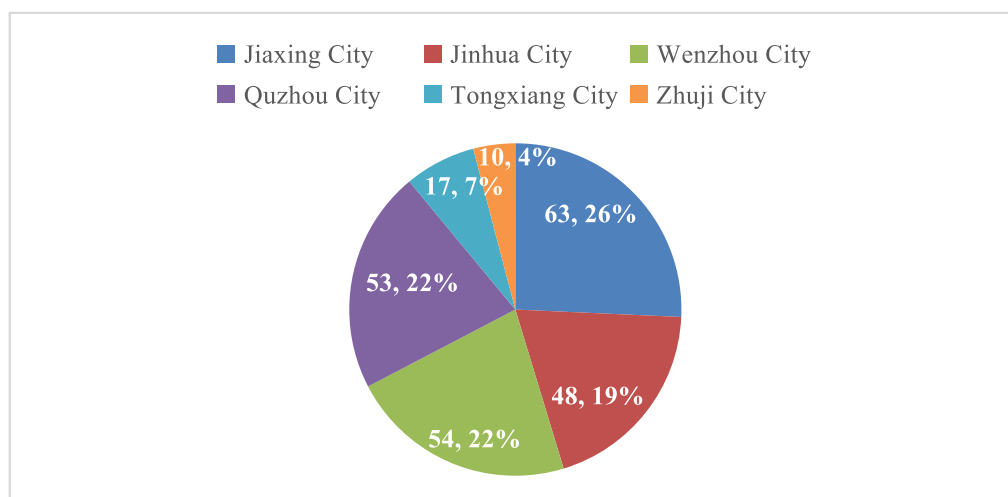


Figure 2. Number of digital farms in Zhejiang Province, China, by region in 2024

3. The practical basis for the application of big data in precision agriculture

3.1. The application of various technologies provides support for the application of big data in precision agriculture

The application of big data in precision agriculture has a solid technical foundation ^[8]. Firstly, high-precision sensors, UAVs (unmanned aerial vehicles), aerial photography, and satellite remote sensing are widely used to accurately collect data on farmland, soil, meteorology, and crop growth, providing rich material for subsequent analysis. Then, with the developed 5G network covering the countryside, relying on the Internet of Things to realize the intelligent management and control of agricultural machinery and irrigation systems to ensure high-speed and stable data transmission. Finally, the local cloud computing platform provides massive storage support with the help of continuously optimized big data analysis tools and algorithms and uses machine learning and other technologies to dig deep into information, providing a scientific basis for precision agriculture decision-making and facilitating the comprehensive development of Zhejiang's precision agriculture.

3.2. The data resource base provides a guarantee for the application of big data in precision agriculture

The data resource base lays a solid foundation for the precise empowerment of agriculture by big data. For example, Zhejiang Mobile's "Digital Field" project uses high-precision sensors to collect soil temperature, humidity, pH, etc. in Nanxun, Huzhou, and optimizes fertilization based on soil data. Collect meteorological information with the help of small weather stations to guide agricultural adjustments. Jiaxing Tongxin Seedling Digital Agriculture Factory integrates multiple technologies to monitor and control the growth trend of crops; Ningbo Fenghua's "Water Garden" AI system identifies diseases and intelligently regulates them according to crop and environmental data.

3.3. Demand for high-quality agricultural industry

In Zhejiang Province, there is a strong demand for the application of big data in precision agriculture. On the one hand, local consumers have stringent requirements for the quality of agricultural products, focusing on the characteristics of taste, nutrition, and green safety, prompting agricultural producers to use big data to precisely track the whole process of agricultural products, optimize production conditions based on soil, climate

and other data, and ensure the quality and stability of products ^[9]. On the other hand, land and water resources are scarce in Zhejiang, and big data can assist in precise fertilization and optimizing irrigation based on soil nutrients, weather forecasts and other information, thereby improving resource utilization efficiency.

According to a questionnaire survey of 1,000 consumers (**Table 2**), 58% of consumers attach great importance to the taste of agricultural products, as shown in **Figure 3**.

Table 2. Consumers' attention to the taste of agricultural products

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Very much taken seriously	580	58.0	58.0	58.0
	Pay more attention	320	32.0	32.0	90.0
	General	80	8.0	8.0	98.0
	Not much attention	20	2.0	2.0	100.0
	Total	1000	100.0	100.0	

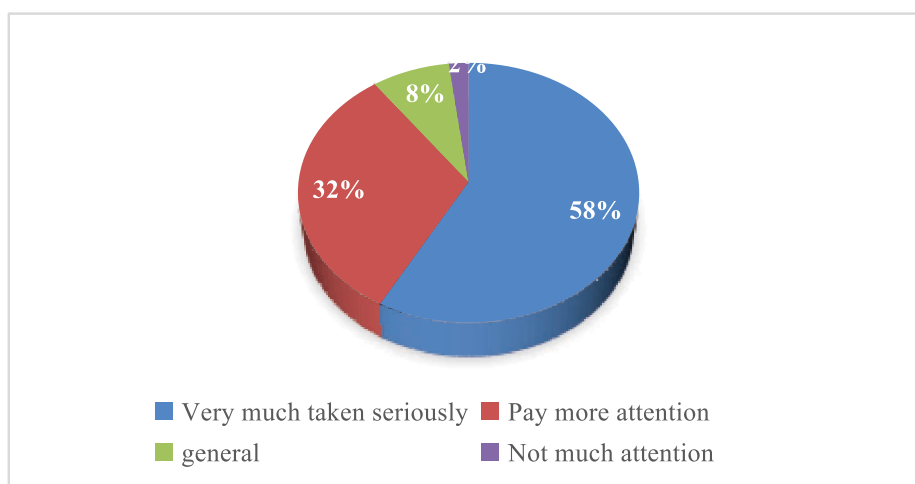


Figure 3. Proportion of consumers attaching importance to the taste of agricultural products

4. The path selection of big data applied to precision agriculture

4.1. Data collection and integration

To apply big data to precision agriculture, data collection and integration are the foundation and support of everything. On the one hand, data collection is diverse and sophisticated. The sensor network is like the “nerve endings” of the farmland, monitoring soil moisture, temperature, nutrients, light, gas, and other conditions in real time and accurately feeding back the microenvironment of crop growth. On the other hand, data integration is efficient and orderly ^[10]. First, build an agriculture-specific big data platform and aggregate and store multi-source data such as sensors, remote sensing, agricultural machinery, meteorology, and traceability according to unified standards. Then, the combination of algorithms and manual methods is utilized to clean and preprocess the data, eliminate errors and redundancy, correct format deviations, and enhance data availability.

4.2. Analysis of data

If data collection and integration is the foundation, then data analysis is the essence. First, build a dedicated platform for agricultural big data, and aggregate data from various sources such as sensors, remote sensing, agricultural machinery, meteorology, and traceability according to unified standards; Eliminate duplicates,

errors, and incomplete data, calibrate deviations, and unify the format to make the data pure and usable; With the help of machine learning and deep learning cutting-edge technologies, we can mine internal correlations. Break the boundaries of departments, institutions, and subjects, establish a data sharing ecology, and the government, scientific research, enterprises, and farmers can access and share according to their authority, collaboratively contributing to the development of precision agriculture.

4.3. Decision support and risk management

In the field of precision agriculture, big data provides a scientific basis for decision-making. By integrating real-time data such as soil and climate collected by field sensors, crop growth dynamic images obtained by satellite and UAV remote sensing, and multi-source information including agricultural machinery operation records, data mining and machine learning algorithms are employed for in-depth analysis to accurately determine the current growth status of crops, required nutrients and water, thereby guiding farmers on the optimal times for watering, fertilizing, and sowing seeds, as well as selecting the most suitable crop varieties.

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The Current Situation and Trends of Trusted Execution Environment Applications

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Abstract: With the rapid development of digital technologies such as big data, cloud computing, and the Internet of Things (IoT), data security and privacy protection have become the core challenges facing modern computing systems. Traditional security mechanisms are difficult to effectively deal with advanced adversarial attacks due to their reliance on a centralized trust model. In this context, the Trusted Execution Environment (TEE), as a hardware-enabled secure isolation technology, offers a potential solution to protect sensitive computations and data. This paper systematically discusses TEE's technical principle, application status, and future development trend. First, the underlying architecture of TEE and its core characteristics, including isolation, integrity, and confidentiality, are analyzed. Secondly, practical application cases of TEE in fields such as finance, the IoT, artificial intelligence, and privacy computing are studied. Finally, the future development direction of TEE is prospected.

Keywords: Trusted execution environment; Data security; Privacy protection; Cloud computing

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1. Introduction

With the rapid development of digital technologies such as big data, cloud computing, and the Internet of Things (IoT), industries and social structures around the world are undergoing profound transformation. These technological advancements have brought unprecedented connectivity, data generation, and computing power, driving innovation in areas such as smart cities, healthcare, and industrial automation. However, this technological advance has also given rise to significant challenges related to data security and privacy. Processing and storing sensitive data in a distributed environment exposes it to risks such as unauthorized access, data breaches, and cyber-attacks^[1]. Traditional security mechanisms, which rely on a centralized trust model and struggle to deal effectively with advanced adversarial technologies, fall short in dealing with these threats. In this context, the concept of a Trusted Execution Environment (TEE) has emerged as a potential solution to these problems. The TEE is a secure isolated area in the processor that is used to isolate sensitive computing from the rest of the system^[2]. It can ensure that the code and data within the secure zone remain confidential and tamper-proof even if the operating system or hypervisor is breached. Hardware-based TEE

technologies such as Intel SGX and ARM TrustZone have received a lot of attention for their strong security capabilities in a variety of applications such as cloud computing and IoT devices ^[3].

The importance of TEE lies in its ability to address key security issues in modern computing environments. By isolating sensitive computing and protecting encryption keys, TEE effectively reduces the risk posed by untrusted hosts or malicious insiders. For example, in IoT applications, TEE protects the integrity of devices and prevents control logic from being tampered with by unauthorized operations ^[4]. In addition, TEE plays an important role in supporting the financial sector, cloud computing, and the IoT, among others. It also helps financial institutions and businesses meet increasingly stringent regulatory requirements by providing verifiable security for sensitive operations.

2. Basic concepts and technical principles of trusted execution environment

2.1. Definition of trusted execution environment

TEE is a secure area in a processor that ensures the confidentiality and integrity of code and data during execution. It operates independently of the main operating system and other applications, providing an isolated execution environment that is resistant to tampering and unauthorized access. TEE is designed to protect sensitive computing and ensure security even if the operating system or hypervisor is breached. This isolation feature makes TEE a core technology in modern secure computing systems.

2.2. The role of trusted execution environments

The primary role of TEE is to provide a trusted execution environment for critical operations, such as encrypted computing, secure data storage, and privacy protection algorithms. By isolating sensitive processes, the TEE can defend against security risks such as malware, side channel attacks, and insider threats. TEE is widely used in fields such as mobile payments, digital rights management (DRM), cloud computing, and IoT security.

2.3. Core features of a trusted execution environment

TEE's functionality is defined by the following three core features:

- (1) Isolation: The TEE establishes a clear boundary between the secure environment and the rest of the system, ensuring that sensitive operations are not interfered with by untrusted components such as the operating system or other applications.
- (2) Integrity: The TEE guarantees that the code executed within its premises will not be tampered with and the data processing will not be subject to unauthorized modifications.
- (3) Confidentiality: The TEE protects the security of sensitive information during the calculation process and prevents the data from being accessed or leaked. This includes encryption keys, user credentials as well as the protection of proprietary algorithms.

2.4. Technical principles

TEE achieves its security objectives through the combination of hardware and software components, and its working mechanism includes the following aspects:

2.4.1. Hardware support

- (1) Intel SGX (Software Protection Extension): Intel SGX creates isolated “enclaves” within the CPU's address space for the safe execution of applications. These safe zones are protected by memory encryption and prevent access by other processes and even privileged software such as the operating system ^[5].

- (2) ARM TrustZone: TrustZone divides the processor into two worlds, which are the “Secure World” and the “Normal World.” Hardware-enforced isolation ensures that sensitive computing in the secure world is not interfered with by the normal world ^[6].
- (3) AMD SEV (Secure Cryptographic Virtualization): AMD SEV ensures data security by encrypting virtual machine memory to achieve isolation between virtual machines and between virtual machines and hypervisors.

2.4.2. Software support

- (1) Remote attestation: TEE integrates basic primitives for trusted computing, such as remote authentication. Remote authentication allows an external entity to verify the integrity of the TEE environment by generating cryptographic proofs to prove its state.
- (2) Security API: The TEE provides a secure application programming interface (API) that enables applications to call the TEE for encryption operations, data encapsulation, as well as secure communication.

2.5. Key components of a trusted execution environment

The TEE’s functionality relies on the following key components:

- (1) Secure memory: Dedicated memory areas are encrypted and isolated to prevent unauthorized access or tampering during computation ^[7].
- (2) Trusted computing base (TCB): The TCB includes all hardware and software components that are critical to the TEE’s secure properties.
- (3) Encryption technology: The data processed internally by the TEE is encrypted during static storage and transmission to ensure confidentiality. The advanced encryption technology also supports secure key management and data encapsulation.
- (4) Remote authentication: The remote authentication mechanism allows remote verification of the integrity of the TEE through proof of encryption, thereby enhancing trustworthiness.

3. Application status of trusted execution environment

3.1. Financial field

The financial sector is highly sensitive to data breaches, fraud, and privacy violations, so the need for secure systems is particularly pressing. TEE plays a key role in securing payment data and ensuring the privacy of transactions, as well as preventing fraud.

- (1) Payment data protection: TEE isolates payment processing operations from the main operating system, ensuring the security of sensitive data such as credit card information and authentication credentials. For example, mobile payment systems such as Google Pay and Apple Pay utilize TEE to secure user data during transactions.
- (2) Transaction privacy: TEE supports secure multi-party computing (SMPC) and can process transactions without exposing sensitive information. This is particularly important in cross-border payments and anti-money laundering (AML) systems, where privacy and compliance requirements are extremely high ^[8].
- (3) Fraud prevention: By integrating machine learning models in TEE, financial institutions can detect fraudulent activity in real time while avoiding exposing sensitive data.

3.2. Cloud computing

Cloud computing has revolutionized the way data is stored and processed, but it also brings data security and privacy challenges. TEE addresses these issues effectively by enabling secure and private computing in a cloud environment.

- (1) Data encryption computing: TEE allows encrypted data to be processed securely without being decrypted, thereby maintaining the confidentiality of the data throughout the calculation process. For example, the Federated Learning framework leverages TEE to train machine learning models on distributed datasets while protecting data privacy ^[9].
- (2) Privacy protection: TEE supports a remote authentication mechanism to ensure the integrity of cloud applications. By isolating sensitive operations within a secure zone such as Intel SGX or AMD SEV, TEE provides strong security against insider threats and malicious attacks ^[10].

