ISSN 2995-5688 (Print)
ISSN 2995-570X (Online)

Global Academic Frontiers

Volume 4 · Issue 1 · March 2026

Published by Editorial Office of Global Academic Frontiers

Global Academic Frontiers

Volume 4 • Issue 1 • March 2026

(Quarterly, Published Since 2023)

Publisher	Editorial Office of Global Academic Frontiers
Place of publication	United States
Website	http://gafj.org
Email	office@gafj.org
Editor-in-Chief	Cunpeng Wu
Office number	+1 818-936-4444
Mailing Address	15617 NE Airport Way, Multnomah Mailbox SHKHVD Portland, OR, USA 97230
Printer	Editorial Office of Global Academic Frontiers self-prints on the Lulu Press
	A4 Paper, Version 1, Printing March 2026
Subscriptions	http://gafj.org/journal
Price	Free Copy
	ISSN: 2995-5688（Print）
	ISSN: 2995-570X（Online）
	International Standard Identifier for Libraries: OCLC-GAFEO
	ISNI: 0000000517857833

TABLE OF CONTENTS

Global Academic Frontiers, Vol. 4, Issue 1, 2026, pp. 1-10 Print ISSN 2995-5688 Online ISSN 2995-570X
DOI: https://doi.org/10.5281/zenodo.18936600

Study on Measuring the Level of High-Quality Development of China's Marine Economy

Zhu Shenghu [1*], Chen Tian [1], Liu jiawen [1], Wei Xinyu [1]

[1] School of Economics and Management, Dalian Ocean University, Dalian, Liaoning 116023, China
*Corresponding author Email: 1299261652@qq.com
Received 28 October 2025; Accepted 3 March 2026; Published 10 March 2026

Abstract： At present, China's economy has shifted from a stage of rapid growth to a stage of high-quality development.The ocean is a strategic place for high-quality development, and the promotion of high-quality development of the marine economy is a fundamental requirement for determining the thinking on the development of the marine economy, formulating routes and implementing macro-control policies in the current and future periods.Based on the five new development concepts, it has constructed an evaluation index system for the high-quality development of the marine economy that includes the five dimensions of "innovation, coordination, greenness, development and sharing".For the panel data of marine economy of 11 coastal provinces from 2017 to 2021, the entropy weight TOPSIS model is applied to construct the evaluation index of high-quality development of marine economy,and conduct quantitative research and assessment analysis.The results show:(1)In 2017-2021, the level of high-quality development of China's regional marine economy as a whole fluctuated upward, and inter-regional differences in the first narrowing and then expanding trend.(2)There were significant differences in the level of high-quality development of the marine economy in the three major ocean economic zones during the study period.

Keywords： Maritime economy； High-quality development； Entropy weight TOPSIS model； Horizontal measurement

I. Introduction

Since the 1990s, with the development of marine resources and the development of the marine economy, the pressure on land-based resources and the environment has been alleviated, and it has played an important role in supporting and leading economic growth as well as promoting sustainable economic and social development.China's gross domestic product (GDP) for the oceans was 285.5 billion yuan in 1996, and will grow to 990.97 billion yuan by 2023, with an average annual growth rate of 14.38 per cent, which is higher than the GDP growth rate for the same period by 0.8 percentage points, and accounts for 7.9 per cent of the GDP.However, with the rapid development of the marine economy, the overexploitation of marine resources has brought about the depletion of marine resources,The degradation of the functions of marine ecosystems and the lack of momentum for marine economic growth are also becoming increasingly evident. These problems have a direct impact on the quality of marine economic growth.

In his report to the 19th National Congress, General Secretary Xi Jinping pointed out that China's economy has shifted from a stage of rapid growth to a stage of high-quality development,During the first session of the National People's Congress, it was stated that "the oceans and seas are a strategic location for high-quality development".It can be seen that the high-quality development of the marine economy is of great practical significance to our country's realization of the goal of a strong marine power and the construction of a modernized economic

system.The ocean is a strategic location for high-quality development, a bridge connecting regional development, and an important area for nurturing new industries, developing new energies and leading new growth.The report of the 20th CPC National Congress clearly puts forward "developing the marine economy, protecting the marine ecosystem and accelerating the construction of a strong marine country", reflecting the great importance that the State attaches to the high-quality development of the marine economy.

II. Literature review

Defining the scientific connotation of high-quality development of the marine economy is the first and foremost task in measuring and benchmarking the current level of high-quality development of the marine economy.High-quality development is responsive to the people's need for a steady rise in the standard of living for a better life, and its connotation has been gradually enriched with the development of productive forces and the economy and society,It has been continuously extended to many fields such as economy, society and ecology.Existing literature mainly defines the connotation of high-quality development from the perspectives of the main contradiction in society [1], the new development concept[2][3], the "five-in-one" layout[4], the three levels of macro, meso, and micro[5], and the comparison with high-speed growth[6].Although the meaning of high-quality development has not yet been finalized, the mainstream view is that high-quality development is development that can well meet the growing needs of the people for a better life.It is a development that embodies the new development concept, one in which innovation becomes the first driving force, coordination becomes an endogenous feature, green becomes a universal form, openness becomes the way to go, and sharing becomes the fundamental purpose.Although the connotation of high-quality development is rich, the connotation of high-quality development of the marine economy cannot be made in the same way.Although the marine economy has certain commonalities with the national economy, it has its own characteristics, given the restorative power of marine ecology and the dynamic nature of marine resource endowment.High-quality development of the marine economy involves complex linked systems such as the marine economic system, the marine resources and environmental system and the marine social system, as it encompasses a wide range of relationships, including the development and utilization of marine resources.Consequently, high-quality development of the marine economy does not refer only to high-quality development of the marine economic system, but rather to the integration of the systems and the harmonization of their interrelationships,To realize high-quality development in synergy with all systems and to achieve the unified development of the marine economy in an innovative, coordinated, green, open and shared manner.

At present, research on high-quality economic development is relatively abundant, and research on the definition and connotation of high-quality development of the marine economy has been carried out mainly from three aspects:The first is based on the perspective of the quality and effectiveness of marine economic growth.Wang Zeyu (2015) and others believe that the quality of the marine economy is a comprehensive reflection of the growth capacity and operational effectiveness of the marine economy,Including the optimization and upgrading of the structure of the marine economy, the renewal of science and technology, the intensive use of resources, the sustainability of the ecological environment and the stability of its own operation,It also constructed a system of indicators in four dimensions: structural excellence, scientific and technological support, resource utilization and ecological environment[7]； Li Bo (2017) and others believe that the quality of marine economic growth includes the improvement of the comprehensive strength of the oceans, the optimization of the structure of marine industries, the improvement of the distribution of marine social welfare, and the harmony of the marine ecological environment,Result of the dynamic equilibrium of the "economy-society-resource-environment" system of the oceans and seas[8].Li Bo (2019) and others point out that the quality of marine economic growth is stimulated by the constraints of externalities such as social, economic, environmental, institutional, cultural, and policy conditions,Measurement of the performance of marine economies and the quality of life of coastal people by integrating the effects of endogenous conditions such as the structure, mode and process of marine economic growth[9].Secondly, it elaborates the connotation of high-quality development of the marine economy based on the

perspective of the five development concepts.Ruayun (2019) and others summarize and generalize the concept of high-quality development of the marine economy,is the ability to meet people's needs for a better life in the process of production activities and in the distribution of the impacts and results of the outcomes of production related to the development of the oceans and seas,Sustainable development with a high ratio of factor inputs to outputs, high efficiency in resource allocation, high technological content, adequate regional and industrial development, balanced market supply and demand, and high quality of products and services,It is a development model that focuses on innovation, coordination, greening, openness and sharing, and involves the balanced development of the marine economy, marine ecology, marine culture and socio-political aspects[10]; Cheng Manman (2022) and others believe that the high-quality development of the marine economy is capable of enhancing the comprehensive strength of the oceans, optimizing the industrial structure, raising the level of openness, promoting the harmony of the ecological environment, improving the distribution of social welfare,Synergistic and high-quality development involving the five systems of the ocean economy, resources, environment, science and technology and society[11].Third, it is defined based on the system object dimension of high-quality development of the marine economy.Di Qianbin (2022) and others defined the high-quality development of the marine economy as keeping innovation-driven, scientific research-led, and promoting the transformation of the kinetic energy of the marine industry on a micro level,Maintaining a stable and upgraded industrial structure at the meso level, with a view to optimizing the industrial structure and encouraging inter-island industrial integration, and improving the efficiency of the marine economy in terms of capital, energy and labour at the macro level,A series of ways to improve market stability and policy management on market regulation to meet the new normal economic development needs of the marine economic development model[12].