3.3. Internet of Things (IoT)

The rapid adoption of IoT devices has raised concerns about data security and privacy due to their limited computing resources and vulnerability to cyber threats. TEE offers a powerful solution for securing the IoT ecosystem.

- (1) Smart device security: TEE protects critical operations on IoT devices by isolating sensitive computing from untrusted components. For example, ARM TrustZone is widely used in IoT devices to create a secure execution environment for critical operations ^[11].
- (2) Protect against malicious attacks: By integrating blockchain technology with TEE, IoT systems can achieve decentralized access control and auditability. Smart contracts are used to enforce access rules, while the TEE ensures that sensitive data remains confidential during execution ^[12].

3.4. Blockchain

Blockchain technology offers decentralized security but lacks built-in privacy protections due to its transparency. TEE compensates for this shortfall by supporting confidential computing and secure smart contract execution.

- (1) Privacy protection: TEE encrypts all data outside the security zone to make it unidentifiable to untrusted network nodes. This ensures that sensitive blockchain transactions are still able to maintain privacy while maintaining the integrity of the ledger ^[13].
- (2) Secure smart contracts: By executing smart contracts in TEE, platforms like Hyperledger Fabric Private Chaincode enhance the security of decentralized applications (dApps). This approach prevents rollback attacks and ensures immutable execution ^[14].

3.5. Medical field

While protecting patient privacy, the healthcare industry also needs to enable secure data sharing to improve the quality of care. TEE offers a solid solution to address these challenges.

- (1) Patient privacy protection: TEE isolates sensitive calculations involving electronic health records (EHRs) from untrusted environments. This prevents unauthorized access to patient information during processing or storage ^[15].
- (2) Secure data sharing: By combining blockchain with TEE technology, healthcare systems can enable controlled sharing of patient data through smart contracts while remaining transparent and auditable. Decentralized authentication mechanisms, for example, leverage blockchain to enhance the credibility of TEE-based healthcare solutions.

4. Future trends in trusted execution environments

4.1. Next-generation TEE technology

TEE development is moving towards more efficient hardware support and flexible isolation mechanisms. Emerging hardware architectures are expected to integrate more advanced features, such as enhanced memory encryption and multi-world isolation, to address increasingly complex application needs. For example, solutions such as ARM TrustZone-M and Intel SGX are being continually optimized to reduce latency and improve scalability for resource-constrained devices such as IoT systems.

4.2. Integration with emerging technologies

TEE is deeply integrated with other advanced technologies to unlock more possibilities:

- (1) Artificial intelligence (AI): TEE is critical in privacy-protected AI applications, such as Federated Learning. With TEE, data can be processed securely without exposing sensitive data. For example, TEE enables secure model training on distributed datasets while maintaining the confidentiality of the data.
- (2) Blockchain: The combination of TEE and blockchain technology enhances the security of decentralized systems. TEE addresses key vulnerabilities in distributed ledger technology by providing a trusted environment for executing smart contracts and ensuring the privacy of blockchain transactions.

4.3. Privacy computing

TEE becomes indispensable in privacy computing applications:

- (1) Federated learning: TEE supports secure aggregation of distributed data in the Federated learning framework. This approach is widely used in healthcare and smart city solutions to train AI models without compromising user privacy.
- (2) Data sharing: In scenarios that involve sensitive data sharing, such as cross-agency collaboration, TEE ensures that data is protected at all times during processing. This is particularly important in industries such as finance and healthcare.

4.4. 5G and edge computing

The deployment of 5G networks and the rise of edge computing bring new opportunities for TEE applications:

- (1) Low-latency processing: TEE is ideal for edge devices that require low-latency secure processing. By performing secure computations close to the data source, TEE reduces the need to transfer data to a centralized server.
- (2) Smart infrastructure: In a 5G-enabled environment, TEE enhances the security of critical infrastructure by protecting critical operations from cyber threats.

5. Conclusion

This paper analyzes the technical principles of TEE and its wide application in the fields of finance, IoT, artificial intelligence, and privacy computing, demonstrating its key role in scenarios such as payment data protection, privacy-protected federation learning, and blockchain smart contract execution. At the same time, the paper also explores the future development trend of TEE. In the future, with the improvement of hardware efficiency and the improvement of the ecosystem, TEE will further promote innovative development in areas such as privacy computing, distributed systems, and edge computing, laying the foundation for building a more secure and trusted digital society.

Disclosure statement

The authors declare no conflict of interest.

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Research on the Digital Transformation of Corporate Finance Based on the Shared Services Model

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Abstract: Against the backdrop of the rapid development of the digital economy, corporate financial management faces unprecedented challenges and opportunities. This paper will start with the concept of financial shared services to deeply explore the role and significance of the financial shared service model in the digital transformation of corporate finance. It analyzes the existing problems in the current process of digital transformation of corporate finance and proposes corresponding solutions, providing valuable references and guidance for enterprises to achieve digital transformation of finance.

Keywords: Financial sharing; Service model; Corporate finance; Digital transformation

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1. Introduction

The rapid development of information technology has made digital transformation an inevitable choice for enterprises in all industries to enhance competitiveness and respond to market changes. Especially in the field of financial management, digital transformation is not only a trend but also key to achieving efficient operations and precise decision-making^[1]. The financial shared services model, as a new type of financial management approach, integrates the information flow, data flow, and business flow of enterprises. It standardizes and streamlines operations by integrating them onto a unified platform, thereby achieving efficient financial management and resource allocation. The core of the financial shared services model is to free financial personnel from tedious and repetitive tasks through the establishment of a financial shared services center, allowing them to focus more on enterprise value creation and decision support^[2]. This model not only improves the management efficiency and financial transparency of enterprises but also effectively reduces operational costs. In recent years, with the national emphasis on digital transformation, more and more large enterprise groups have begun to explore and practice this model and have achieved significant results. However, in the process of promoting shared financial services and digital financial transformation, enterprises still face many challenges, including insufficient cognitive understanding, lack of systematic planning, weak capacity building, and talent shortages. Therefore, it is urgent to explore optimization strategies to promote the digital transformation of enterprise finance.

2. Related concepts

2.1. Financial shared services model

The financial shared services model refers to the establishment of a financial shared services center that integrates financial operations within an enterprise that are easy to standardize and process onto a unified platform ^[3]. This model achieves centralized processing and efficient management of financial data. The core of this model lies in leveraging information technology to consolidate the enterprise's data flow, information flow, and business flow, eliminating information silos between departments, and providing consistent and high-quality financial services. The advantages of the financial shared services model are mainly reflected in improving work efficiency, reducing operational costs, enhancing financial transparency, and supporting strategic decision-making within enterprises. By centralizing financial operations, enterprises can better utilize resources, reduce repetitive labor, and improve the accuracy and timeliness of data, providing management with more valuable support for value creation and reliable decision-making ^[4].

2.2. Enterprise financial digital transformation

The financial shared services model is an essential tool for the digital transformation of enterprise finance. The so-called enterprise financial digital transformation refers to the systematic and comprehensive upgrading and transformation of traditional financial management models by introducing advanced digital technologies and tools ^[5]. This aims to achieve intelligent financial management, data-driven operations, and increased efficiency. The digital transformation of finance plays a significant role in enterprises, as it not only changes the way financial data is processed but also drives the role transformation of finance personnel ^[6]. It shifts them from traditional accounting and reporting to decision support and risk management. Additionally, it enables real-time monitoring and analysis of financial data and enhances the scientific nature of business management and the accuracy of decision-making, ultimately achieving efficient operation and strategic goals of the enterprise.

3. The necessity of building a financial sharing model in the digital economy era

3.1. Changes in the objective environment

With the rapid development of big data, cloud computing, artificial intelligence, and other technologies, the business environment in which companies operate has undergone profound changes, posing new challenges and demands for financial management ^[7]. First, digital technology has made companies face a more complex business environment and intense competitive pressure. To maintain an unbeatable position in the competition, companies must accelerate the pace of digital transformation of financial management and use advanced technological means to improve the efficiency and quality of financial management. The financial sharing model, as a new financial management approach, can effectively integrate internal and external resources of the enterprise, achieving the sharing of financial data, resources, and knowledge and enhancing the competitiveness of the enterprise. Second, the development of digital technology has led to issues such as information silos, low collaboration efficiency, and data security risks in corporate financial management ^[8]. The traditional financial management model can no longer meet the needs of enterprises, especially financial enterprises, in terms of efficiency, safety, and sustainability. The financial sharing model uses digital technology to break down information barriers, achieve real-time sharing and collaborative processing of financial information, reduce corporate operating costs, and improve financial management levels and risk prevention and control capabilities. In addition, digital technology has promoted the deep integration of enterprise business and finance. In the digital economy era, companies need to pay more attention to business-finance integration to achieve a close combination of business scenarios and financial data ^[9]. The financial sharing model can promote close collaboration between various departments within

the enterprise, optimize business processes, and enhance the synergy between business and finance, creating greater value for the enterprise.

3.2. Changes in organizational structure

With the rapid development of information technology, the organizational structure of enterprises is shifting from traditional hierarchical and regional structures to flat, intelligent, and global directions, providing a good opportunity for the construction of the financial sharing model. The flattening of organizational structures requires financial management work to be more efficient and flexible. In the digital economy era, enterprises face more rapid business changes and decision-making needs, and the traditional hierarchical financial management model cannot meet these requirements ^[10]. The financial sharing model, by centralizing financial affairs, simplifies financial management processes, improves financial management efficiency, and enables enterprises to respond quickly to market changes. In addition, the intelligence of organizational structures also requires the transformation of financial management work towards intelligence. Enterprises need to use advanced information technology to improve financial management levels ^[11]. The financial sharing model uses artificial intelligence, big data, and other technological means to achieve automatic collection, processing, and analysis of financial data, improving the automation and intelligence level of financial management and providing more accurate decision support for enterprises. Moreover, the globalization and networking of organizational structures require the internationalization and collaboration of financial management work. In the digital economy era, enterprises need to pay more attention to the integration and collaboration of global resources. The financial sharing model can establish a global financial sharing center to achieve unified allocation and collaborative processing of financial resources, improve the internationalization level of financial management, and enhance the global competitiveness of enterprises.

3.3. Transformation of professionals

With the development and application of information technology, the roles and skill requirements of finance professionals have undergone significant changes, providing momentum for the advancement of the financial sharing model. The digital economy era demands that finance professionals transition from traditional accounting and reporting roles to higher-level financial management roles ^[12]. The financial sharing model can free finance professionals from tedious accounting tasks, allowing them to devote more time and energy to strategic decision-making, risk management, and financial analysis, thereby enhancing their value and influence. This model not only requires finance professionals to master basic financial management knowledge but also to understand and apply information technology, data analysis, and other related knowledge and professional skills. This also helps enterprise finance professionals better adapt to the needs of the digital economy era, providing more comprehensive and in-depth financial management services for the enterprise. The advent of the digital economy era also requires finance professionals to possess innovative thinking and teamwork skills. The financial sharing model requires finance professionals to have an open mindset and teamwork skills, enabling them to work closely with other departments and teams to jointly promote the digital transformation and development of the enterprise. This will help finance professionals better adapt to the requirements of the digital economy era and enhance the overall competitiveness of the enterprise.

4. Issues in enterprise financial digital transformation based on the financial shared services model

4.1. Outdated thinking and difficulties in conceptual change

In the process of promoting shared financial services and financial digital transformation, many enterprises face

challenges in terms of cognitive understanding. Some enterprise management and staff have an insufficient understanding of financial digital transformation and exhibit outdated thinking and resistance. While management is aware of the concept of financial shared services, they often lack a deep understanding of its value, perceiving it merely as a technological change rather than a strategic transformation ^[13]. This leads to a superficial implementation of the financial shared services model, failing to fully explore its potential. Moreover, grassroots financial personnel have a low acceptance of new technologies, worrying about job stability, and lack active participation and cooperation, further hindering the advancement of financial digital transformation. The lag and resistance in cognitive thinking make it difficult for enterprises to achieve the expected outcomes during the transformation process.

4.2. Lack of planning and unclear pathways

Many enterprises face issues when promoting financial shared services and financial digital transformation. Due to a lack of systematic and comprehensive planning, the transformation process becomes disorderly and inefficient. Some companies, without adequate preliminary assessment and research, blindly pursue transformation by directly copying other companies' successful experiences or introducing popular theories and tools without considering their actual situation and business needs. The lack of a clear strategic plan and detailed implementation path can lead to poor inter-departmental coordination and unreasonable resource allocation in the construction of financial shared services models, causing a disconnect between system construction and the actual business processes of the enterprise ^[14]. Furthermore, the absence of a long-term transformation plan makes it difficult for enterprises to effectively respond to various challenges and changes encountered during the transformation process, hindering the smooth progress of financial digital transformation.

4.3. Weak technology and severe data silos

Financial shared services and financial digital transformation require enterprises to have strong information construction capabilities and data empowerment capabilities. However, many enterprises have a relatively weak foundation in this area. The construction and maintenance of information systems are costly, and some enterprises, due to limitations in funding and technical resources, have not yet established comprehensive information systems, making it difficult to effectively integrate and utilize data. Existing information systems generally have issues such as non-uniform data standards and incompatible interfaces, leading to difficulties in inter-system communication and the formation of "data silos." Additionally, there is a significant gap in the application of intelligent technologies, and enterprises have not fully utilized advanced technologies such as big data and artificial intelligence for the analysis and mining of financial data. The insufficiency in information construction and data empowerment capabilities seriously restricts the process of enterprise financial digital transformation.

4.4. Scarcity of talent and difficulty in finding composite talent

Establishing financial shared services models and promoting financial digital transformation cannot be separated from high-quality financial personnel with composite knowledge and skills. However, many enterprises have a relatively scarce reserve of such talent, and the overall quality of existing financial personnel needs to be improved ^[15]. Traditionally, financial personnel mainly engage in basic work such as accounting and report preparation, and their grasp of information technology and data analysis is relatively weak, making it difficult to adapt to the requirements of digital transformation. Some enterprises, due to limited salaries and development space, find it hard to attract and retain high-quality talent, which makes it difficult to improve the overall quality and capabilities of the financial team. Furthermore, there are deficiencies in the enterprise's talent training and incentive mechanisms, which fail to systematically enhance the professional skills and professional quality of

financial personnel, making the talent shortage problem more prominent and seriously affecting the effectiveness of financial digital transformation.