There is a wealth of research on evaluation measures of high-quality development of the marine economy,Most scholars use the new development concept of innovation, coordination, greenness, openness and sharing as the standard to construct the evaluation index system,and using different methods to measure the level of high-quality development of the marine economy.Liu Bo (2020) and others used linear weighting method, coupled coordination model and kernel density method to study the spatial and temporal characteristics of high-quality development of Jiangsu's marine economy[13]; Zhao Hui (2020) and others measured the index of high-quality development of Tianjin's marine economy by constructing a judgment matrix and applying the AHP method, and made a longitudinal comparison of its development trend[14]; Di Qianbin (2022) and others used subjective and objective comprehensive evaluation method and TOPSIS modeling,Evaluation of marine economic development in Tianjin, Shandong and Liaoning[15]; Qiu Rongshan (2023) et al. Using AHP-EW combined weight optimization model to measure the level of high-quality development of China's marine economy,and analyze their spatial differences and dynamic evolutionary trends[16].In addition to the new development concept, some scholars have proposed different research perspectives.Liu, Guichun (2019) and others used set-pair analysis,to measure marine economic growth driving factors,It was further decomposed and compared with spatio-temporal differences using the LMDI method[17]; Gao Sheng (2022) and others constructed an evaluation index system from six aspects, such as quality and efficiency improvement, structural optimization and production and life,And using TOPSIS model to measure the high-quality development of China's marine economy[18].

In summary, studies on the measurement of the level of high-quality development of the marine economy have attracted the attention of some scholars, but the existing studies still have certain singularities and limitations.To promote the high-quality development of the marine economy, first of all, we need to have a profound and comprehensive understanding of the actual level of high-quality development of China's marine economy,Understanding the shortcomings and deficiencies in the current process of high-quality development of the marine economy, and accurately hitting the pain points in order to truly realize high-quality development of the marine economy.At the same time, China has a vast territory and a long coastline, and the coastal provinces and cities have different geographic locations,Their resource endowments and industrial layout are very different, so

there are certain regional differences in the process of high-quality development of the marine economy,Scientific identification of the differences in the high-quality development of the marine economy in various regions and the reasons for them can provide effective ideas for the future high-quality development of the marine economy and the adjustment of policies for regional coordinated development.Therefore, based on the five new development concepts, this paper constructs a high-quality development evaluation index system for the marine economy that includes the five dimensions of "innovation, coordination, green, development and sharing",Quantitative analysis of marine economic panel data for 11 coastal provinces from 2017 to 2021 to study the comprehensive level of high-quality development of China's marine economy and the differences among regions.

III. Research design

(i) Data sources

The scope of this paper is the 11 coastal provinces and cities of China (excluding Hong Kong, Macao and Taiwan),Data from China Marine Statistical Yearbook, China Statistical Yearbook, China Environmental Statistical Yearbook, China Science and Technology Statistical Yearbook, and Statistical Yearbooks of Coastal Provinces, etc., 2017-2021.Individual missing data are filled in using exponential smoothing based on previous years' data.

(ii) Measurement of variables

This article refers to the Opinions of the Central Committee of the Communist Party of China and the State Council on Promoting High-Quality Development and other relevant documents,Based on the scientific connotation and basic characteristics of high-quality development of the marine economy, such as high efficiency, stability, sustainability, coordination and long-term development,Following the principles of systematicity, scientificity, dynamism and operability, based on economic aggregates and guided by the five development concepts,and refer to the research of scholars such as Ruyayun (2019)[10],Constructing an evaluation index system for the high-quality development level of China's marine economy from the five dimensions of innovation, coordination, greenness, development and sharing.

(iii) Determination of weights

The study in this paper draws on the calculations of scholars such as Yin Peng (2021)[19],Applying the entropy method,Calculate the weight of each indicator,And construct a comprehensive index evaluation model to calculate the level of high-quality development of urban-rural integration.The steps are as follows：

Step 1: Programmability of data,Adoption of formulas (1) and (2).

$$x_{ij}' = \frac{x_{ij} - x_j^{min}}{x_j^{max} - x_j^{min}} \quad (1)$$

$$x_{ij}' = \frac{x_j^{max} - x_{ij}}{x_j^{max} - x_j^{min}} \quad (2)$$

Step 2: Calculate the share of the ith evaluated subject in year j.

$$y_{ij} = \frac{x_{ij}}{\sum_{i=1}^{n} x_{ij}} \quad (3)$$

Step 3,suppose that $\theta = \frac{1}{\ln(n)}$,n represents the year of measurement,Measuring the information entropy of evaluation metrics using equation (4).

$$e_j = -\theta \sum_{i=1}^{n} (y_{ij} \times \ln y_{ij}) \quad (4)$$

Step 4,Calculate the entropy weight vector of the evaluation indicators using equations (5) (6)w=[w_1, w_2,…, w_k]

$$d_j = 1 - e_j \quad (5)$$

$$w_j = \frac{d_j}{\sum_{j=1}^{k} d_j} \quad (6)$$

Step 5,Measurement of the corresponding level of integrated development using the statistical formula (7).

$$S_{ij} = w_j \times x_{ij}' \quad (7)$$

In accordance with the design of the indicator system described above,and the collection and processing of relevant data.After scientific calculations and comprehensive analyses, the weighted values of the indicators were obtained,As shown in table 1.

Table 1 Indicator system and weights of indicators for measuring the level of high-quality development of the marine economy

	Level 1 indicators	Secondary indicators	Indicator properties	Indicator weights
Ocean Economy The level of high-quality development of the ocean economy	blaze new trails	Number of R&D projects in marine research and development organizations	forward	0.0745
		R&D personnel in marine research and development organizations	forward	0.0686
	trade-off	Coastal GDP growth rate	forward	0.2242
		Coastal GDP	forward	0.0779
	greener	Per capita water use in coastal areas	forward	0.0442
		Area of marine nature reserves nationwide	forward	0.3175
	liberalization	Cargo throughput at coastal ports	forward	0.0349
		International standard container throughput at coastal ports	forward	0.0763
	enjoy together	Number of undergraduate marine majors in higher education	forward	0.0424
		Coastal travel agency	forward	0.0395

IV. Analysis of results

(i) Analysis of the results of the level of high-quality development of the marine economy by province

This paper is based on panel data from 11 coastal provinces in China,Measurement of specific research data selected from China Marine Statistical Yearbook, China Marine Statistical Bulletin, China Statistical Yearbook and China Science and Technology Statistical Yearbook, etc.According to the evaluation index system for the level of high-quality development of China's marine economy constructed above,The entropy weight TOPSIS model was used, taking into account both subjective and objective weights,Calculation of the index of the level of high-quality development of the marine economy in 11 coastal provinces, 2017-2021,As shown in table 2.