5. Strategy for digital transformation of enterprise finance based on the financial shared service model

5.1. Change concepts, clarify goals

To promote the digital transformation of enterprise finance, a comprehensive change is needed at the ideological level. The management should fully recognize the intrinsic value of the financial shared service model and digital transformation, not just as a technical upgrade but as an important part of the strategic transformation of the enterprise. Starting with the management, various forms of publicity and training should be used to enhance the awareness and importance of the financial shared service model and digital transformation among ordinary employees, especially finance personnel, to eliminate conceptual barriers. The management should take the lead, learn and apply digital management tools, and create a positive transformation atmosphere. At the same time, the enterprise can also set clear digital transformation goals, establish specific implementation paths, key performance indicators, and incentive mechanisms in stages to ensure that all employees have rules to follow and a basis to rely on during the transformation process. Through this top-down promotion, financial digital transformation becomes a common understanding and goal of the enterprise, thereby laying a solid ideological foundation for the smooth implementation of the transformation.

5.2. System planning and coordinated implementation

The digital transformation of finance is a vast systematic project involving various levels and multiple aspects of a company. Therefore, enterprises need to formulate a comprehensive and systematic transformation plan and conduct effective coordination during the implementation process. First, enterprises should conduct thorough preliminary research and evaluation to understand their business characteristics, information infrastructure, and transformation needs, thereby formulating a feasible transformation plan. During the planning process, it is essential to fully consider the company's long-term development strategy and business reality, avoiding blindly pursuing advanced technology or simply copying others' successful experiences. Second, enterprises should establish a dedicated team for the digital transformation of finance, composed of core members from various departments, responsible for specific implementation and coordination tasks. During the implementation process, attention should be paid to coordination and collaboration between departments to ensure smooth progress of all tasks. Lastly, enterprises also need to establish a sound supervision and evaluation mechanism to regularly inspect and assess the progress and effectiveness of integrating the financial shared service model into the digital transformation of finance, promptly discovering and resolving issues to ensure orderly and efficient operations. Through systematic planning and coordinated implementation, enterprises can effectively reduce risks and costs during the transformation process and increase the success rate of digital transformation in finance.

5.3. Technological enhancement and foundation building

Informatization and data empowerment are the foundation of digital transformation in finance; hence, enterprises need to comprehensively enhance their technological level. First, enterprises should increase investment in information systems to build a comprehensive financial informatization platform, achieving seamless data integration between various business systems and eliminating "information silos." Second, during the system construction process, enterprises should standardize data standards and interface specifications to ensure data accuracy and consistency. By introducing advanced intelligent technologies such as big data, artificial intelligence,

and robotic process automation, the efficiency and accuracy of data processing and analysis can be improved. By adopting process automation technologies, enterprises can achieve the automatic generation of financial statements, automatic review of bills, and automatic data reconciliation, thereby reducing the error rate and labor intensity of manual operations.

5.4. Talent cultivation and capability enhancement

The key to digital transformation in finance lies in people; therefore, enterprises need to invest more effort in talent cultivation to enhance the overall quality and capabilities of finance personnel. First, enterprises should develop comprehensive training plans to improve the digital skills and knowledge levels of existing finance staff. For example, by regularly organizing training courses, inviting industry experts to give lectures, and holding internal sharing sessions, finance personnel can master cutting-edge technologies such as big data, artificial intelligence, and cloud computing, improving their data analysis and application capabilities. Second, enterprises should introduce and cultivate compound finance talents who not only understand finance but also possess knowledge in business and digital technology. For instance, through school-enterprise cooperation, industry exchanges, and talent introduction, enterprises can attract high-quality talents with multidisciplinary backgrounds to provide intellectual support for the digital transformation of finance. Lastly, enterprises also need to establish a sound talent incentive mechanism to stimulate the work enthusiasm and innovative spirit of finance personnel. For example, performance assessments, salary incentives, and promotion opportunities, encourage finance personnel to actively participate in digital transformation and continuously improve their capabilities and quality.

5.5. Process reengineering and management optimization

The implementation of the financial shared service model is not only a technological innovation but also a profound change in business processes and management models. Enterprises should thoroughly sort out and optimize existing business processes to ensure that process design meets the requirements of digital management. First, enterprises need to determine which business processes are suitable for inclusion in the shared service scope and carry out optimization and standardization. For example, financial operations with high repetition and standardization, such as reimbursements, accounting, and payments, can be centralized in the financial shared service center for unified processing to improve efficiency and accuracy. Second, enterprises should establish a dynamic management system covering before, during, and after processes to achieve real-time linkage between business and finance. For instance, with the support of information systems, enterprises can achieve full-process data sharing and real-time monitoring from order processing, production planning, and inventory management to financial settlement, enhancing the collaborative efficiency between business and finance.

6. Conclusion

The financial shared service model plays a significant strategic role in promoting the digital transformation of corporate finance. Through the transformation of concepts, systematic planning, technological advancement, talent cultivation, and process reengineering, companies can effectively respond to various challenges encountered during the transformation process, enhancing the efficiency and quality of financial management and achieving deep integration of business and finance. This not only helps companies reduce operational costs and improve the scientific and accurate nature of decision-making but also enhances the overall competitiveness and sustainable development capabilities of the enterprise. In the future, with the continuous advancement and widespread application of information technology, the financial shared service model will be widely promoted in more enterprises, providing strong support for the high-quality development and innovation of enterprises. Through

continuous optimization and innovation, companies will be able to gain a favorable position in the digital economy era and achieve long-term development goals.

Disclosure statement

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Study on the Influence and Strategy of Low-carbon Economy on International Trade Development

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Abstract: With increasingly severe global climate change, a low-carbon economy has become an inevitable trend in the development of the international community. Low-carbon economy is not only related to environmental protection but also has a profound impact on international trade. The purpose of this paper is to explore the impact of a low-carbon economy on the development of international trade and put forward corresponding strategy suggestions. By analyzing the connotation, characteristics, and mechanism of the low-carbon economy on international trade, this paper reveals the important role of the low-carbon economy in promoting the optimization of international trade structure, promoting green technology innovation, and strengthening international cooperation. At the same time, given the challenges brought by a low-carbon economy, this paper puts forward strategies such as strengthening policy guidance, promoting green technology innovation, and improving international trade rules to provide a reference for the sustainable development of international trade ^[1,2].

Keywords: Low-carbon economy; Development of international trade; Influence; Tactics

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1. Introduction

Low-carbon economy refers to a form of economic development under the guidance of the concept of sustainable development, through technological innovation, institutional innovation, industrial transformation, new energy development and other means, as far as possible to reduce the consumption of coal, oil and other high-carbon energy, reduce greenhouse gas emissions, and achieve a win-win situation of economic and social development and ecological environmental protection. With the intensification of global climate change, a low-carbon economy has become the consensus and direction of action of the international community. International trade is an important link in global economic integration, its development model is facing the profound impact of a low-carbon economy. Low-carbon economy not only requires international trade to reduce carbon emissions in the exchange of goods and services but also promotes the development of international trade in a more green and sustainable direction. Therefore, it is of great significance to study the influence and strategy of the low-carbon economy on the development of international trade for promoting the sustainable development of international trade.

2. Connotation and characteristics of a low-carbon economy

2.1. The connotation of a low-carbon economy

As a new model of economic development, the core of the low-carbon economy is to emphasize the harmonious coexistence between economic development and environmental protection. This concept requires that while pursuing economic growth, we must pay attention to reducing carbon emissions, and strive to actively adopt low-carbon technologies, promote low-carbon products and provide low-carbon services in all aspects of economic activities such as production, consumption and circulation. Low-carbon economy is not only an innovation to the traditional economic development model but also an important way for human beings to cope with the challenge of global climate change^[3,4].

2.2. Characteristics of a low-carbon economy

2.2.1. Innovation

A distinctive feature of the low-carbon economy is its innovation. The development of this economic model depends on continuous technological and institutional innovation. Through the promotion of new technologies, new processes, and new models, the low-carbon economy can significantly improve energy efficiency and achieve clean energy use. Technological innovation is not limited to the field of energy but also includes industrial production, transportation, architectural design and other aspects. At the same time, institutional innovation is also a key factor in promoting the development of a low-carbon economy, including policy guidance and market mechanism improvement, which can provide a strong guarantee for the research and development, and application of low-carbon technologies^[5,6].

2.2.2. Systematic

Low-carbon economy has significant systemic characteristics. It is not only a single field of problem but involves energy, transportation, construction, industry, and other aspects, and it requires the joint efforts of the government, enterprises, society, and other aspects to form a systematic solution. The government needs to formulate scientific policy planning to guide the development direction of a low-carbon economy; Enterprises need to actively adopt low-carbon technologies, optimize production methods, and improve energy efficiency; All aspects of society need to enhance environmental awareness and advocate a low-carbon lifestyle. Only when all sides work together can we promote the comprehensive development of the low-carbon economy.

2.2.3. Long-term

The development of the low-carbon economy is a long-term and arduous task. It requires sustained investment in policy support, funding, and technology research and development to achieve a green transformation of the economy. In the short term, the development of a low-carbon economy may face some challenges and difficulties, such as high technology costs and limited market acceptance. However, in the long run, a low-carbon economy is the only way to promote sustainable economic and social development. This process requires the joint efforts and long-term investment of the government, enterprises and society^[7].

3. The impact of low-carbon economy on the development of international trade

3.1. Improving the structure of international trade

As a new development model, the low-carbon economy has a profound impact on the development of international trade, the most significant of which is to promote the optimization and upgrading of international trade structure. Driven by the low-carbon economy, international trade is gradually developing in a more green and sustainable

direction. On the one hand, low-carbon technology and low-carbon products have become a new hot spot in international trade because of their environmental protection and efficient characteristics. This not only promoted the rapid development of green industries such as clean energy, energy conservation, and environmental protection but also led to the rapid growth of upstream and downstream enterprises in the related industrial chain. These green industries not only have broad market prospects, but also can effectively reduce carbon emissions and achieve a win-win situation of economic benefits and environmental protection. On the other hand, the proportion of traditional energy-intensive and high-emission industries in international trade has gradually declined. This change not only reflects the global awareness of environmental protection but also provides a broader space for the rise of green industries. With the in-depth development of a low-carbon economy, the international trade structure will become more reasonable, and the green industry will become an important force in international trade ^[8,9].

3.2. Promoting green technology innovation

The development of the low-carbon economy is closely related to the innovation of green technology. To cope with the challenge of carbon emissions and improve energy efficiency, governments and enterprises have increased their investment in green technology research and development to occupy a favorable position in the fierce market competition. The innovation of green technology not only provides strong support for the development of a low-carbon economy but also effectively improves the competitiveness of domestic industries. By adopting advanced green technologies, enterprises can reduce production costs and improve product quality, thus gaining a larger market share in international trade. At the same time, these innovative technologies can also promote industrial upgrading and transformation, and promote the optimization of economic structure. More importantly, green technology innovation has significant spillover effects. Through international trade, these advanced technologies can be spread to other countries, promoting the common progress of global green technology. This not only helps to enhance the global capacity to cope with climate change but also promotes the sustainable economic development of all countries. It can be said that the development of a low-carbon economy and the innovation of green technology are mutually promoting and developing together ^[10].

3.3. Strengthening international cooperation

In the face of the severe challenge of global climate change, no country can remain immune, and international cooperation has become a key way to deal with this global issue. As a new economic model aimed at reducing carbon emissions and achieving sustainable economic development, the low-carbon economy provides a new opportunity and platform for international cooperation. Through the bridge of international trade, countries can share low-carbon technologies and successful experiences and strengthen cooperation and exchanges in the field of climate change. Such cooperation will not only help to upgrade the level of low-carbon technologies in various countries and promote the development of green industries but also promote the green transformation of the global economy. At the same time, the low-carbon economy has also become one of the important issues in international trade negotiations. During the negotiations, countries actively explored how to balance the relationship between economic development and environmental protection, and promoted the improvement and development of international trade rules to better meet the requirements of the era of a low-carbon economy. The low-carbon economy has not only promoted the optimization of international trade structure and the innovation of green technologies but also strengthened international cooperation and injected new impetus to the challenge of global climate change ^[11].

3.4. Challenges and opportunities coexist

While promoting the development of international trade, a low-carbon economy also brings a series of challenges.

These challenges and opportunities coexist, and together constitute a new pattern of international trade in the era of a low-carbon economy. On the other hand, low carbon technologies and inconsistent standards of products have become a major obstacle to international trade. Due to the differences in the level of development of low-carbon technologies and products among countries, the increase in international trade barriers has brought certain difficulties to the smooth progress of international trade. On the other hand, the development of a low-carbon economy requires a large amount of capital investment and technical support, which is undoubtedly a huge pressure for developing countries. While pursuing economic growth, these countries will also need to invest significant resources to meet the challenges of a low-carbon transition. However, it is these challenges that breed new opportunities. Through enhanced international cooperation, countries can jointly address the problem of low carbon technologies and product standards and promote technological innovation and the improvement of international trade rules. At the same time, the development of a low-carbon economy has also provided new economic growth points for countries, and promoted the rise of green industries and the green transformation of the economy. In this process, countries can strengthen exchanges and cooperation, share low-carbon technologies and experience, and achieve mutual benefit and sustainable development ^[12,13].

4. Coping strategy suggestion

4.1. Strengthening policy guidance

Governments have a crucial role to play in addressing the impact of a low-carbon economy on the development of international trade. To guide international trade to develop in a green and sustainable direction, the government should strengthen policy guidance and formulate clearer and forward-looking low-carbon economic policies. On the other hand, the government can encourage enterprises to actively adopt low-carbon technologies and products to reduce carbon emissions through tax incentives, financial support, and other measures. These policies can not only stimulate the innovation vitality of enterprises, promote the development of green industries but also promote the optimization and upgrading of the international trade structure. On the other hand, the government should also strengthen communication and coordination with the international community to jointly promote the development of the global low-carbon economy. By participating in international climate negotiations and strengthening cooperation with international organizations, the government can actively advocate the concept and practice of a low-carbon economy and promote the improvement and development of global trade rules. In addition, the government should also strengthen the publicity and education of low-carbon economy, and improve the awareness and participation of the whole society. By popularizing low-carbon knowledge, promoting a low-carbon lifestyle, and other measures, the government can guide the public to form the concept of green consumption and low-carbon life and create a good social atmosphere for the development of a low-carbon economy ^[14,15].