Table 2 Index of high-quality development of the marine economy in coastal provinces

Region	provinces	2017	2018	2019	2020	2021
North	Tianjin	0.0752	0.2513	0.0686	0.0635	0.0789
	anhui	0.0773	0.0902	0.0914	0.0644	0.0785
	Liaoning	0.1217	0.1227	0.1184	0.0981	0.1128
	Shandong	0.2257	0.2624	0.2717	0.2554	0.2919
	Mean value	0.1250	0.1817	0.1375	0.1204	0.1405
Eastern	Shanghai	0.1585	0.1617	0.1695	0.1986	0.2214
	Jiangsu	0.2213	0.2165	0.2387	0.1607	0.1947
	Zhejiang	0.1725	0.1761	0.1875	0.1511	0.1698
	Mean value	0.1841	0.1848	0.1986	0.1701	0.1953
South	Fujian	0.1113	0.1188	0.1276	0.1011	0.1149
	hillsides	0.3298	0.3439	0.3723	0.3106	0.3401
	Guangxi	0.0598	0.0684	0.0722	0.0553	0.0673
	Hainan	0.1551	0.1660	0.3671	0.3640	0.3871
	Mean value	0.1640	0.1743	0.2348	0.2078	0.2274
National average		0.1553	0.1798	0.1895	0.1657	0.1870

On the whole, the level of high-quality development of China's marine economy has shown a fluctuating upward trend,Overall index except for a small decline in 2019,The rest of the years show a steady increase.It may be due to the fact that during the epidemic, the high quality development of China's marine economy showed a certain downward trend.In terms of the latest level of high-quality development of the marine economy in China's coastal provinces and cities in 2021,Guangdong (0.3401), Jiangsu (0.1947), Shanghai (0.2214), and Shandong (0.2919) as the PRD Economic Zone,Major coastal provinces and cities in the Yangtze River Delta and Bohai Rim Economic Zones, which are strategically located,Reasonable industrial structure,As a large economic province with a strong foundation of marine economy； At the same time, the four provinces and cities have a large number of colleges and universities specializing in the field of marine science and technology and scientific research institutions, which provide strong personnel and technical force for the development of marine science and technology innovation.And Zhejiang Province (0.1698) is also in the Yangtze River delta,In the radiation and driving role at the same time, focusing on building the economic development of the Bay Area of Zhejiang, the pioneer area,Many research institutes in the province provide sufficient public services in marine science and technology, and therefore its level of high-quality development of the marine economy is also at the forefront.

Looking at the whole research cycle,Guangxi marine economic development level of high quality has been in a relatively backward position, the reason for this is mainly due to the lower level of industrial structure,Still dominated by marine primary industries with low labor productivity,Inadequate marine science, technology and innovation capacity due to poor levels of education and social welfare； Hainan's tertiary industry is developing well and there is less damage to the marine ecosystem, but the overall level of social development is low and the population size is small,The number of research institutes, higher education institutions and research funding are insufficient to support Hainan's significant progress in the field of marine science and technology innovation,As a result, the level of high-quality development of its marine economy is low； Tianjin has outstanding marine environmental resource problems, small economic scale and slow upgrading of industrial structure, and the gap is more obvious when compared with provinces and cities with high level of high-quality development of marine economy； Hebei Province mainly focuses on traditional marine industries with high energy consumption and serious environmental pollution, and the high-quality development of the marine economy has been at a relatively

low level.

(ii) Analysis of the results of the level of high-quality development of the marine economy by region

To further explore the evolutionary pattern and regional differences in the level of high-quality development of China's marine economy,Based on the measurement of the composite index of high-quality development of the regional marine economy,Mapping the trends in the level of high-quality development of the marine economy in China's three major marine economic zones[1], as well as in the country as a whole, from 2017 to 2021,See figure 3.

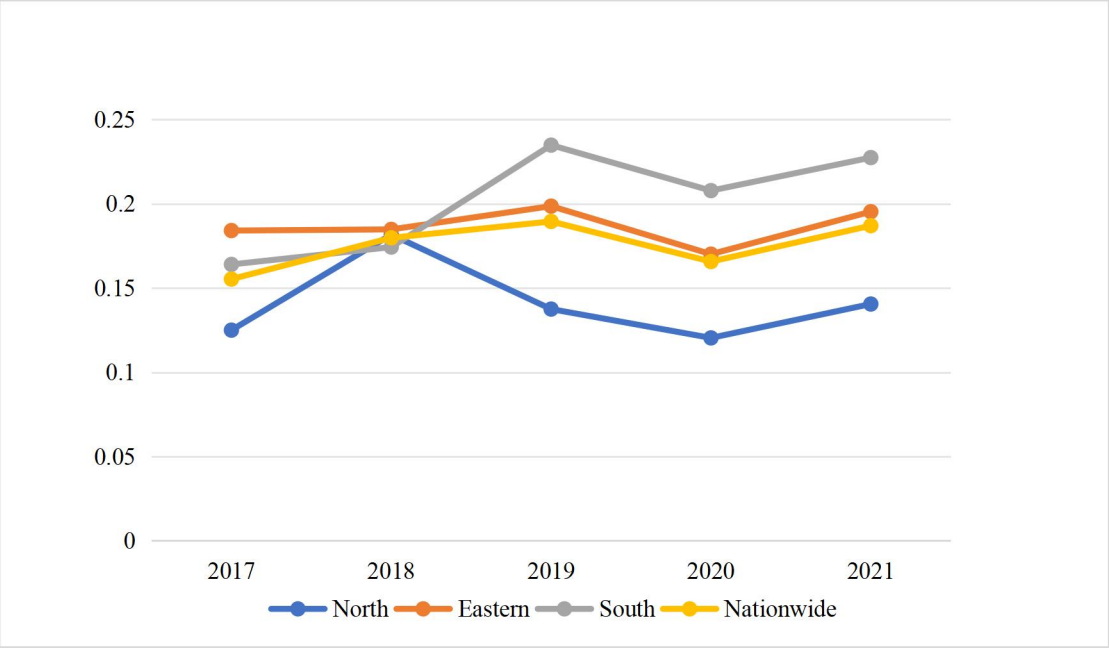

Figure 3 Trends in the index of the level of high-quality development of the marine economy at the national level and in the three major marine economic circles, 2017-2021

Looking at the macro level,Composite index of high-quality development of the marine economy in China's coastal provinces during the overall study period,Showing a fluctuating upward trend.This trend demonstrates the remarkable progress made by our marine economy on the path to high-quality development.With the exception of the Northern Maritime Economic Circle, which has seen more pronounced fluctuations over a period of time,The marine economies of the other regions have maintained a steady upward trend.This trend has undoubtedly injected strong confidence and momentum into the future development of China's marine economy.

In detail, from 2017 to 2019, the comprehensive index of high-quality development of the marine economy in China's coastal provinces has continued to grow.This shows that during this period, China's marine economy has achieved remarkable results on the road to high-quality development.However, by 2019 to 2020, this index showed a slight decline.This could be due to changes in the external environment, policy adjustments or other factors.However, it is encouraging to note that from 2020 to 2021, the index begins to rise steadily,This shows that after a brief period of fluctuation, China's marine economy has returned to a track of steady growth.

In terms of regional differences:: The level of high-quality development of the marine economy in China's eastern ocean economic circle is significantly higher than the national average.This fully demonstrates that the Eastern Ocean Economic Circle plays a leading and driving role in the development of the national ocean economy.At the same time, the Southern Ocean Economic Circle also shows a high level of high-quality development of the marine economy,It also shows that the marine economy of the southern region has made significant progress in recent years.In contrast, the Northern Ocean Economic Circle has the lowest composite index of high-quality development of the marine economy,This suggests that we in the North need to step up our efforts to catch up in terms of quality development of the marine economy.

In general, with the development of the national economy and the in-depth implementation of the five development concepts,The level of high-quality development of China's marine economy continues to rise.All

coastal provinces have achieved remarkable results on the road to high-quality development of the marine economy,At the same time, however, there are a number of challenges and difficulties.In the future, we need to continue to increase investment and efforts to promote the marine economy on the road to high-quality development.

V. Conclusions of the study and recommendations for countermeasures

(i) Conclusion

This article is based on the five development concepts,A comprehensive evaluation index system for the high-quality development of the regional marine economy, consisting of five subsystems and 10 specific indicators for innovation, coordination, greening, openness and sharing, has been constructed,Comprehensive index of high-quality development of China's regional marine economy from 2017 to 2021 was measured using entropy weight TOPSIS modeling,and at different levels of spatial scales, including the whole country, the three major ocean economic zones and the 11 coastal provinces,Comprehensive description of the spatial differences in the level of high-quality development of China's regional marine economy and the trend of its dynamic evolution,Based on the measurement results and taking into account the actual situation of high-quality development of the marine economy in each region,Analyzing the level of high-quality development of China's marine economy.The findings of the relevant studies are as follows：

From the composite index,Overall fluctuating upward trend of China's comprehensive index of high-quality development of regional marine economy, 2017-2021,and the absolute differences between regions show a trend of narrowing followed by a small increase,of which the composite index continues to rise from 2017-2019,Small decline in the composite index in 2019-2020,Continued steady increase in the composite index in 2020-2021.Viewed on the scale of the three major ocean economic zones,Higher composite index of high-quality development of the marine economy in the Eastern Ocean Economic Circle than in the Northern and Southern Ocean Economic Circle, 2017-2018,Differences between the three are gradually narrowing； Eastern and Southern Maritime Economic Circle consistently above the national average, 2018-2021,The northern maritime economic zone, on the other hand, is developing more slowly and is significantly below the national average； The three major ocean economic zones show the same trend of change as the national average in 2019-2021, with a decline followed by a sustained rise.

(ii) Recommendations

Based on the above findings,To effectively promote the realization of high-quality development of the marine economy in China's coastal areas,and fully integrating the development characteristics of each region,This paper makes the following recommendations：

(1) Deepening openness and cooperation and setting up development benchmarks.Shanghai should further accelerate the construction of the whole industrial chain base of the marine industry,Relying on its openness,Cultivate and promote a number of sea-related brand enterprises with international long-term competitiveness,Deeper integration into domestic and international economic cycles,Promote the supply chain, value chain and industrial chain to be in line with international standards.Guangdong should seize the opportunity of the times,Fully utilize the multiple policy advantages of the "Belt and Road" construction, the Guangdong-Hong Kong-Macao Greater Bay Area, and the Pilot Free Trade Zone,Promoting the rapid development of sea-related industries,Expansion of sea-related employment,Enabling people to share in the fruits of the ocean economy,and to play a leading role in demonstrating the high-quality development of the marine economy.

(2) Mending the shortcomings of development and tapping the potential for growth.Shandong and Tianjin should capitalize on their resource and location advantages,Adhere to land and sea integration and promote the integrated development of the Bohai Rim,Enhancing the radiation-driven role of the marine economy for neighboring non-coastal regions.At the same time, the pace of research and development should be accelerated in the fields of marine biomedicine and new marine materials,Improving efficiency in the utilization of marine resources.Jiangsu and Zhejiang should seize the opportunity of environmental management in the Yangtze River

Basin,In-depth promotion of ecological restoration of key sea areas and bays,Actively develop marine strategic emerging industries with high technological content and environmental friendliness,Enhancing green productivity in the marine economy.Liaoning and Fujian should build on their strengths in industries such as marine fisheries, marine engineering equipment manufacturing, etc,Extending the industry chain,Enhancement of the efficiency-generating capacity of the whole industrial chain,and strengthening the interregional division of labor in the marine industry,Promoting the free flow of factors such as logistics, people, capital, information and technology flows.Hainan should take full advantage of free trade port,Deepening open cooperation in the marine high-tech industry,Actively introduce large marine scientific research institutions, research institutes and science and technology innovation-oriented enterprises,Enhancement of independent innovation capacity.

(3) Improving the quality of development and strengthening the drive for innovation.Hebei and Guangxi provinces should improve the quality of marine economic development on all fronts,Transforming the development of the marine economy,Promoting the transformation and upgrading of the marine industry.The two provinces should phase out low-efficiency, high-energy-consumption and high-pollution sea-related industries and technologies,Optimizing the layout and structure of marine industries based on the comparative advantages of coastal cities,Enhancement of factor and energy utilization efficiency in traditional marine industries,Improving the structure of human capital supply,Comprehensively improving the quality of marine economic development.

(4) Adhere to the sharing of the fruits of marine economic development for the purpose of enhancing the well-being of the people.Jiangsu, Guangdong, Guangxi and Hainan should fully utilize the conditions of sea resources,Promoting the construction of modernized sea ranches,Enhancing the supply of seawater products,Ensuring food security,At the same time actively explore "oil, gas, electricity and hydrogen" multi-energy complementary integration development,Promoting the scale development of offshore wind power,Building an offshore wind power base.Coastal areas should actively develop and improve all kinds of coastal tourism infrastructure facilities and play products,Enriching the supply of tourism products such as marine sports, marine recreation, coastal vacation, etc.High-quality leisure and tourism economic development zones that are pleasant to live in, work in and visit, etc., to meet market demand.Regions other than Guangdong, Zhejiang and Jiangsu should fully learn from the experience of their gradient cultivation of sea-related market players,Actively creating a favorable business environment,To create a group of sea-related leading enterprises to lead, specializing in new enterprises to attack small and medium-sized enterprises to build the foundation of the enterprise group,Cultivate new marine industries and grow new marine industries,Creating sea-based employment opportunities and increasing the income of coastal residents.Tianjin, Hebei, Fujian, Guangxi and other regions rely on the foundation of sea-related specialties in local universities,Integration of the actual needs of the development of the marine economy,Formation of specialized marine universities or colleges with distinctive features,Cultivating Composite, Professional and Skilled Marine Talents.

References

[1] Jin, Bo. (2018). An economic study on ‘high-quality development’. China Industrial Economics, (4), 5–18.

[2] Ren, Baoping., & Wen, Feng'an. (2018). Criteria, determinants and pathways for achieving high-quality development in China's new era. Reform, (4), 5–16.

[3] Jin, Gang., & Shen, Kunrong. (2019). Economic development in New China's seventy years: Evolution of government conduct and transformation of growth drivers. Macro Quality Research, 7(3), 1–16.

[4] Yang, Weimin. (2018). Implementing the Central Economic Work Conference spirit to advance high-quality development. Macroeconomic Management, (2), 13–17.

[5] Ren, Baoping. (2018). China's economic transition from high-speed growth to high-quality development in the new era: Theoretical explanation and practical orientation. Academic Monthly, 50(3), 66–74, 86.

[6] Ren, Baoping., & Li, Y. (2018). Constructing China's high-quality development evaluation system and its transformation path in the new era. Journal of Shaanxi Normal University: Philosophy and Social Sciences Edition, 47(3), 105–113.

[7] Wang, Zeyu., Zhang, Zhen., Han, Zenglin.(2015). Analysis of coordination between quality and scale of China's marine economy under the new normal. Regional Research and Development, 34(6), 1–7.

[8] Li, Bo., Tian, Chuang., & Shi, Zhaoyuan. (2017). Spatiotemporal differentiation and typology of marine economic growth quality in the Bohai Rim region. Resources Science, 39(11), 2052–2061.

[9] Li, Bo., Tian, Chuang., Shi, Zhaoyuan. (2019). Spatial characteristics and influencing factors of marine economic growth quality in coastal Liaoning. Advances in Geographical Science, 38(7), 1080–1092.

[10] Lu, Yayun., Yuan, Feng., & Li, Xingyun. (2019). Research on the construction and application of an evaluation indicator system for high-quality development of China's marine economy: A perspective based on the five development concepts. Enterprise Economy, 38(12), 122–130.

[11] Cheng, Mannan., Chen, Wei., & Yang, Rui. (2022). Construction and spatio-temporal analysis of China's high-quality marine economic development indicator system: Against the background of the marine power strategy. Resource Development and Market, 38(1), 8–15.

[12] Di, Qianbin., Gao, Guangyue., & Yu, Zhe. (2022). Evaluation and influencing factors of China's high-quality marine economic development. Geographical Science, 42(4), 650–661.

[13] Liu, Bo., Long, Ruyin., Zhu, Chuangeng. (2020). Evaluation of high-quality development level of Jiangsu Province's marine economy. Economic Geography, 40(8), 104–113.

[14] Zhao, Hui., Zhang, Wenliang., Zhang, Jjingling. (2020). Research on the connotation and indicator system of high-quality development of Tianjin's marine economy. China Land and Resources Economics, 33(6), 34–42, 62.

[15] Di, Qianbin., & Wan, Lini. (2022). Research on the evaluation of high-quality development of the marine economy based on new development concepts: A case study of the Bohai Rim region. Productivity Research, (1), 7–13, 17.

[16] Qiu, Rongshan., Yin, Wei., & Han, Linin. (2023). Evaluation and typology of high-quality development in China's regional marine economy. Statistics and Decision Making, 39(1), 103–108.

[17] Liu, Guichun., Shi, Qingbin., Wang, Zeyu. (2019). Spatiotemporal variations in growth drivers of China's marine economy. Economic Geography, 39(2), 132–138.