4.2. Promoting green technology innovation

In the context of low-carbon economy, green technology innovation has become an important driving force to promote the development of international trade. To cope with this challenge and opportunity, enterprises should increase investment in green technology research and development and actively enhance their independent innovation ability. On the one hand, enterprises should make full use of innovative resources such as universities and scientific research institutions to accelerate the development and application of low-carbon technologies through industry-university-research cooperation and other ways. This mode of cooperation can not only shorten the technological research and development cycle, improve the conversion rate of technological achievements but also promote the mutual benefit and win-win situation between enterprises and scientific research institutions. On the other hand, enterprises should also actively carry out international cooperation, introduce and absorb

international advanced low-carbon technology and management experience, and enhance their international competitiveness. In the process of promoting green technology innovation, enterprises should also pay attention to intellectual property protection. By applying for patents, registered trademarks, and other ways to ensure the legality and sustainability of green technologies, laying a solid foundation for the long-term development of enterprises. At the same time, enterprises should also strengthen the management and application of intellectual property rights and realize the commercialization and value maximization of intellectual property rights through technology licensing and patent transfer^[16,17].

4.3. Improving international trade rules

In the era of a low-carbon economy, the improvement and development of international trade rules are of great significance to promote the smooth progress of global trade and realizing the green transformation of the economy. To cope with the impact of a low-carbon economy on international trade, the international community should jointly promote the improvement of international trade rules and provide a strong guarantee for the development of the low-carbon economy. On the one hand, countries should step up negotiations and consultations to formulate fairer and more reasonable international trade rules. These rules should take full account of the characteristics of low-carbon technologies and products, reduce their trade barriers, and create more convenient conditions for the international trade of low-carbon products. At the same time, the rules should also strengthen the protection of intellectual property rights, encourage the innovation and dissemination of green technologies, and promote the rapid development of global green industries. On the other hand, the international community should strengthen cooperation and exchanges in the field of climate change. By jointly addressing the challenge of global climate change, countries can share low-carbon technologies and experience and promote the development of a global low-carbon economy. Such cooperation will not only help to upgrade the level of low-carbon technologies in various countries but also promote the green transformation of the global economy and achieve sustainable development. In the process of improving international trade rules, countries should also give full consideration to the special situation and needs of developing countries. By providing technical assistance, financial support, and other measures, we will help developing countries enhance their capacity to meet the challenges of low-carbon transition and achieve balanced and sustainable development of global trade^[18].

4.4. Strengthening personnel training and introduction

The development of a low-carbon economy cannot be separated from the support and promotion of talent. To cope with the challenges and opportunities brought by a low-carbon economy, the government and enterprises should strengthen the training and introduction of low-carbon talents to provide a solid talent guarantee for the development of the low-carbon economy. On the other hand, the government should increase investment in the cultivation of talents in the low-carbon field. By setting up special scholarships and providing research grants, we will encourage more students to choose low-carbon-related majors and cultivate low-carbon talents with professional knowledge and innovative ability. At the same time, the government should also strengthen the training and re-education of on-the-job personnel to enhance their low-carbon awareness and professional skills to meet the needs of low-carbon economic development. On the other hand, enterprises should also actively participate in the training and cultivation of low-carbon talents. Enterprises can cooperate with universities and scientific research institutions to jointly carry out low-carbon technology research and development and application, and cultivate low-carbon talents with practical experience and innovation ability. At the same time, enterprises can also attract more outstanding talents to join the low-carbon cause by providing generous salaries and broad career development space. While strengthening talent training, the government and enterprises should

also pay attention to the introduction of low-carbon talents. Through the formulation of preferential policies, provide a good working and living environment and other ways to attract domestic and foreign outstanding low-carbon talents to work and start businesses in China. The introduction of these talents can not only provide new ideas and impetus for the development of a low-carbon economy but also promote the exchange and cooperation of low-carbon technologies at home and abroad and the development of a global low-carbon economy^[19].

5. Conclusion

Low-carbon economy has become an inevitable trend in the development of the international community, which has a profound impact on international trade. By promoting the optimization of the international trade structure, promoting green technology innovation, and strengthening international cooperation, the low-carbon economy provides new impetus and opportunities for the sustainable development of international trade. However, the low-carbon economy also brings certain challenges. To meet these challenges and seize the opportunities, governments, enterprises, and the international community should work together to strengthen policy guidance, promote green technology innovation, improve international trade rules, and strengthen personnel training and introduction. Only in this way can we achieve the coordinated development of international trade and a low-carbon economy and contribute to the sustainable development of the global economy.

Disclosure statement

The author declares no conflict of interest.

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Research on the Application Strategies of Short-Term Cost Curves in the Field of Economics

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Abstract: This paper deeply explores the application strategies of short-term cost curves in the field of economics. Firstly, it elaborates on the basic theories and constituent elements of short-term cost curves. By drawing and analyzing the short-term cost curve graphs, it presents the internal relationship between costs and output. Then, it focuses on researching its application strategies in multiple aspects such as enterprise production decisions, market pricing, and industry competition analysis.

Keywords: Short-term cost curves; Application strategies; Production decisions; Market competition

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1. Introduction

In the complex and ever-changing arena of economic activities, cost is undoubtedly a core and key factor that affects the direction of enterprise decisions and the operation trend of the market. The short-term cost curve, as an important tool that accurately reflects the relationship between costs and output in the short term, is like a key, opening the door for enterprise managers and economic researchers to understand the changing laws of costs and helping them formulate more reasonable and scientific decisions. In-depth research on the application strategies of short-term cost curves has extremely important practical significance for enterprises. It can help enterprises keenly observe market dynamics, accurately grasp the delicate balance between costs and output to better adapt to changes in the market environment and achieve the long-term goal of sustainable development.

2. Theoretical basis of short-term cost curves

2.1. Concepts and classifications of short-term costs

The short term refers to a period in which producers have no time to adjust the quantities of all production factors, and at least the quantity of one production factor remains fixed. In the short term, costs can be divided into fixed costs (TFC) and variable costs (TVC) ^[1].

Fixed costs (TFC) are like the cornerstone of enterprise operations. They are costs that do not change with the

change in output. For example, the production equipment purchased by an enterprise is depreciated according to a certain depreciation method over time, and this part of the depreciation expense also belongs to fixed costs and does not change with the increase or decrease in output.

Variable costs (TVC) are costs that change correspondingly with the change in output. Taking a manufacturing enterprise as an example, the procurement cost of raw materials will increase with the increase in output because more products require more raw materials to be consumed.

The total cost (TC) is equal to the sum of fixed costs and variable costs, that is, $TC = TFC + TVC$.

2.2. Derivation and shapes of short-term cost curves

2.2.1. Total cost curve (TC)

The fixed cost curve (TFC) is presented uniquely. It is a straight line parallel to the horizontal axis ^[2]. This is because regardless of how the output changes, the fixed cost always remains constant and will not be affected by output fluctuations. The variable cost curve (TVC) starts from the origin and rises as the output gradually increases. In the initial stage, due to the relatively high utilization efficiency of production factors, the rising speed of variable costs is relatively slow; however, as the output continues to expand, the production factors gradually become saturated, and the rising speed of variable costs will gradually accelerate.

The formation of the total cost curve (TC) is the result of the superposition of the fixed cost curve and the variable cost curve. It starts from the intercept of the fixed cost on the vertical axis and rises steadily with the increase in output. Its shape is very similar to that of the variable cost curve. This is because the fixed cost is only vertically translated based on the variable cost and does not change the basic trend of cost changing with output (Figure 1).

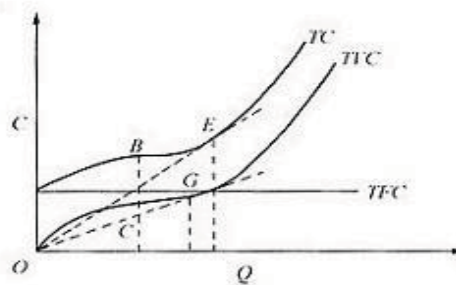


Figure 1. Short-term cost curves

2.2.2. Average cost curves

The average fixed cost (AFC) curve is like a hyperbola approaching both axes, vividly showing the trend that the average fixed cost continuously decreases with the continuous increase in output.

The average variable cost (AVC) curve presents a unique U shape. In the early stage of production, due to the relatively small production scale, the enterprise can fully utilize the potential of production factors to effectively control costs, and the average variable cost decreases accordingly; however, when the output exceeds a certain limit, the marginal return of production factors begins to decline, resulting in the gradual increase of the average variable cost.

The average total cost (AC) curve also has a U shape. It is formed by the superposition of the average fixed cost curve and the average variable cost curve. Since the average fixed cost is always positive, the average total cost curve is always above the average variable cost curve, and the vertical distance between them is exactly equal to the average fixed cost (Figure 2).

2.2.3. Marginal cost curve (MC)

The marginal cost curve also has a U-shaped feature. It intersects the average variable cost curve and the average total cost curve at their lowest points ^[3]. This intersection point has extremely important economic significance. When the marginal cost is less than the average cost, it means that the increase in cost brought by each additional unit of output is less than the current average cost, and at this time, the average cost will decrease with the increase in output; conversely, when the marginal cost is greater than the average cost, the average cost will increase with the increase in output (**Figure 2**).

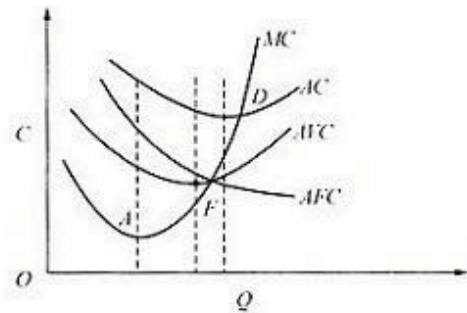


Figure 2. Short-term cost curves

3. Analysis of short-term cost curve graphs

3.1. Short-term cost curves and their interrelationship

Taking output as the horizontal axis and cost as the vertical axis, draw the short-term cost curve graph (**Figure 2**). In the graph, we can see the trends and interrelationships of various cost curves. For example, the marginal cost (MC) curve has specific intersection points with the average total cost (AC) curve and the average variable cost (AVC) curve. When MC is less than AC and AVC, the AC and AVC curves decline; when MC is greater than AC and AVC, the AC and AVC curves rise. The MC curve intersects the lowest points of the AC curve and the AVC curve, respectively.

3.2. The slope of the cost curve reflects the rate of change of cost

For example, the slope of the marginal cost curve represents the increase in cost for each additional unit of output ^[4].

3.3. Positional relationship and internal connection of cost curves

The positional relationship among various cost curves reflects the internal connection among costs. For example, the average total cost curve is always higher than the average variable cost curve, and the vertical distance between them is the average fixed cost.

3.4. Significance of the intersection of marginal cost and average cost curves in determining optimal production scale

The intersection point of the marginal cost curve and the average cost curve is a key node of cost change. At the intersection point, the average cost reaches the minimum value, which is of great significance for enterprises to determine the optimal production scale.

4. Application strategies of short-term cost curves

4.1. Application in enterprise production decisions

4.1.1. Determining the optimal output

In the game of the market economy, the core goal of an enterprise is to maximize profits ^[5]. The key principle to achieve this goal is that marginal revenue (MR) equals marginal cost (MC). In a perfectly competitive market environment, an enterprise is a price taker, and marginal revenue equals the market price (P). Therefore, an enterprise needs to accurately determine the optimal output based on the market price and the marginal cost curve.

When the market price P equals the marginal cost MC, the enterprise reaches the ideal state of maximizing profits. At this time, the revenue brought by each additional unit of output of the enterprise is exactly equal to the increase in cost caused by adding this unit of output, and the enterprise's profit reaches the maximum value; when the market price P is less than the marginal cost MC, it means that the increase in cost caused by each additional unit of output of the enterprise is greater than the revenue obtained, and continuing to increase output will lead to a reduction in profits. Therefore, the enterprise should decisively reduce output to avoid further expansion of losses; when the market price P is greater than the marginal cost MC, the revenue obtained by the enterprise for each additional unit of output is greater than the increase in cost caused by adding this unit of output. At this time, the enterprise should seize the opportunity to increase output to obtain more profits.

4.1.2. Short-term shutdown decision

In the case of market price fluctuations, an enterprise also needs to make short-term shutdown decisions ^[6]. When the market price is lower than the average variable cost, if the enterprise continues to produce, it will not only be unable to cover the fixed costs but also further exacerbate losses. At this time, the enterprise's sales revenue cannot even fully cover the variable costs, and each unit of product produced will bring additional losses. In this case, the wise choice for the enterprise is to stop production to reduce unnecessary losses.

When the market price is higher than the average variable cost, although the enterprise may still be in a loss state, continuing to produce can cover part of the fixed costs. At this time, the enterprise's sales revenue, after deducting the variable costs, still has a part left that can be used to offset the fixed costs. Therefore, the enterprise should continue to produce to reduce the overall loss level.

4.2. Application in market competition analysis

4.2.1. Cost advantage analysis

By analyzing short-term cost curves ^[7], an enterprise can understand its cost advantages and disadvantages. Compared with competitors, if an enterprise's average total cost is lower, it has a price advantage in market competition and can obtain more market share at a lower price.

4.2.2. Market entry and exit decisions

Potential entrants can evaluate the feasibility of entering the market by studying short-term cost curves ^[8]. If they can control costs within a reasonable range after entering and the expected revenue is greater than the costs, they can consider entering; for incumbent enterprises, if they face long-term losses and cannot improve the situation by adjusting the cost structure, they may need to consider exiting the market.

4.3. Application in market pricing

4.3.1. Cost-plus pricing method

The cost-plus pricing method is a commonly used pricing strategy by enterprises ^[9]. An enterprise can determine the minimum price of a product according to the short-term cost curve. Specifically, the product price is

determined by adding a certain profit margin based on the average total cost.

4.3.2. Competition-oriented pricing

In the fierce market competition, it is far from enough for an enterprise to only consider costs. It also needs to pay attention to the price strategies of competitors. By deeply analyzing short-term cost curves, an enterprise can clearly understand its cost advantages and disadvantages and then make a detailed comparison with the costs of competitors to formulate a more competitive price strategy.

5. Case analysis

5.1. Case background

Select a certain automobile manufacturing enterprise as the case object for in-depth study. In the short term, the enterprise faces fixed production equipment and factories, which makes its cost structure show obvious characteristics, including two important components: fixed costs and variable costs^[10].

5.2. Cost data analysis and curve drawing

Based on the detailed cost data of the enterprise, use professional drawing methods and tools to carefully draw the short-term cost curve graph (**Figure 2**). After in-depth analysis of the curve, it is found that in the stage of low output, due to the low utilization efficiency of production equipment, the marginal cost and the average cost are relatively high. With the gradual increase in output, the production equipment is more fully utilized, the specialization degree of labor is continuously improved, the production efficiency is greatly improved, and the marginal cost and the average cost gradually decline. However, when the output reaches a certain level, due to factors such as the limitation of the production site, the aging of equipment, and the increase in management difficulty, the marginal cost and the average cost start to rise again.