[18] Gao, Sheng., Li, Ziyi., Wang, Runjie. (2022). Evaluation analysis of high-quality development in Jiangsu Province's marine economy. Marine Development and Management, 39(10), 41–46.

[19] Peng, Yin., Wang, Fuxi., & Duan, Peili. (2021). Spatiotemporal coupling relationship between efficiency of basic public services and quality of urbanisation in China. Geographical Science, 41(4), 571–579.

Global Academic Frontiers, Vol. 4, Issue 1, 2026, pp. 11-21 Print ISSN 2995-5688 Online ISSN 2995-570X
DOI: https://doi.org/10.5281/zenodo.18936756

A Study on the Acceptance Willingness and Driving Factors of Agricultural Drones Among Smallholder Farmers in Liaoning Province

Liu Jiawen [1], Zhu Shenghu [1*], Ju Youxiu [1], Li Mianxue [1]

[1] School of Economics and Management, Dalian Ocean University, Dalian, Liaoning 116023, China
*Corresponding author Email: 1299261652@qq.com
Received 5 February 2026; Accepted 3 March 2026; Published 10 March 2026

Abstract : This study investigates the acceptance willingness and driving factors of agricultural drones among 229 smallholder farmers in Liaoning Province. Based on the UTAUT model and incorporating policy support variables, the research explores their attitudes toward adopting agricultural drones.A stratified random sampling method was employed to select smallholder farmers from six regions within the province for in-person interviews and online questionnaires. SPSS 27.0 was used for reliability and validity testing, correlation analysis, and multiple regression analysis.Results indicate that the questionnaire demonstrated good reliability and validity. Performance perception, perceived ease of use, social environment, and policy support all exerted significant positive effects on smallholder farmers' acceptance intention, with performance perception having the strongest influence and perceived ease of use the weakest. Based on empirical findings, the study proposes countermeasures including strengthening benefit guidance, establishing a socialized promotion network, optimizing the policy support system, and improving drone service models. These measures aim to enhance smallholder farmers' acceptance of agricultural drones and promote the intelligent transformation of agriculture.

Keywords: Smallholder farmers; Agricultural drones; Acceptance willingness; Driving factors

1 Introduction

Against the backdrop of accelerating global agricultural digitalisation, agricultural drones have emerged as pivotal equipment in modernising farming. Leveraging their efficiency, precision and cost-saving advantages, they have become a key solution to overcoming traditional agricultural production bottlenecks. As a major agricultural nation, China has persistently advanced agricultural technological progress in recent years. The application of agricultural drones in plant protection, seeding, and monitoring has expanded significantly, with accelerating technological iteration. However, the focus of promotion has predominantly centred on large-scale farming entities, while research and practical implementation tailored to smallholder farmers—who constitute the absolute majority of agricultural producers—remain relatively underdeveloped[1].

Liaoning Province, a major grain-producing region in China, cultivates staple crops such as maize and rice across over 70% of its arable land, with agriculture playing a pivotal role in its regional economy. According to data from Liaoning's Third National Agricultural Census, the province has 5.527 million agricultural households, of which only 127,000 are large-scale operations. Smallholder farmers constitute over 97% of the total, remaining the core force in agricultural production. However, accelerated urbanisation has led to a significant outflow of young and able-bodied rural labour, exacerbating Liaoning's agricultural labour shortage.Concurrently, labour costs have risen steadily, with average daily wages for agricultural workers increasing by over 8% annually over the past five years. This poses severe challenges to the traditional production models of smallholder farmers. Agricultural drones can

cover 80-120 mu (approximately 5.3-8 hectares) per day for crop protection operations – 15-20 times the efficiency of manual labour – while reducing pesticide wastage by 15-20%. Their advantages of precision application, high operational efficiency, and cost-saving benefits align precisely with the core needs of smallholder farmers[2] .

Currently, Liaoning Province has launched pilot programmes for agricultural drone adoption in Dalian, Tieling and other regions, facilitating technology implementation through skills training and policy subsidies. Dalian City plans to add 355 agricultural drones by 2025, expanding operational scenarios from crop protection spraying to seed sowing, crop monitoring and other domains[3] .However, research indicates that smallholder farmers' acceptance of agricultural drones remains relatively low. Common issues include insufficient awareness, weak policy perception, and limited service accessibility, which constrain the technology's widespread adoption. Therefore, systematically investigating smallholder farmers' willingness to adopt agricultural drones and the core drivers in Liaoning Province not only provides practical pathways to address their production challenges but also holds significant practical implications for accelerating regional agricultural digitalisation and safeguarding national food security.

Theoretically, existing studies on agricultural UAV acceptance predominantly rely on the generic UTAUT model, lacking targeted consideration of regional characteristics such as the ageing, part-time nature, and small-scale operations typical of smallholder farmers. Furthermore, integrated research on policy support—a critical external variable—remains insufficient. Building upon the UTAUT framework, this study incorporates policy support variables tailored to the characteristics of Liaoning Province's smallholder farmers, thereby optimising the theoretical framework. This research fills a regional gap in studies examining agricultural technology adoption among smallholders in major grain-producing areas, enriches empirical findings on UAV acceptance, and provides theoretical references and methodological insights for similar regional investigations.

At the practical level, identifying key factors influencing smallholder adoption intent provides precise data support for governments to formulate differentiated promotion policies and for enterprises to optimise product and service offerings. Targeted measures to lower the cost, cognitive, and service barriers to technology adoption among smallholders can drive the scaled application of agricultural drones in rural Liaoning. This, in turn, enhances agricultural productivity, reduces environmental pressures, and contributes to green sustainable agriculture and rural industrial revitalisation.

Accordingly, this study first defines core concepts such as smallholder farmers and agricultural drones, systematically reviews the application of the UTAUT model, agricultural technology diffusion, and existing research on agricultural drone promotion both domestically and internationally, thereby identifying gaps in current scholarship[4]. Secondly, a driver model is constructed comprising four core independent variables—performance cognition, operational perception, social environment, and policy support—with farmer individual characteristics as control variables and adoption intention as the dependent variable. A survey questionnaire tailored to smallholder cognitive levels is designed. Subsequently, employing stratified random sampling, six regions in Liaoning Province—Shenyang, Dalian, Tieling, Jinzhou, Yingkou, and Dandong—were selected. These areas encompass diverse terrains including plains and hills, and encompass both maize and rice production zones. Primary data from 229 smallholder farming households was collected through a combination of face-to-face interviews and online questionnaires. Finally, SPSS 27.0 was employed to conduct reliability and validity testing, correlation analysis, and multiple regression analysis. This validated the influence of each variable on adoption willingness, ultimately proposing targeted and actionable policy recommendations. These findings provide robust support for advancing the adoption of agricultural drones among smallholder farmers and facilitating the intelligent transformation of agriculture.

2 Research Design

2.1 Variable Definition and Research Hypotheses

Based on the operational characteristics of smallholder farmers in Liaoning Province and existing research

findings, the following variables were selected: Performance Perception, Perceived Ease of Use, Social Environment, and Policy Support as core independent variables; Farmer Individual Characteristics as control variables; and Acceptance Intention as the dependent variable. SPSS analysis was used to verify the influence of each variable on acceptance intention, leading to the following research hypotheses:

H1: Performance perception has a significant positive effect on smallholder farmers' willingness to adopt agricultural drones;

H2: Perceived ease of operation significantly and positively influences smallholder farmers' willingness to adopt agricultural drones;

H3: Social environment has a significant positive effect on smallholder farmers' willingness to adopt agricultural drones;

H4: Policy support has a significant positive effect on smallholder farmers' willingness to adopt agricultural drones.

Variable Definitions: (1) Performance Perception: Smallholder farmers' actual recognition of drones' ability to enhance operational efficiency, reduce production costs, and increase crop yields; (2) Perceived Operation: Smallholder farmers' subjective assessment of drone operational difficulty and learning costs; (3) Social Environment: Influence from external groups such as relatives, neighbors, agricultural cooperatives, and village officials through demonstration and recommendation;(4) Policy Support: Perceived level of government support policies such as purchase subsidies, operational training, and technical services; (5) Adoption Intent: Smallholder farmers' willingness to use, lease, or purchase agricultural drones in the future; (1) Control Variables: Individual farmer characteristics including gender, age, education level, farm size, and part-time farming status.

2.2 Questionnaire Design

The questionnaire comprises three sections: Section One covers individual farmer characteristics, including gender, age, education level, farm size, and secondary occupation status; Section Two presents the core variable scales using a 7-point Likert scale (1=Strongly Disagree, 7=Strongly Agree), consisting of 20 items: 4 on performance expectations, 4 on effort expectations, 4 on social influence, 4 on policy support, and 4 on acceptance willingness;The third part consists of open-ended questions to gather farmers' suggestions and concerns regarding drones.

2.3 Sample Selection and Data Collection

A stratified random sampling method was employed, selecting six regions in Liaoning Province: Shenyang, Dalian, Tieling, Jinzhou, Yingkou, and Dandong. These areas encompass diverse terrains including plains and hills, and include both corn and rice-producing regions.The survey was conducted from October to December 2025. A total of 230 questionnaires were distributed through a combination of in-person interviews and online surveys, with 229 valid responses collected, yielding a valid response rate of 99.6%. Sample characteristics are as follows:

(1)Gender Distribution

The gender distribution of the survey sample shows 106 female respondents (46.29%) and 123 male participants (53.71%). As illustrated in Figure 1, the gender composition exhibits a slightly higher proportion of male respondents.

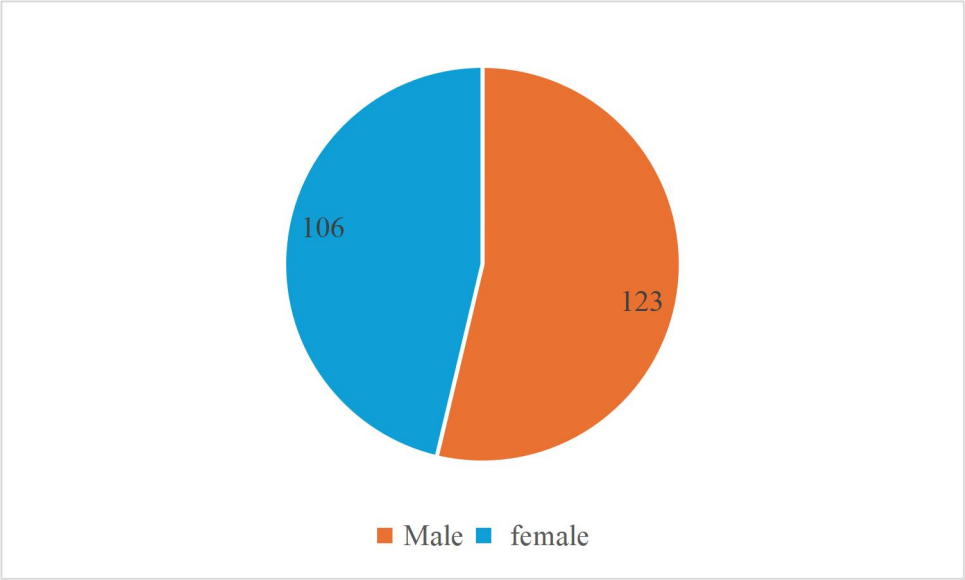

Figure1 Gender Distribution of Survey Participants

(2)Age Distribution

The age structure is dominated by middle-aged and young adults, with the 36-54 age group accounting for the highest proportion at 48.03% (110 cases). This is followed by those aged 35 and under at 27.51% (63 cases) and those aged 55 and over at 24.45%(56 cases). As shown in Figure Figure2 , the sample consists mainly of prime-age laborers with a moderate proportion of younger farmers, suggesting that new technologies like agricultural drones may spread more readily within this demographic.

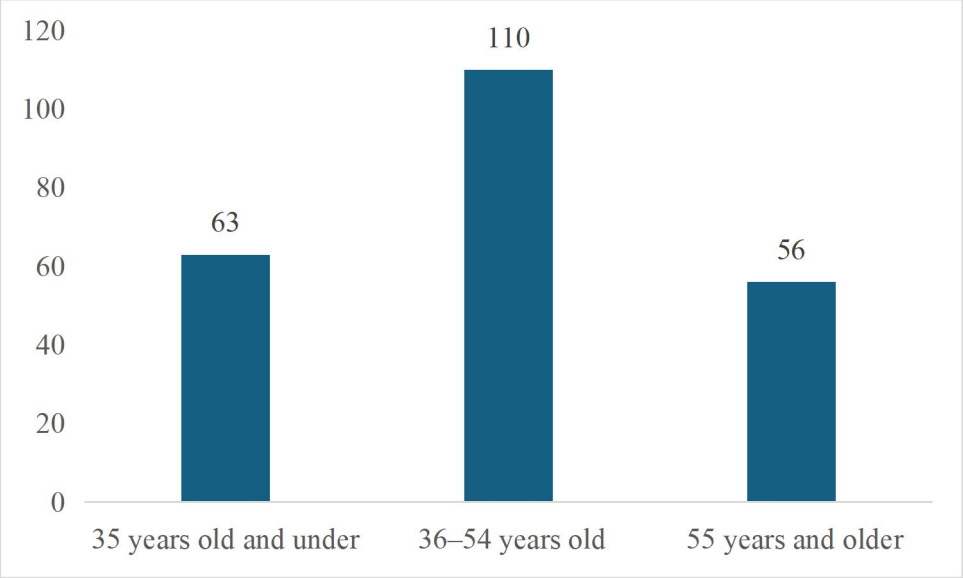

Figure2 Age distribution of survey respondents

(3) Educational Background Distribution

Regarding educational attainment, junior high school or below dominated at 52.84% (121 cases), senior high school/vocational school accounted for 30.57% (70 cases), while college or above represented only 16.59%(38 cases). As shown in Figure and3 , the educational reflects the typical characteristics of a rural sample. This suggests that when promoting drones, emphasis should be placed on providing simple and easy-to-understand operational training to reduce the constraints on acceptance posed by educational barriers.

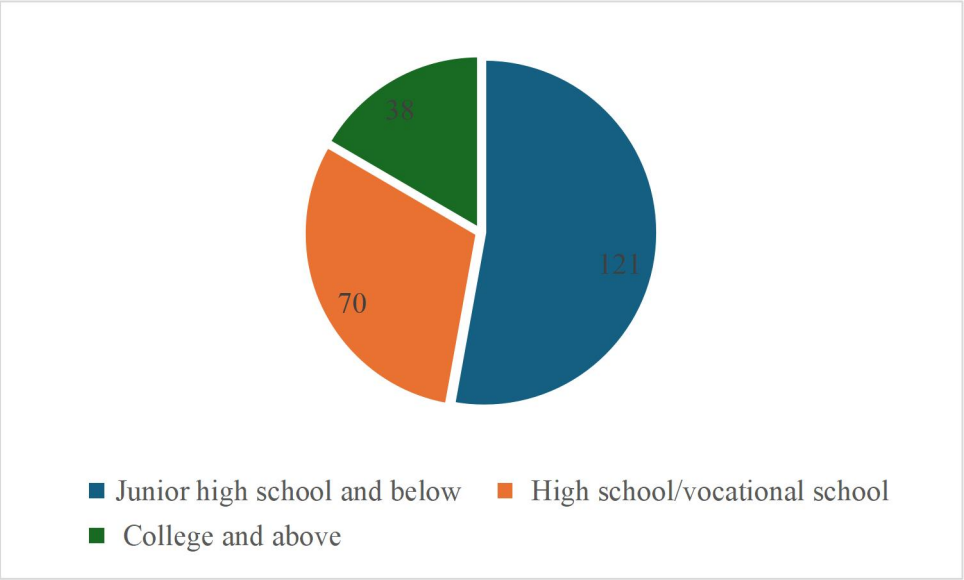

Figure3 Educational Attainment Distribution of Survey Respondents

(4)Analysis of Agricultural Operation Scale

A gricultural operation scale is predominantly concentrated in small-to-medium sizes: 51.53% (118 cases) operate 50-100 mu, 31.00% (71 cases) operate under 50 mu, and 17.47% (40 cases) operate over 100 mu. As shown in Figure4, the sample primarily consists of small-to-medium-sized farmers with few large-scale operators, making it suitable for evaluating the applicability of drones in precision operations.