5.3. Application strategy analysis

5.3.1. In terms of production decisions

The enterprise closely adjusts the output according to the market price and the marginal cost curve^[11]. When the market price is high, which means that the market demand for automobiles is strong, the enterprise should promptly increase output to obtain more profits. When the market price drops, the enterprise realizes that the market demand may have shrunk. Therefore, the enterprise should decisively reduce output to avoid unnecessary losses and maintain its financial health of the enterprise.

5.3.2. In terms of market pricing

The enterprise skillfully combines its own costs and market competition situation and adopts a combination of the cost-plus pricing method and the competition-oriented pricing method^[12]. On the one hand, the enterprise determines the basic price of the product according to its own average total cost plus a reasonable profit margin to ensure that the enterprise can achieve profitability in the production process. On the other hand, the enterprise closely monitors the price changes of competitors, analyzes the differences between itself and competitors in terms of costs and product characteristics. If it is found that competitors reduce prices, the enterprise will, according to its own cost advantages and market positioning, decide whether to follow the price reduction or maintain the price by improving the added value of products, etc., to maintain market competitiveness.

5.3.3. In terms of industry competition analysis

By making a detailed comparison with the cost curves of other enterprises in the same industry, the enterprise recognizes that it has cost advantages in some production links ^[13]. For example, in terms of parts procurement and production processes, the enterprise has reduced production costs by establishing long-term cooperative relationships with high-quality suppliers and continuously optimizing production processes. Based on this advantage, the enterprise further increases investment in these links, optimizes the production process, and improves production efficiency, thereby further consolidating its cost advantage and occupying a more favorable position in market competition.

6. Conclusions and prospects

6.1. Research conclusions

The short-term cost curve, as an important analytical tool in the field of economics, provides strong support for enterprise production decisions, market pricing, and industry competition analysis. By reasonably applying the application strategies of short-term cost curves, enterprises can better adapt to market changes, optimize resource allocation, and improve economic benefits.

6.2. Deficiencies and prospects

Although this study has conducted a relatively comprehensive and in-depth analysis of the application strategies of short-term cost curves, it cannot be ignored that in actual economic activities, the factors affecting cost curves are complex and diverse, far beyond the scope covered by this study. For example, fluctuations in the macroeconomic environment have a profound impact on cost curves ^[14]. During periods of economic prosperity, when the market demand is strong, enterprises expand the production scale and may enjoy the cost reduction brought by economies of scale; during the economic recession, when the demand shrinks and the enterprise has excess production capacity, the cost will rise.

Given the above deficiencies in the research, the future research direction should focus on further expanding the application scope of short-term cost curves and incorporating more complex factors into the research framework ^[15]. On the one hand, in-depth exploration of the long-term impact of the macroeconomic environment on cost curves, construction of more accurate economic models, and quantification of the relationship between factors such as economic cycles and inflation and cost curves. On the other hand, detailed analysis of the specific action mechanism of policy and regulation adjustments on the cost structure of enterprises and provision of strategic suggestions for enterprises to respond to policy changes. Through more in-depth research, more accurate and reliable decision-making support will be provided for enterprises and economic decision-makers to help the healthy and sustainable development of the economy.

Disclosure statement

The author declares no conflict of interest.

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Study on the Measurement and Influencing Factors of Chongqing Residents' Carbon Inclusion Literacy under the “Double Carbon” Target

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Abstract: In the context of the global “double carbon” goal, this article uses the Analytic Hierarchy Process and Multiple Linear Regression combined with a survey questionnaire to study the issue of carbon literacy among residents in Chongqing. The weights of each dimension are determined to promote the formation of a good situation of multi-party collaborative promotion and help achieve the “double carbon” goal. The level of carbon literacy reflects the residents’ understanding of carbon literacy and has important significance for economic and social operation and environmental protection. The results indicate that the deepening of the concept of carbon inclusiveness and the continuous advancement of technology will lead to a continuous process of improving the carbon inclusiveness literacy of Chongqing residents. Corresponding suggestions are proposed on how to improve the carbon inclusiveness literacy of Chongqing residents, which is of great research significance.

Keywords: Carbon inclusive literacy; Influencing factors; Chongqing resident; Analytic hierarchy process

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1. Introduction

In 2015, the Guangdong Provincial Development and Reform Commission first put forward the concept of carbon inclusion, which is a mechanism to encourage public participation in green and low-carbon ways. It aims to quantify and give small and micro enterprises, community families, and individuals a certain value in energy conservation and carbon reduction behaviors and promote the participation of the whole people in low-carbon behaviors. In October and November 2022, the Chinese government successively released the “2022 Annual Report on China’s Climate Change Policies and Actions” and the “Progress Report on China’s Implementation of Nationally Determined Contribution Targets (2022),” proposing to explore and carry out innovative voluntary emission reduction mechanisms — carbon inclusion and incentives for the whole society to participate in carbon emission reduction. In October 2023, the “2023 Annual Report on China’s Climate Change Policies and Actions” issued by the Ministry of Ecology and Environment once again emphasized the development of green and low-carbon actions for all. Enhance the degree of public participation in carbon inclusion; in the “Opinions of the

Central Committee of the Communist Party of China and the State Council on the Comprehensive Promotion of the Construction of a Beautiful China” issued on January 11, 2024, it is proposed to explore the establishment of public participation mechanisms such as “carbon inclusion”^[1]. To adapt to the development of carbon inclusion literacy in the times, this study defines the relevant content of measuring the carbon inclusion literacy of residents in our country through the development and research of the Carbon Generalized System of Preferences at home and abroad, as well as related theoretical analysis. It constructs a measurement index system for the carbon inclusion literacy of residents in our country. And analyzes the influencing factors of the carbon inclusion literacy of residents in Chongqing through the analytic hierarchy process. The study of carbon inclusion literacy helps to enhance public awareness of climate change and environmental protection, promote the formation of low-carbon lifestyles, and help to achieve the “double carbon” goal.

2. Research status

Generalized System of Preferences (GSP) is a pioneering low-carbon development system to mobilize all walks of life, especially the public, to participate in carbon emission reduction, quantify daily low-carbon behavior and incentives. Although there were issues such as legislation, trading mechanisms, and regulatory systems in the early stage, Zeng proposed to upgrade the legislative level and enhance synergy^[2]. Hu proposed that its core includes three elements: Focusing on “carbon” to tap the potential for emission reduction, focusing on “universal” diversity and inclusiveness, and settling on “beneficial” quantitative incentives^[3]. Yan *et al.* said that it can promote green technology innovation and is a system of quantitative incentives, diversified operation, and local conditions^[4]. Xiang *et al.* summarized that it has low-carbon^[5], inclusive, and incentive. The characteristics of marketization, the practice of many places in China has been effective and challenging, such as Guangdong, Wuhan, and Chongqing, which also give transportation and industry-related points rewards in combination with the characteristics of mountain cities; in terms of carbon inclusion and low-carbon behavior, Alexander *et al.* and many scholars define low-carbon behavior from different perspectives^[6], pointing out that the key to carbon emission reduction is energy conservation, emission reduction, and promotion of clean energy. Actions can be taken in many fields in daily life. Ajzen pointed out the willingness of low-carbon behavior to lead public action^[7]. The theory of planned behavior emphasizes the coordinated promotion of multiple factors. Chongqing citizens practice energy conservation, emission reduction, and clean energy utilization according to their urban characteristics and use the carbon inclusion mechanism to encourage the creation of a low-carbon future. As for carbon inclusion and low-carbon consumption, scholars have different opinions, covering concepts that are Views, mainly including reducing energy consumption, Wang and other scholars’ experiments showed that multiple factors cause carbon emissions to increase^[8], Peng *et al.* divided direct and indirect carbon emissions, and there are also problems such as the disconnect between public low-carbon willingness and behavior^[9]. Shi *et al.* empirically found that residents’ low-carbon consumption is affected by psychological, personal cognition and other factors^[10]. Zeng proposed to guide residents’ green consumption to force the transformation of the production side^[11]. Wu said that carbon inclusion helps to promote the goal of a beautiful China^[12], and there are many factors affecting the public’s attitude towards carbon inclusion.

3. Research method

3.1. Construct an indicator system

Based on the relevant literature and the construction principles of the indicator system, we constructed a carbon inclusion literacy assessment system that includes three first-level indicators of carbon inclusion knowledge, low-carbon behavior, and participation willingness, and 11 second-level indicators. The specific indicator design is

shown in **Figure 1**, covering a comprehensive assessment of carbon inclusion policies, platforms, incentives, relevant knowledge, low-carbon behavior, and participation willingness.

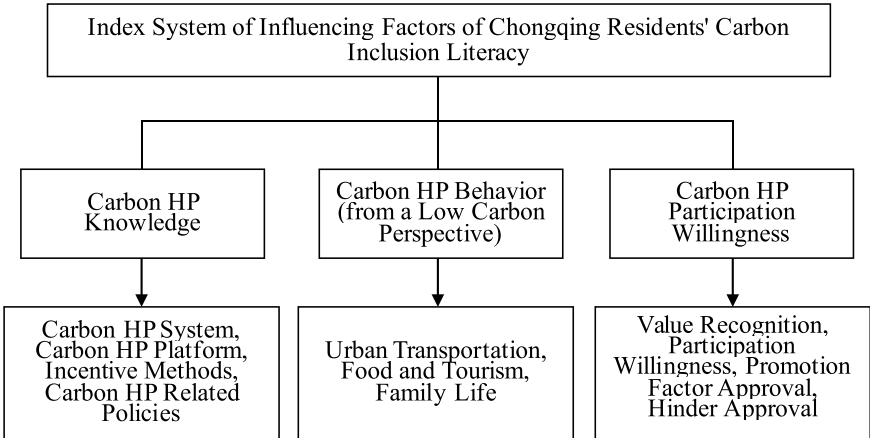


Figure 1. Chongqing residents’ carbon inclusive literacy influencing factors index system

3.2. Method selection

Common comprehensive evaluation methods include the analytic hierarchy process, weighted comprehensive scoring method, fuzzy comprehensive evaluation method, data packet network analysis, entropy method, TOPSIS method, etc. These methods provide a variety of tools and frameworks to improve the validity and reliability of the evaluation. The analytic hierarchy process adopted in this paper is also one of them.

3.3. Data evaluation and analysis

First, according to the Chongqing residents’ carbon inclusive literacy influencing factors index system to establish a judgment matrix. Among them, the data of the judgment matrix in this paper is obtained by consulting the relevant index data such as “2023 China Urban Green and Low-Carbon Development Competitiveness Index Report,” “Wuhan Carbon Inclusion Scenario Evaluation Specification” and “Low-Carbon City Evaluation Index System,” and combining the index data with the expert scoring method. Secondly, using the analytic hierarchy process through the SPSS software, the relative importance of the indicators is compared to obtain the judgment matrix. Next, the characteristic roots are calculated, and the consistency is checked. Finally, the weights are calculated and sorted to evaluate the indicators.

The detailed steps are as follows:

- (1) According to the 1–9 scale method, the importance of each index is indicated. As shown in **Table 1**.

Table 1. Importance comparison evaluation

a	Definition	a	Definition
1	a_i is equally important as a_j	2	It is between equally important and slightly more important
3	a_i is slightly more important than a_j	4	It is between slightly more important and obviously more important
5	a_i is obviously more important than a_j	6	It is between obviously more important and very obviously more important
7	a_i is very obviously more important than a_j	8	It is between very obviously more important and absolutely more important
9	a_i is absolutely more important than a_j	Countdown	a_{ij} is the result of the comparison of the importance between index i and j , and $a=1/a$.

(2) Comparing the importance of the indicators, a judgment matrix about the factors affecting the carbon inclusion literacy of Chongqing residents is obtained, as shown in **Table 2**.

As can be seen from **Table 2**, $\lambda_{\max} = 8.6213$, $R = 0.525$, $CR = CI/RI = 0.062 \leq 0.1$, the judgment matrix is consistent.

Table 2. First-level indicator judgment matrix

First-level indicators	Knowledge of carbon inclusion B1	Carbon inclusion behavior B2	Willingness to participate in carbon inclusion B3	W weight value (%)
Carbon inclusion knowledge B1	1	0.143	0.2	7.193
Carbon inclusion behavior B2	7	1	3	64.912
Carbon inclusion participation willingness B3	5	0.333	1	27.895

(3) Compare the elements in the carbon inclusion knowledge index in pairs, as shown in **Table 3**.

As can be seen from **Table 3**, $\lambda_{\max} = 4.043$, $R = 0.882$, $CR = CI/RI = 0.016 \leq 0.1$, obviously the judgment matrix is consistent.

Table 3. Carbon inclusion knowledge index

Carbon inclusion knowledge	Generalized system of preferences C1	Carbon inclusion platform C2	Incentive mode 3	W weight value (%)
Generalized System of Preferences C1	1	0.333	0.2	7.759
Carbon Inclusion Platform C2	3	1	0.333	20.096
Incentive Mode 3	5	3	1	52.049
Policy C4	3	1	0.333	20.096

(4) Compare the elements in the carbon inclusion knowledge index in pairs, as shown in **Table 4**.

As can be seen from **Table 4**, $\lambda_{\max} = 3.0$, $R = 0.525$, $CR = CI/RI = 0.0 \leq 0.1$, obviously the judgment matrix is consistent.

Table 4. Carbon inclusion behavior

Carbon inclusive behavior	Urban transportation D1	Catering tourism D2	Family life D3	W weight value (%)
Urban transportation D1	1	5	1	45.455
Catering tourism D2	0.2	1	0.2	9.091
Family life D3	1	5	1	45.455

(5) Compare the elements in the carbon inclusion knowledge index in pairs, as shown in **Table 5**.

As can be seen from **Table 5**, $\lambda_{\max} = 4.037$, $R = 0.882$, $CR = CI/RI = 0.028 \leq 0.1$, obviously the judgment matrix is consistent.

Table 5. Carbon inclusion willingness index

Willingness for carbon inclusion	Value recognition E1	Willingness to participate E2	Promotion factor approval E3	Hindrance factor approval E4	W weight value (%)
Value recognition E1	1	0.2	3	3	19.149
Willingness to participate E2	5	1	7	7	65.406
Promotion factor approval E3	0.333	0.143	1	1	7.723
Hindrance factor approval E4	0.333	0.143	1	1	7.723

Finally, the weights of each indicator are summarized as shown in **Table 6**.

Table 6. Weight calculation results

Dimension	Weight (%)	Secondary indicator	Relative weight (%)	Total weight	Ranking
Carbon Inclusion Knowledge	7.193	Generalized System of Preferences C1	7.759	0.078	7
		Carbon Inclusion Platform C2	20.096	0.201	4
		Incentive Mode 3	52.049	0.520	2
		Policy C4	20.096	0.201	4
Carbon inclusive behavior	64.912	Urban transportation D1	45.455	0.455	3
		Catering tourism D2	9.091	0.091	6
		Family life D3	45.455	0.455	3
Willingness for carbon inclusion	27.895	Value recognition E1	19.149	0.191	5
		Willingness to participate E2	65.406	0.654	1
		Promotion factor approval E3	7.723	0.077	8
		Hindrance factor approval E4	7.723	0.077	8

According to the data analytics in **Table 6**, the influencing factors of Chongqing residents' carbon inclusion literacy can be summarized into three main dimensions: Carbon inclusion behavior, carbon inclusion awareness, and carbon inclusion knowledge. Among them, the weight of carbon inclusion behavior is as high as 64.912%. Under this dimension, residents' participation willingness and family life habits have a particularly significant role in promoting carbon emission reduction behavior, accounting for 65.406% of participation willingness and 45.455% of catering tourism and family life, respectively. Secondly, the weight of carbon inclusion awareness is 27.895%, of which value recognition is the key factor affecting literacy, while the satisfaction of promoting and hindering factors is 7.723%, respectively. Finally, the weight of carbon inclusive knowledge is low, only 7.193%, but the implementation of incentive measures and related policies can effectively improve the knowledge level of residents.

4. Establishment of the model

4.1. Selection of indicators

This paper defines the influencing factors of carbon inclusive literacy as eight factors: Age, gender, education level, occupation field, personal monthly disposable income, permanent residence and region, and based on the above descriptive statistical analysis, it is found that Chinese residents have high levels of carbon inclusive literacy.

To further study whether the above factors have an impact on the carbon inclusive literacy of Chinese residents and the corresponding degree of influence, we first conducted a normal test on the carbon inclusive literacy level of Chinese residents and then used a multiple linear regression model to analyze its influencing factors.

4.2. Empirical analysis

4.2.1. Normality test of the data

Because the data collected through the questionnaire are individual-level data of residents, it is not suitable for multiple linear regression models, so we need to perform a normality test on it first and then determine whether the data group obeys or approximately obeys the normal distribution. The normality test of the data is carried out, and the test results are shown in **Figure 2**.

	Kolmogorov-Smirov			Shapiro-Wilk		
	Statistics	Degrees of freedom	Significance	Statistics	Degrees of freedom	Significance
Average	0.157	9	0.200	0.924	9	0.429

Figure 2. The average level of carbon inclusion literacy in each main urban area

It can be seen from the test results in **Figure 2** above that the P values of the KS test and SW test are 0.200 and 0.429, respectively, both greater than 0.05. Therefore, the null hypothesis cannot be rejected; that is, the data are considered to follow a normal distribution. Secondly, the Q-Q graph is plotted at the level of the average level of carbon inclusion literacy of residents in each main urban area, as shown in **Figure 3** below. It can be seen from the graph that the points in the graph are roughly on a straight line, indicating that the theoretical percentiles of the data are in good agreement with the actual percentiles, so the set of data satisfies the normal distribution, and the next step can be studied.

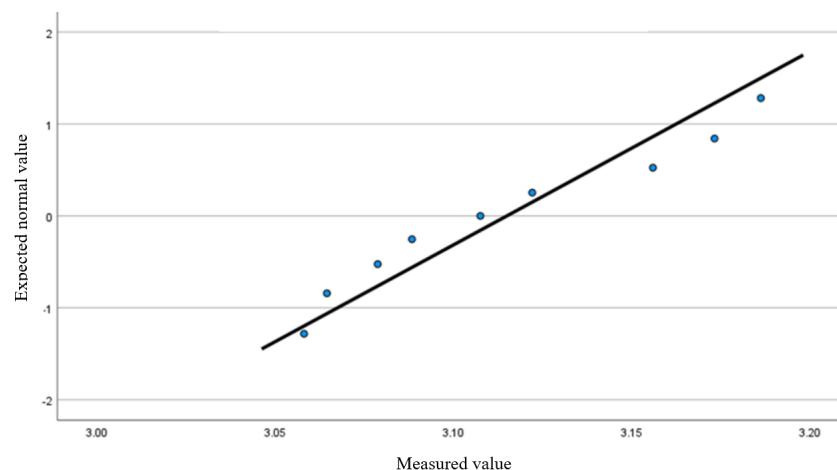


Figure 3. Normal Q-Q of the average carbon inclusion literacy level in each main urban area

Finally, a Q-Q map is drawn for the carbon inclusion literacy level of individual residents. The results are shown in **Figure 4**:

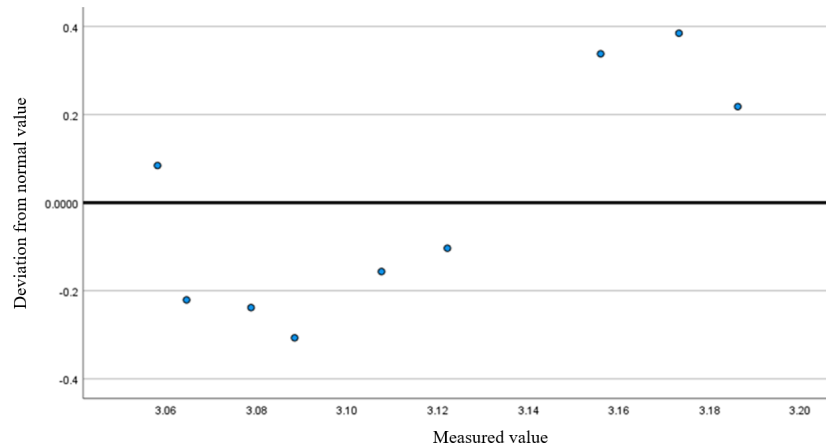


Figure 4. Detrending normality Q-Q of the average carbon inclusion literacy level in each main urban area

It can be generally seen from the above chart that the measurement value of the carbon inclusion literacy level in each main urban area and the individual level of residents is in line with the assumption of constructing a multiple linear regression model; that is, the collected data sets are normally distributed. Therefore, the next step is to construct a multiple linear regression model to further explore whether the factors contained in the basic information affect the residents' carbon inclusion, literacy level, and its influence.

4.2.2. Multiple linear regression model construction

Since there are many factors affecting the residents' carbon inclusion literacy level, this paper uses multiple linear regression analysis to model. Among them, a series of factors affecting residents' carbon inclusion literacy level are used as independent variables, and residents' carbon inclusion literacy level is used as a dependent variable. The specific model is as follows:

$$CL = \alpha_0 + \alpha_1 \text{gender} + \alpha_2 \text{age} + \alpha_3 \text{region} + \alpha_4 \text{education} \\ + \alpha_5 \text{profession} + \alpha_6 \text{income} + \varepsilon$$

Among them: α_0 -- intercept variable; α_j ($j = 1, 2, 3 \dots 7$) -- regression coefficient to be estimated; ε -- stochastic perturbation term; CL – carbon inclusive literacy level of residents.

The age, gender, region, education, profession, and income in the model represent the age, sex, permanent residence, educational level, occupation, and personal monthly disposable income of the respondents, respectively. The above variable definitions are shown in **Table 7** below:

Table 7. Variable definitions

Variable type	Variable name	Variable indicator	Definition or assignment
Explained variables	Carbon inclusion literacy		Taken from a survey questionnaire and calculated using a scoring method
	Age	Under 18 years old	agei=1,2,3,4,5=0
		18–25 years old	Age1,agei=2,3,4,5=0
		26–35 years old	Age2,agei=1,3,4,5=0
		36–45 years old	Age3,agei=1,2,4,5=0
		46–60 years old	Age4,agei=1,2,3,5=0
		61 years old and above	Age5,agei=1,2,3,4=0
	Gender	Male	1
		Female	2
	District	Yuzhong District	Regioni=1,2,3,4,5,6,7,8=0
		Dadukou District	Region1=1, regioni=2, 3,4,5,6,7,8=0
		Jiangbei District	Region2=1, regioni=1,3, 4,5,6,7,8=0
		Shapingba District	Region3=1, regioni=1,2,4,5,6,7,8=0
		Jiulongpo District	Region4=1, regioni=1,2,3,5,6,7,8=0
		Nanan District	Region5=1, regioni=1,2,3,4,6,7,8=0
		Beibei District	Region6=1, regioni=1,2,3,4,5,7,8=0
		Yubei District	Region7=1, regioni=1,2,3,4,5,6,8=0
Explanatory variables		Banan District	Region8=1, regioni=1,2,3,4,5,6,7=0
	Highest education	High school and below	1
		College	2
		Undergraduate	3
		Graduate and above	4
	Occupation	Students	Professioni=1,2,3,4,5=0
		Administrative and institutional personnel	Profession1=1, professioni=2,3,4,5=0
		Enterprise personnel	Profession2=1, professioni=1,3,4,5=0
		Individuals and freelancers	Profession3=1, professioni=1,2,4,5=0
		Retirees	Profession4=1, professioni=1,2,3,5=0
		Other	Profession5=1, professioni=1,2,3,4=0
	Disposable monthly income	Less than 1,000 yuan	1
		1001–3000 yuan	2
		3001–5000 yuan	3
		5001–8000 yuan	4
		8001–10000 yuan	5
		10000 yuan or more	6

4.2.3. The correlation test of the regression equation

(1) The degree of fit and independence test

As can be seen from **Figure 5** below, the degree of fit of the relevant predictor variable $R^2 = 21.9\% > 10\%$, indicating that the predictor variable has a certain impact on the dependent variable; In addition, the Durbin-Watson statistic is equal to $1.862 < 2$, and the gap between the two is small, indicating that the varieties are independent.

Model	R	R-Square	Adjusted R-Square	Errors in Standard Estimates	Durbin-Watson
1	0.468	0.219	0.212	0.114	1.862

Figure 5. Model summary

(2) Significance analysis of specific predictor variables on dependent variables

It can be seen from **Figure 6** below that the significance analysis corresponding to the variables of age, highest education, occupation, and disposable monthly income is less than 0.05, which has a certain impact on the dependent variables. Among them, the unstandardized regression coefficient of age and disposable monthly income of residents in the main urban area is > 0 , indicating a positive correlation with the carbon inclusive literacy level of residents in the main urban area; the unstandardized regression coefficient of the highest education and occupation of residents in the main urban area is < 0 , indicating a negative correlation with the carbon inclusive literacy level of residents in the main urban area.

Model	Variable	Standard coefficient	t	Sig.
	Gender	0.064	1.838	0.067
	Age	0.181	4.711	0
	Residence	0.014	0.395	0.693
	Education	-0.162	-4.853	0
	Occupation	-0.112	-3.138	0.002
	Income	0.322	8.331	0

Figure 6. Significance analysis

(3) Residual test

After building the regression model, the residual is tested, and it can be seen from the scatter distribution in **Figure 7** below that there is no heteroscedasticity in this regression, so the multiple regression model is valid.

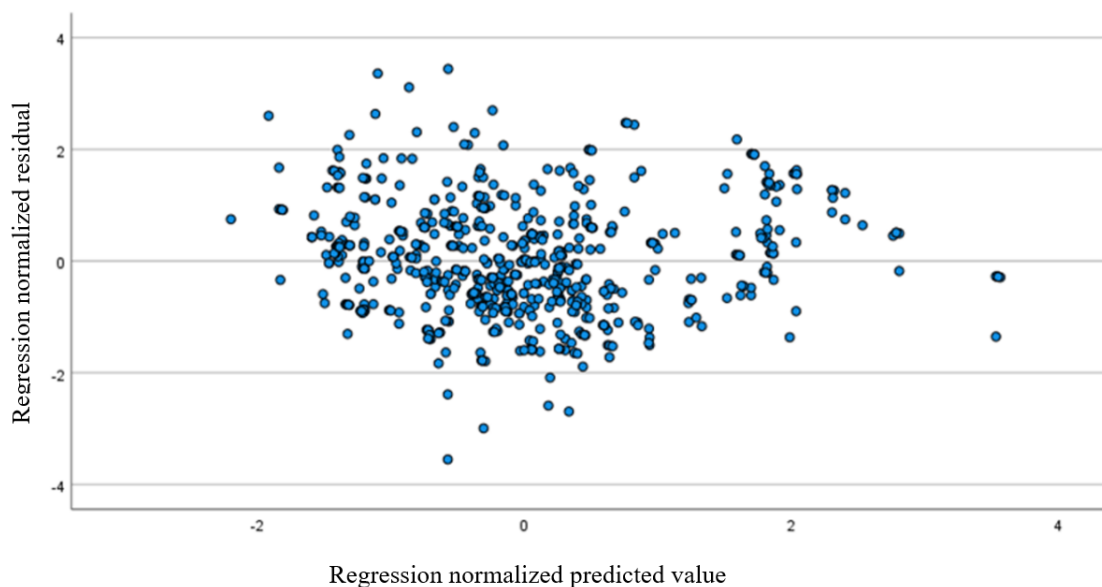


Figure 7. Scatter chart

4.3. Regression results analysis

Analyzing **Figure 8** below, we can obtain the degree and correlation of different factors on the carbon inclusion literacy of residents in the main urban area of Chongqing.

Model	Variables	Standard coefficients	t	Sig.
	Gender	0.038	1.817	0.070
	Age	0.031	1.296	0.195
	Permanent residence	0.034	1.660	0.098
	Education	-0.041	-1.909	0.057
	Occupation	-0.024	-1.146	0.252
	Monthly income	-0.023	-0.869	0.385
	Whether you have heard or not	-0.019	-0.911	0.363
	Whether you understand	-0.011	-0.535	0.593
	Travel mode	0.339	16.028	0
	Personal wishes	0.155	5.353	0

Figure 8. Regression result analysis

According to the above regression result table, it can be seen that the variables significantly related to the carbon inclusion literacy level of residents in the main urban area of Chongqing are: Age, permanent residence, educational level, daily living habits and attitudes towards carbon inclusion, while gender, occupation, income level and carbon inclusion base have no significant impact on the carbon inclusion literacy level of residents in the main urban area of Chongqing.