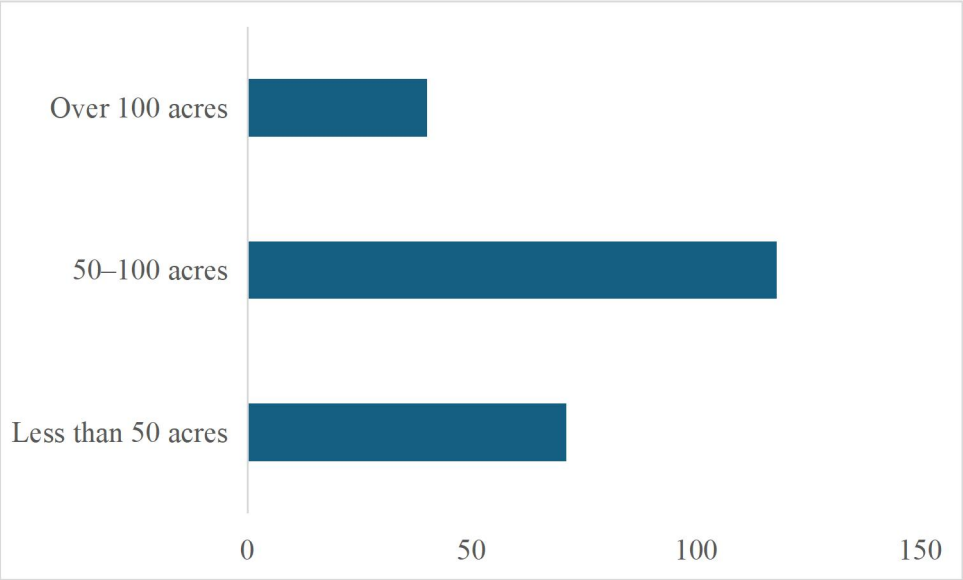

Figure4 Farming Scale of Surveyed Households

(5)Engagement in Non-Agricultural Work

Regarding non-agricultural work (side jobs), 59.39% (136 cases) of respondents engaged in side jobs, while 40.61% (93 cases) were purely agricultural. As shown in Table1 , the relatively high proportion of side-job farmers reflects the reality of diversified rural labor, which may impact their time commitment to and willingness to adopt new technologies.

Table1 : Whether Survey Participants Engage in Non-Agricultural Work

Item	Option	Sample Size	Proportion (%)
Non-agricultural work (part-time)	Yes	136	59.39
	No	93	40.61

Item	Option	Sample Size	Proportion (%)
Total		229	100.00

Overall, this sample represents typical characteristics of Chinese rural households, primarily consisting of young and middle-aged individuals with junior high school education who engage in part-time farming on small to medium-sized plots. It demonstrates strong representativeness and provides a solid foundation for exploring factors influencing the adoption of agricultural drones.

3 Empirical Analysis

3.1 Reliability Analysis

Reliability testing, also known as validity testing, uses Cronbach's Alpha coefficient to indicate data stability. A coefficient closer to 1 signifies higher reliability. A value above 0.8 indicates high reliability for the scale data. A Cronbach's Alpha coefficient below 0.6 suggests that scale items require modification.The specific results of the reliability test in this study are shown in the table below. As indicated by Table2 , the Cronbach's Alpha value of the scale is 0.952, exceeding the reliability threshold of 0.8, confirming good data reliability.

Table2 Reliability Test Table

Number of Items	Cronbach's Alpha Coefficient
20	0.952

3.2 Validity Analysis

Validity reflects the effectiveness of a measurement tool; a higher value indicates stronger consistency between the measured content and the target characteristics. The KMO test is used to assess questionnaire validity, with values ranging from 0 to 1. A value closer to 1 indicates better suitability for factor analysis. A KMO value exceeding 0.7 indicates data suitability for factor analysis, while a value below 0.5 is not recommended.The KMO value for this study's scale is 0.968 (see Table7), demonstrating the questionnaire's strong validity and reliability.

Table3 Validity Test Table

KMO Value		0.968
Bartlett's Sphericity Test	Approximate Chi-Square	2636.307
	df	190
	p-value	0.000

3.3 Descriptive Statistics

This study conducted descriptive statistical analysis on the mean scores of the five core dimensions of the UTAUT model (performance expectancy, effort expectancy, social influence, policy support, and acceptance readiness) using a sample of 229 valid questionnaires.These variables were calculated using a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree). Mean scores above 4 indicate overall positive attitudes among farmers. The median score of 5.25 further confirms that most respondents tended to "agree" or "strongly agree," providing a solid data foundation for subsequent model validation.

As shown in4 at Specifically, the dimension of smallholder acceptance willingness scored highest (mean 4.782, SD 1.474), indicating the strongest willingness among farmers to purchase, recommend, and learn drone technology in the future. This reflects robust latent market demand, potentially driven by anticipated practical benefits.Performance expectations (mean 4.723, SD 1.532) and social impact (mean 4.719, SD 1.505) ranked next. Farmers recognize drones' potential to enhance efficiency and reduce costs, driven by social demonstration effects. However, moderate variability (SD ~1.5) indicates individual cognitive differences, possibly related to farm scale or experience.Effort Expectations (mean 4.674, SD 1.472) scored lowest, with slightly weaker perceived operational ease and the smallest standard deviation, indicating high consensus. Policy Support (mean 4.709, SD 1.558) showed the greatest variation, suggesting that external incentives like subsidies and training affect different farmers differently.

Table4 Descriptive Statistics Analysis Table

Variable	N	Mean	Standard Deviation
Performance Expectations	229	4.723	1.532
Striving for Expectations	229	4.674	1.472
Social Impact	229	4.719	1.505
Policy Support	229	4.709	1.558
Willingness to Accept	229	4.782	1.474

3.4 Correlation Analysis

As shown in Table5 at , the Pearson correlation matrix for the five variables—performance expectancy, effort expectancy, social influence, policy support, and acceptance willingness—displays correlation coefficients. The ** in the upper right corner indicates significant correlation at the p<0.01 level.All correlation coefficients between variables range from 0.758 to 0.846, indicating strong positive correlations. Performance Expectation shows the highest correlation with Policy Support (0.846), Effort Expectation with Social Influence (0.796), and Policy Support with Acceptance Willingness (0.815).Overall, the four factors—performance expectancy, effort expectancy, social influence, and policy support—are all closely and positively associated with acceptance willingness. However, the high correlations among variables also indicate a risk of multicollinearity. If subsequent empirical studies such as regression analysis are conducted, this issue should be tested and addressed using metrics like the variance inflation factor.

Table5 Correlation Analysis Table

Variable	Performance Expectation	Effort Expectation	Social Influence	Policy Support	Willingness to Accept
Performance Expectations	1				
Effort Expectations	0.758**	1			
Social Influence	0.777**	0.796**	1		
Policy Support	0.846**	0.762**	0.830**	1	
Willingness to Accept	0.822**	0.756**	0.798**	0.815**	1

* p<0.05 ** p<0.01

3.5 Regression Analysis

As shown in Table6 at REF _Ref220263878 \h , this study employed a multiple linear regression model to

examine the predictive effects of performance expectancy, effort expectancy, social influence, and facilitating conditions on farmers' intention to use agricultural drones under the UTAUT theoretical framework.Results indicate the model exhibits good overall fit (R^2=0.757, adjusted R^2=0.753) with a significant F-test (F=174.454, p<0.001). This demonstrates that the four dimensions collectively explain 75.7% of the variance in behavioral intention, robustly validating the explanatory power of the UTAUT model in agricultural technology adoption contexts.The Durbin-Watson statistic was 1.911, close to the ideal value of 2, indicating no significant autocorrelation in residuals. All variable VIF values were below 5 (maximum 4.853), ruling out multicollinearity interference and ensuring robust coefficient estimates.