5. Research conclusions and policy recommendations on the carbon inclusion literacy of residents in Chongqing

5.1. Research conclusions

The age of Chongqing residents positively affects the carbon inclusion literacy level of residents. This means that the older the age, the higher the carbon inclusion literacy of residents, and the middle-aged and the elderly have higher carbon inclusion literacy levels than young people. We should expand the cognitive opportunities of young people for carbon inclusion related knowledge. The education level of the population has a negative correlation with the carbon inclusion literacy level of residents. The higher the education level of residents, the smaller the individual carbon inclusion literacy level. We guess that with the increase of educational level, the carbon inclusion learning may be ignored, and the enthusiasm to participate in related activities may be lacking. However, they are more likely to understand and accept carbon inclusion knowledge in this area, so we suggest that colleges and universities can increase the publicity of carbon inclusion knowledge and open more carbon reduction activities and related courses. Residents' occupations significantly affect residents' carbon inclusion literacy. Students and individuals associated with public administration and institutions have higher levels of carbon inclusion literacy than others. Because students and individuals working in public administration and institutions are often affected by related activities, their carbon inclusion literacy levels are improved. Monthly disposable income is negatively correlated with residents' carbon inclusion literacy levels. Income levels indirectly reflect social status. The higher the per capita disposable income level, there may be excessive consumption, extravagant and wasteful behavior, which in turn leads to a lower level of carbon inclusion literacy per capita among high-income people. Low-income people, on the other hand, are constrained by their spending power and passively choose more low-carbon

behaviors in their lives, such as taking public transportation and participating in carbon inclusion behaviors, and their carbon inclusion literacy is also higher.

5.2. Recommendations

To promote green and low-carbon development, individual residents can register low-carbon behaviors and obtain carbon points or carbon assets through the registered carbon inclusion platform. These points can be traded or exchanged for rewards in the carbon trading market. The platform should pay attention to user information protection and clarify rules to protect rights and interests. At the same time, it is necessary to publicize the concept and typical cases of carbon inclusion through multiple channels such as TV, radio, Internet and community activities to enhance public awareness and participation enthusiasm; the government should organize activities such as energy conservation and emission reduction competitions, and establish feedback mechanisms to optimize policies and services. In addition, the government should take the lead in building a unified carbon inclusion platform, promote its integration with the carbon trading platform, strengthen the construction of data security and management standards, and integrate social resources through policy guidance. Joint enterprises and scientific research institutions will jointly promote carbon inclusion, and enhance the content of science and technology and social participation.

6. Conclusion

This study proposes targeted measures to improve the carbon inclusion literacy of Chongqing residents through in-depth analysis and discussion. In terms of promoting individual residents' participation in carbon inclusion, the importance of enhancing residents' awareness and ability of carbon inclusion was emphasized; In terms of carrying out multi-form and multi-channel carbon inclusion activities, specific measures such as promoting successful cases, organizing activities and establishing feedback mechanisms were put forward; In terms of building a carbon inclusion platform, the leading role of the government was emphasized, as well as the necessity of data management and security. These countermeasures aim to improve the carbon inclusion literacy of Chongqing residents and promote carbon emission reduction and sustainable development. Looking to the future, with the deepening of the concept of carbon inclusion and the continuous progress of technology, the improvement of Chongqing residents' carbon inclusion literacy will be a continuous process. The government should continue to strengthen policy guidance and support to promote the in-depth development of carbon inclusion work. At the same time, all sectors of society should actively participate and jointly promote the development of carbon inclusion. Through continuous efforts, it is believed that the carbon inclusion literacy of Chongqing residents will be significantly improved and contribute to building a green and low-carbon society.

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Research on the Path of Integration between Logistics and Manufacturing in Haikou Driven by Big Data

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Abstract: With the constant changes of the times, China's science and technology have entered a period of rapid development. At the same time, the economic structure is also changing with the changes of the times, and the original Haikou logistics industry in the process is also facing new impacts and challenges. And related enterprises want to stand out in the fierce market competition, we must optimize and upgrade the current industry development situation, promote the integrated development of Haikou logistics and manufacturing industry, to constantly promote the innovative application of digital technology in the logistics industry and manufacturing industry, the formation of a multi-force economic development model. This paper mainly starts with the development status of Haikou logistics, analyzes the importance of the integration of Haikou logistics and manufacturing industry under the background of big data drive, and makes an in-depth discussion on the path of the integration of Haikou logistics and manufacturing industry under the drive of big data, hoping to contribute new strength to the development of social economy.

Keywords: Big data; Haikou logistics; Manufacturing industry; Convergence; Paths

Online publication:

1. Introduction

From the perspective of big data, manufacturing and producer services are important contents of the currently developed countries to achieve two-wheel drive and integrated innovation. The logistics industry is one of the important industries of the producer service industry, and Haikou logistics can promote the further development of the manufacturing industry to a certain extent. Therefore, in the current process of new economic development, it is very important to study the integrated development path of Haikou logistics and manufacturing industry. From the perspective of the synergistic agglomeration of the two, the collaborative agglomeration development of the manufacturing industry and Haikou logistics industry is studied. To optimize the industrial structure and promote the coordinated development of the regional economy from the aspects of transforming the growth power of the manufacturing industry and realizing the dual-wheel drive, to provide stronger support for the development of social economy.

2. Haikou logistics development status

With the constant change of social structure and the transformation and upgrading of economic structure, Haikou logistics industry has made remarkable achievements in infrastructure construction. On the one hand, the warehouse facilities, logistics parks, and sorting centers needed for modern development have been built and perfected, which has promoted the rapid development of the logistics industry ^[1]. At the same time, with the support of various transportation networks such as road, railway, water, and air, the rapid and efficient distribution of goods has been realized. On the other hand, driven by big data technology, Haikou logistics industry has also integrated new technologies to analyze and optimize the logistics workflow, collect and analyze historical data to improve operational efficiency, predict the future logistics needs of enterprises, to rationally arrange transport capacity, and constantly reduce the empty driving rate, to reduce the logistics costs of enterprises and alleviate the financial pressure of enterprises ^[2]. In addition, big data technology in warehouse management, logistics route optimization and other links also has a strong role to promote, while providing data analysis, predictive modeling and other functions, these aspects can also provide more support for the development of the manufacturing industry, and in the integration of logistics and manufacturing, logistics efficiency, manufacturing optimization and cost effectiveness can be provided by big data technology to a certain extent; And in the consumer market, it can ensure its development through new consumer products and improved services ^[3]. The specific process is shown in **Figure 1**.

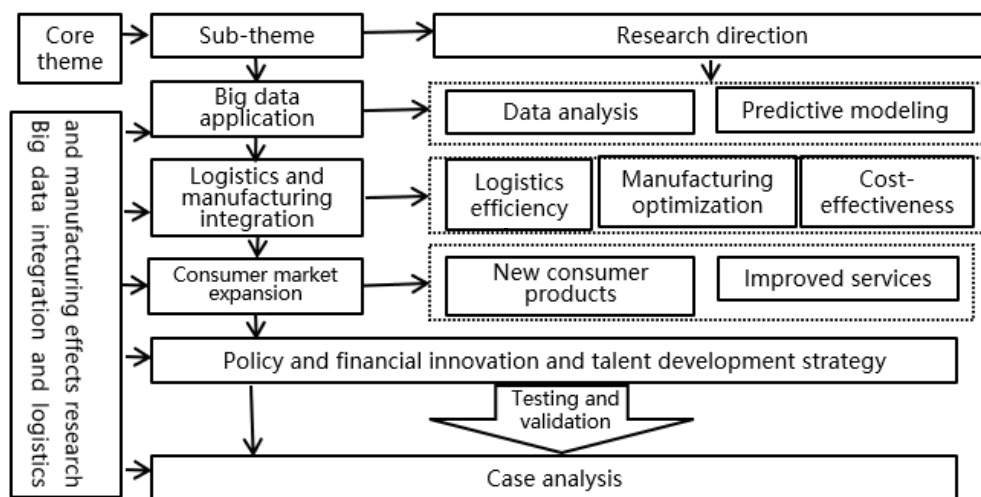


Figure 1. Big data driven integration process diagram of logistics and manufacturing industry in Haikou

3. The importance of the integration of logistics and manufacturing industry in Haikou under the background of big data

3.1. Promoting the deep integration of the two industries

In the context of big data, Haikou logistics and manufacturing industries can obtain strong technical support. By using advanced big data technology for analysis and mining, logistics enterprises can analyze and forecast market demand more accurately and adjust the logistics path based on it. In this way, inventory costs can be effectively reduced, and operational efficiency can be improved to the greatest extent ^[4]. At the same time, with the support of big data, manufacturing enterprises can also use advanced production technology to implement more refined management and can monitor the entire supply chain at any time to find potential risks in time, to improve the quality of production products. In addition, the deep integration of Haikou logistics and manufacturing can help the industry form a new industrial structure. In the process of continuous cooperation and communication, the original barriers and boundaries between the two industries are gradually disappearing, the logistics industry can gradually

access the manufacturing industry related to the supply chain management, inventory management, logistics distribution and other core links, and manufacturing enterprises will pay more attention to the optimization and upgrading of logistics in Haikou ^[5]. This kind of work mode integrating the two industries can not only further break the barriers existing in the traditional industry mode, but also promote the formation of a new work mode, which opens up a new situation for the development of regional economy.

3.2. Promoting economic structural transformation and upgrading

On the one hand, Haikou's integration of logistics and manufacturing can make the upstream and downstream of the industrial chain more closely linked. Relying on the support of big data, the logistics industry can comprehensively analyze the in-depth needs of manufacturing enterprises and provide more accurate logistics services to continuously simplify the manufacturing process of manufacturing enterprises, reduce manufacturing costs, and improve the competitiveness of products. The manufacturing enterprises can also change the production plan according to the feedback of the logistics data, improve the efficiency of the supply chain, and then realize the transformation and upgrading of the industry ^[6]. On the other hand, the application of big data technology can transform and upgrade the current economic structure. In the process of integration, new industrial models such as intelligent logistics and supply chain finance will constantly emerge, which can constantly generate new job demands and new economic demands. These new industries not only have the characteristics of high added value and high-tech content but also can constantly promote the development of related enterprises, thus forming an industrial cluster effect. And further enhance the competitiveness of the regional economy ^[7].

4. The path of Haikou logistics and manufacturing integration driven by big data

4.1. Establishing long-term strategic cooperative relations and integrating internal resources

With the continuous development of big data technology, the traditional Haikou logistics and manufacturing industries need to readjust and upgrade their original short-term and scattered cooperation mode, with the main purpose of establishing a long-term cooperation relationship, accurately docking each other's work needs, to form a more stable strategic alliance ^[8]. Through this form of deep integration, Haikou logistics related inventory dynamics, transportation time and other work content closely related to the manufacturing industry can help the relevant manufacturing managers to arrange more detailed production plans, overall arrangement of time and energy, maximize the efficiency of related manufacturing tasks, to avoid possible overproduction and delayed delivery ^[9]. At the same time, with the support of advanced technology, logistics enterprises can also obtain the order scheduling of manufacturing enterprises in advance, and the production law of products in off-season and peak seasons, on this basis, to make future transport capacity and warehousing planning, to ensure that the manufacturing enterprises can provide timely support when they need to ensure the stability and smooth operation of the supply chain. In addition, the managers of the two industries can also build an information-sharing platform. The manufacturing enterprises can upload the relevant data generated by their raw material procurement, production and processing, and finished product warehousing, breaking the limitations of information transmission and ensuring that Haikou logistics can pay attention to the development of enterprises in time. Meanwhile, logistics enterprises should also dig deep into the internal potential. Integrating dispersed transportation lines and warehouse bases, using big data to achieve intelligent optimization of storage layout, according to the flow of goods, flow characteristics, the warehouse is set closer to the manufacturing plant, where the traffic is more convenient, and the transfer cost is reduced.

4.2. Improving the construction of logistics infrastructure and optimizing the transportation structure

The construction of logistics infrastructure and the optimization of transportation structure play a very important role in the integration of Haikou logistics and manufacturing industry. In terms of infrastructure, the logistics industry in Haikou needs to overhaul and improve hardware facilities such as logistics parks, warehousing centers and distribution stations, and at the same time assist big data technology to relocate, and arrange related enterprises around the manufacturing cluster, to further improve the collection and distribution speed of goods ^[10]. In addition, the relevant facilities of the port and wharf should be enhanced, the utilization rate of the berth of the port and wharf should be monitored in real time by using big data, and the docking time of ships should be recorded, to rationally arrange the future operation process and make full use of the berth of Haikou port, thus reducing the backlog of goods to the greatest extent and improving the efficiency of container handling. To ensure the efficient flow of import and export manufacturing products. For the transportation structure, Haikou logistics involves different modes of transportation such as road, railway, water, and air transportation, and the selection of specific modes of transportation requires big data technology for more detailed differentiation ^[11]. For example, when transporting conventional goods, Haikou logistics needs to arrange the corresponding transportation mode according to the specific content of different seasonal conditions, time will give you demand and other influencing factors; When transporting urgent and valuable goods, air transportation can be arranged according to the specific situation of logistics at that time, and the fastest transportation method can be used to complete the corresponding transportation work. In this way, it can effectively improve the transportation efficiency and economic benefits, inject strong impetus into the integration of Haikou logistics and manufacturing industry, and create a more resilient pattern of industrial collaborative development ^[12].

4.3. Promoting integrated supply chain management and customized logistics services

From the perspective of integration, the integration of the supply chain can promote closer cooperation between logistics and manufacturing. In the specific management process, manufacturing enterprises can put forward practical demands to Haikou logistics. To enable logistics enterprises to provide more customized and personalized services ^[13]. At the same time, Haikou logistics service should be adjusted with the transformation and upgrading of the manufacturing industry. The use of big data technology logistics enterprises can accurately grasp the transportation mode that manufacturing enterprises need to use when transporting different goods, provide appropriate warehousing services and distribution services, and provide value-added services such as supply chain design and logistics finance that are more in line with the needs of enterprises. In addition, customized logistics services are also an important demand content in the development process of the current new era. In this way, Haikou Logistics can help manufacturing enterprises improve customer satisfaction, enhance customer loyalty, and create greater business value for manufacturing enterprises. At the same time, Haikou Logistics itself can continue to expand its service capabilities through this new work content, laying a foundation for its future development.

4.4. Strengthening policy support and guidance, optimizing talent training

The government can provide stronger policy guarantees for the development of enterprises. For the development of the industry, the cultivation of talents is an important direction to ensure that it can stand out in the increasingly fierce market competition. Therefore, the cultivation and introduction of talents is the current industry transformation and upgrading process needs to focus on, especially in the process of Haikou logistics and manufacturing integration, the relevant government departments need to promote the creation of “two industries” talent gathering platform, and introduce relevant policies to ensure the training and development of practical talents ^[14]. At the same time, to attract more outstanding industry talents, the relevant scientific research work system also needs to be further developed,

specifically adding comprehensive positions, promoting the construction of the green channel for the introduction of high-level technical production and service talents, and giving certain preferential policies to attract more talents to join the integration of the two industries^[15]. In addition, with the support of policies, big data technology can further promote the “integration of the two industries,” and use intelligent technology to promote inventory management, manufacturing automation, demand forecasting, product analysis and logistics optimization functions to form a flexible and efficient supply chain system, which can also promote the upgrading of manufacturing and logistics industry. Thus supporting them to occupy a place in the growing consumer market. The detailed process is shown in **Figure 2**. At the same time, enterprises attract talents with different technologies and excellent abilities to join the development of enterprises using technology investment, commissioned development, and team introduction. At the same time, relevant policies issued by the government provide more convenience for the flow of talents in different regions to break the restrictions of traditional industries and maintain the development of the market and industry.

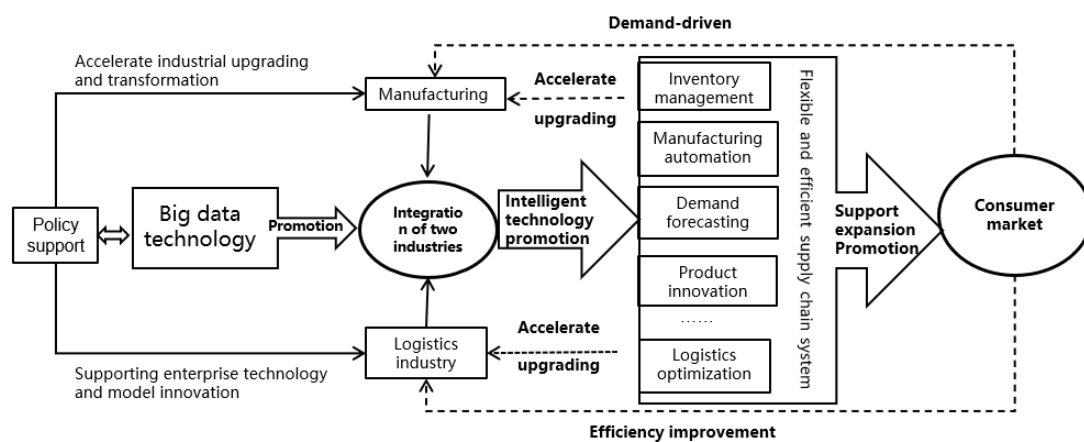


Figure 2. Schematic diagram of the integration mechanism between Haikou’s logistics and manufacturing industries driven by big data

5. Conclusion

In short, with the support of big data, Haikou logistics and manufacturing industry can further realize the deep integration of both sides, which can not only improve the work and production quality of Haikou logistics and manufacturing industry, but also cooperate with other industries involved, such as information service industry, financial service industry, business service industry and other producer services. Through the establishment of long-term cooperative relations and the improvement of relevant infrastructure, the production and service capabilities of the two industries can be further improved, and the cooperation content with various industries can be improved under continuous adjustment and development to promote the coordinated development of the logistics industry and manufacturing industry.

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Research on the Financing Constraints of Small and Medium-sized Enterprises in Hainan under the Background of Digital Inclusive Finance

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Abstract: Under the socialist market economic system of our country, the government, through the “invisible hand,” carries on macro regulation and control to improve the financing constraints that small and medium-sized enterprises are facing. But because of the huge base number of small and medium-sized enterprises in our country, there are many kinds, and the problem of financing constraints is still puzzling the development of enterprises at present. With the continuous promotion of inclusive finance in our country, the problems plaguing SMEs in the last mile of financing are gradually improved. In this context, small and medium-sized enterprises in Hainan Free Trade Port are taken as the research object to study the role of digital inclusive finance on the financing constraints of SMEs. The research shows that, first of all, small and medium-sized enterprises in Hainan Free Trade Port generally have financing problems. The development of digital inclusive finance solves the “last kilometer” problem of traditional finance, enhances financial access ability, broadens the financial service group, provides convenience and diversified services for SMEs’ financing, and provides inexhaustible impetus for the long-term healthy development of SMEs. Secondly, digital inclusive finance alleviates the financing difficulties faced by SMEs on the island by reducing financial costs and expanding the scale of credit.

Keywords: Digital inclusive finance; Small and medium-sized enterprises; Financing constraints

Online publication: April 28, 2025

1. Introduction

Since its reform and opening up, China’s economic and social development has achieved remarkable results that have attracted worldwide attention. Among them, the vast number of small and medium-sized enterprises have provided a powerful driving force for the continuous prosperity and progress of China’s socialist market economy^[1]. As the forefront of China’s opening up, small and medium-sized enterprises in Hainan Province, as one of the most active subjects in economic development, have achieved excellent development results in the wave of reform and opening up. Especially in the new era, under the promotion of national policies, the establishment of Hainan Free Trade Port has provided new impetus and policy support for the development of small and medium-sized enterprises on the island. In the development of small and medium-sized enterprises, the problem

of financing constraints has long been a major test for the development of small and medium-sized enterprises in the world. Although under the conditions of China's socialist market economy system, the "invisible hand" of the government constantly improves the financing constraints faced by small and medium-sized enterprises through macroeconomic regulation and control, for small and medium-sized enterprises with a large base and many kinds, financing constraints are still puzzling the development of enterprises at present^[2]. With the continuous promotion of inclusive finance in our country, the problem of the last mile of financing for small and medium-sized enterprises has gradually been improved, but there are still some shortcomings in solving the last "one kilometer" problem^[3]. Digital inclusive finance, based on artificial intelligence, big data, and cloud computing, has brought new opportunities to the traditional financial industry, given the traditional financial industry a new definition, and opened up a new path for SMEs to finance.

2. Current situation of financing for SMEs in Hainan

The main difficulties faced by SMEs in financing in Hainan are summarized in the following aspects:

(1) Single financing channels

Small and medium-sized enterprises in Hainan have relatively single financing channels, mainly bank loans. However, due to their small scale and relatively high risk, banks are usually reluctant to provide sufficient loan support, making it difficult for these enterprises to obtain funds through traditional bank loan channels^[4].

(2) High financing costs

Even if they can get bank loans, SMEs usually need to pay higher interest, increasing the financing cost of enterprises. In addition, due to the lack of adequate collateral, these enterprises often need to pay higher guarantee fees, further increasing financing costs^[5].

(3) Limited financing scale

Small and medium-sized enterprises in Hainan are generally small in scale, and their operating income is limited, so their internal financing ability is relatively weak. This means that it is difficult for these enterprises to meet their financing needs through their accumulation, and they must rely on external financing support^[6].

(4) Insufficient policy support

Although the government has introduced some policies to support SME financing, the implementation effect of these policies is not obvious. For example, some policies have made it difficult for SMEs to enjoy the benefits of these policies due to asymmetric information, cumbersome approval procedures, and high application costs.

(5) Insufficient risk prevention mechanisms

Small and medium-sized enterprises in Hainan generally do not do enough in risk prevention. Once they encounter a financial crisis, these enterprises are often unable to deal with it and are prone to problems such as a capital chain break. The development of small and medium-sized enterprises needs a large amount of capital support, which is mainly reflected in the development of small and medium-sized enterprises^[7]. They need to continuously improve their production efficiency, and the improvement of production efficiency requires enterprises to constantly innovate in the production link. Including the renewal of manufacturing equipment, product performance innovation, and other aspects of comprehensive innovation to continuously improve the overall production efficiency of small and medium-sized enterprises to improve^[8]. According to the statistics of the Department of Commerce of

Hainan Province, at present, more than 99% of small and medium-sized enterprises in Hainan Province are mainly concentrated in agriculture, forestry, husbandry and fishing, accommodation and catering, and traditional manufacturing industries. And these traditional industries market competition pressure, the industry innovation difficulty is high objective factors lead to the small and medium-sized enterprises in Hainan Province in the enterprise innovation need to pay more cost input, and small and medium-sized enterprises due to their limited scale of operation, it is difficult to meet the further development of the capital needs through business sales. This leads to the objective problem that there is a universal financing demand of SMEs in Hainan Province. However, the financing demand of SMEs is almost universal. As a result, when providing services to such SMEs, financial institutions need to consider whether they can provide the financing funds required by relevant enterprises and also fully combine the operation and development of enterprises with capital needs to meet the requirements on the repayment ability of corresponding funds. As a result, SMEs need a long time to wait for financing, and after layers of screening, they can get the financing support of corresponding financial institutions.

In general, there is an imbalance between the large financing demand formed by the main body of small and medium-sized enterprises with a large total amount and the financial institutions with a small number of institutions serving too many clients^[9]. The difficulties faced by small and medium-sized enterprises in Hainan in financing mainly include single financing channels, high financing cost, limited financing scale, insufficient policy support, and insufficient risk prevention mechanism. These factors together lead to obvious financing difficulties faced by SMEs in Hainan Province.

3. The development status of digital inclusive finance in Hainan

Since 2011, Hainan's digital inclusive finance has shown an obvious development trend, with the overall development index constantly improving. This reflects that in the past ten years, Hainan Province has continuously promoted the development of digital inclusive finance and achieved relatively remarkable development results, and the development efficiency has shown an overall development trend of steady progress. The two indicators of the coverage breadth and use depth of the development of digital inclusive finance it is consistent with the development trend of the overall digital inclusive finance and have maintained a stable and sustainable development trend. This reflects the overall development of digital inclusive finance in Hainan Province, which has not only realized the sustainable development of a wider scope of coverage but also continuously improved the depth of use of digital inclusive finance in Hainan Province. In addition, it shows that the overall development of digital inclusive finance in Hainan Province shows a benign development trend based on constantly expanding the coverage and use level of digital inclusive finance. However, according to the change trend of the digitalization degree in the development of digital inclusive finance, the development of digital inclusive finance in Hainan Province shows obvious fluctuations. This reflects that the digitalization degree of digital inclusive finance in Hainan Province is not stable.

As a form of inclusive finance, digital inclusive finance has shown a good development trend in recent years. Through consulting the data on the website of Peking University Digital Finance Center, it is found that the digital inclusive finance index of Hainan Province reached 158.26 in 2013 and rose to 385.58 in 2019. The digital inclusive finance of Hainan Province as a whole shows an increasing trend of development year by year.

However, due to the low digital inclusive financial development index in some county-level cities, the digital inclusive financial development index of Hainan Province has grown slowly in the past two years, but as a whole, it has increased by at least 18 index points every year. At the same time, in 2015, the growth rate of

digital inclusive finance in Hainan Province was faster, increasing by 28.23% compared with 2014. But in 2016, the growth rate of digital inclusive finance in Hainan Province was 0.53%, showing a slowing trend. To a certain extent, it indicates that the initial popularization of digital inclusive finance in Hainan Province has achieved remarkable results, but there is still a large room for improvement.

From 2016 to 2018, it showed a rapid upward trend, indicating that with the implementation of the reform of digital inclusive finance in Hainan Province, some economically underdeveloped cities have gradually increased their efforts to promote digital inclusive finance. Furthermore, the development level of inclusive finance in Hainan Province as a whole has improved rapidly. Compared with 2016, the growth rate in 2017 was 19.04%, which is a fast growth rate. In 2019, the digital inclusive financial index of Hainan Province was 328.75, which showed a decrease in growth rate compared with 2018, while the average of the national digital inclusive financial index in 2019 was 323.73. It can be seen that the development status of the digital inclusive financial index of Hainan Province is closely in line with the national average on the whole.

However, the development level of digital financial inclusion in Hainan Province is still not stable enough, and the gap between cities in the province is still large. It is necessary to further strengthen the popularization of digital financial inclusion in Hainan Province.

4. Suggestions

The development of digital inclusive finance has continuously enriched the supply channels of financial products, and financial institutions need to pay attention not only to the launch of financial products that are popular in the market but also to the launch of diversified product portfolios to meet the financial needs of a small number of consumers. In the current market environment, the financing needs of small and medium-sized enterprises are obviously at the end of the market for financial institutions. However, because there are many small and medium-sized enterprises and their financing needs are diverse, they can also match the bulk financing transaction volume well. Financial institutions can also greatly promote the development of financial institutions by providing financing channels for many small and medium-sized enterprises and combining the aggregate advantage. The emergence of digital inclusive finance, by its significant role in reducing information asymmetry and financial exclusion, has gradually enhanced the tail-end effect of SME financing. That is, SMEs can also gain the attention of financial institutions and markets by their extensive coverage and wide range of business operations. This is conducive to the reduction of financing costs of SMEs, the expansion of financing scope, and then alleviating the financing constraints of SMEs.

4.1. Building a credit system for SMEs

One of the causes of SME financing constraints is information asymmetry, and digital inclusive finance is an effective way to solve this problem. At present, the information of small and medium-sized enterprises is scattered and unsystematic, and the information of small and medium-sized enterprises held by financial institutions is not complete, but if the information is blindly disclosed, it will inevitably cause serious information security problems. Therefore, government departments can organize and summarize the relevant information of small and medium-sized enterprises^[10], establish a general credit evaluation system for small and medium-sized enterprises, and improve the credit evaluation indicators, to provide referable evaluation standards for financial institutions and provide convenient financing services to support the development of small and medium-sized enterprises.

4.2. Promoting the digital development of financial institutions

China's large banking financial institutions have shown a clear trend of digitalization, with the increase of

financial technology investment and the promotion of digital transformation, the digital transformation of traditional banking financial institutions provides more convenient financing channels for small and medium-sized enterprises. Digitalization will become the mainstream trend of the next development of the financial industry, and other financial institutions should also join the ranks of digital transformation to keep up with the pace of the digital era, to cope with the diversified financing needs of small and medium-sized enterprises^[11]. In addition, the financing difficulties of SMEs are partly due to the low quality and efficiency of financial services. Therefore, in the process of digital transformation, attention should be paid to the supply-side structural reform of financial services, which should be optimized not only in terms of the quantity of supply, but also in the way of supply, to provide financial services that can better meet the financing needs of SMEs^[12].

4.3. Improving SMEs' awareness of information disclosure

On the one hand, as the main body of information disclosure, SMEs have the initiative in information disclosure. They should be encouraged and guided to consciously disclose information related to production, operation and finance on the premise of not harming their interests, improve information transparency, facilitate banks and other financial institutions to obtain such information in a timely and comprehensive manner^[13], and reduce transaction costs between financial institutions and SMEs. It is conducive to the long-term and healthy development of both financial institutions and SMEs^[14]. On the other hand, driven by the blockchain economy, information sharing has brought upstream and downstream enterprises closer together, and SMEs' improved information transparency is also conducive to their business expansion and long-term development^[15].

Disclosure statement

The authors declare no conflict of interest.

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