Regarding predictive contribution, all independent variables exerted significant positive effects on behavioral intention (p<0.05).Performance Expectation exhibited the most pronounced effect (standardized coefficient β=0.35, p<0.001). Each one-unit increase in perceived performance raised behavioral intention by 0.337 units. This highlights that perceived benefits of drones in enhancing operational efficiency and reducing costs serve as the core driver of farmer decision-making, consistent with UTAUT theory's classic conclusion that performance expectation is the strongest predictor. Social Influence（β=0.235,p=0.001) and facilitating conditions（β=0.219, p=0.003) followed, indicating significant influence from recommendations by friends and relatives, cooperative encouragement, and subsidy services . Effort expectancy（β=0.137, p=0.021) showed relatively weaker impact, possibly due to low perceived barriers to drone operation among farmers.

Table6 Regression Analysis Table

	Unstandardized Coefficients		Standardized Coefficient			Multicollinearity Diagnosis	
	B	Standard Error	Beta	t	Significance	VIF	Tolerance
Constant	0.488	0.172	-	2.838	0.005	-	-
Performance Expectations	0.337	0.063	0.35	5.314	0.000**	3.994	0.25
Social Impact	0.137	0.059	0.137	2.322	0.021*	3.195	0.313
Policy Support	0.23	0.065	0.235	3.524	0.001**	4.105	0.244
Effort Expectation	0.207	0.069	0.219	3.022	0.003**	4.853	0.206

R^2 = 0.757, adjusted R^2 = 0.753, F(4,224) = 174.454, p = 0.0, DW = 1.911, N = 229

* p<0.05 ** p<0.01

4 Discussion of Results

This study examined the influence of performance expectations, effort expectations, social influence, and policy support on the acceptance intention of agricultural drones among smallholder farmers in Liaoning Province based on the UTAUT model. Combining empirical data with survey findings, the following key conclusions were drawn:

4.1 Performance Perception is the Primary Driver

Smallholder farmers prioritize the practical benefits of agricultural technologies. Drones' advantages—reducing labor requirements, improving pesticide utilization efficiency, and lowering production costs—precisely address core challenges faced by Liaoning's smallholders, such as labor shortages and rising labor costs.Regression analysis

reveals that the standardized coefficient for performance expectancy is β=0.35 — the highest among the four variables—indicating its most significant positive impact on adoption willingness. This aligns with relevant domestic and international empirical research findings and validates the classic assertion in UTAUT theory that performance expectancy is the core predictor of technology adoption.

4.2 Significant influence of social environment

Smallholder production decisions are highly influenced by surrounding groups. The usage experiences of relatives, friends, and neighbors, along with demonstration and promotion efforts by cooperatives and village officials, effectively reduce smallholders' unfamiliarity and concerns about drones. Case studies in Dalian and other areas indicate that methods such as on-site demonstration operations and farmer experience sharing can rapidly increase smallholders' acceptance of drones.Data analysis reveals that the standardized coefficient for social influence (β=0.235) exerts a positive effect on adoption intent second only to performance expectations. This underscores the powerful driving force of demonstration effects within the context of rural familiar-society networks.

4.3 Policy Support is Indispensable

Policies such as subsidies and training directly reduce the cost and technical barriers for smallholder farmers to adopt drones. Regression results show that the standardized coefficient for policy support (β=0.219) has a significant positive impact on adoption willingness. However, field research indicates that while drone-related training has been implemented in some areas of Liaoning Province, its coverage remains limited. Most smallholder farmers lack sufficient awareness of subsidy policies, preventing the full realization of policy support's positive effects.Given that the standard deviation for policy awareness was the highest (1.558) in descriptive statistics, it is evident that perceptions of policies vary significantly among farmers. There remains considerable room for improvement in policy implementation and outreach.

4.4 Perceived ease of operation has a relatively weak impact

Among the four variables, effort expectation exhibits the weakest positive influence on smallholder farmers' willingness to adopt agricultural drones, with a standardized coefficient of only 0.137. This stems primarily from the severe aging of Liaoning's smallholder farming population (48.5% aged 55 and above), where most farmers possess limited learning capacity and prefer outsourcing drone services over purchasing and operating equipment themselves. Consequently, they pay less attention to operational complexity and learning costs.Furthermore, descriptive statistics reveal that the mean effort expectation of 4.674 is the lowest among the five variables, accompanied by the smallest standard deviation (1.472). This indicates a convergence in farmers' perceptions of drone operational difficulty, further diminishing its influence on adoption willingness.

5 Countermeasures and Recommendations

5.1 Highlight the practical benefits of agricultural drones and strengthen performance-based awareness guidance

Governments and agricultural enterprises should collaborate on diversified promotional activities. Through regular field demonstrations and case studies highlighting typical benefits, they should vividly showcase the advantages of agricultural drones in core operations such as plant protection, seeding, growth monitoring, and pest/disease early warning.For Liaoning's dominant grain crops like corn and rice, tailor-made drone operation plans should be developed based on specific growth stage requirements. Examples include precision seeding during rice seedling cultivation and efficient pest control during corn grain filling. Clearly articulate efficiency gaps between drone operations and traditional manual/small-scale mechanical methods — such as drones covering 80-120 mu (5.3-8 hectares) per day for pest control, 15-20 times faster than manual labor,while reducing pesticide loss by 15%-20%, significantly lowering input and labor costs. By distributing benefit comparison manuals, conducting on-site cost-benefit calculations, and inviting beneficiary farmers to share their experiences, smallholder farmers gain tangible awareness of the economic gains from technology. This approach dispels misconceptions like "technology is useless" or "costs are too high," enhancing their willingness to adopt these innovations[5] .

5.2 Establishing a Socialized Promotion Network to Amplify Demonstration Effects

Leveraging grassroots agricultural service systems, we fully utilize the organizational strengths of agricultural cooperatives, the coordination capabilities of village cadres, and the exemplary role of large-scale growers. Agricultural drone demonstration and promotion sites are deployed in townships and administrative villages to extend service coverage to rural areas.Regularly organize on-site observation activities for smallholder farmers, allowing them to closely observe drone operation processes and outcomes. Concurrently hold experience-sharing sessions where demonstration households share drone operation techniques, field insights, and income changes. Leveraging the trust foundation and word-of-mouth characteristics of rural communities, this approach effectively reduces smallholders' unfamiliarity and concerns about adopting new technologies.Establish a demonstration household support mechanism, encouraging these households to form assistance partnerships with neighboring farmers. Provide services such as free trials and hands-on guidance to create a virtuous promotion pattern where "one household drives a cluster, and multiple clusters radiate across the entire area," accelerating technology penetration among smallholder farmers[6] .

5.3 Optimize the policy support system to enhance policy implementation and awareness

Further refine agricultural drone purchase subsidy policies by expanding coverage to include all small-to-medium-sized, cost-effective drones suitable for Liaoning's staple crops. Adjust subsidy ratios to align with smallholder farmers' economic capacity, substantially lowering purchase barriers and initial investment costs.Addressing the characteristics of Liaoning's smallholder farmers—relatively low educational attainment, high aging rates, and limited capacity to adopt new technologies—optimize technical training and guidance models. Replace lectures laden with technical jargon with a combination of "hands-on instruction + field classroom practice." Technicians should demonstrate operational procedures and troubleshooting methods on-site to ensure farmers can learn and master the skills effectively.Simultaneously, policy outreach channels have been expanded. Through diverse methods — including posters on village bulletin boards, explanatory content shared in village WeChat groups, offline presentations by township agricultural technicians, and leaflet distribution at local markets—policy information such as subsidy standards, application procedures, and training schedules is precisely delivered to every household[7]. This approach bridges the "last mile" of policy implementation, enhancing farmers' awareness and sense of benefit.

5.4 Refining Drone Service Models to Lower Operational Barriers

Addressing the practical needs of small-scale farmers who are reluctant to purchase drones independently or lack operational skills, actively guide agricultural enterprises and cooperatives to expand flexible service models such as drone operation services, short-term rentals, and per-acre fee structures. This allows farmers to access drone services without purchasing equipment, meeting fragmented and low-cost operational demands.Encourage drone manufacturers to optimize product design by simplifying interfaces and adding user-friendly features for elderly farmers, such as one-touch start/stop, voice navigation, and preset flight paths. This reduces operational complexity and improves accessibility.Simultaneously, establish a comprehensive after-sales maintenance service system covering county, township, and village levels. Set up repair stations in key townships, staffed with professional technicians and equipped with common spare parts[8]. Offer services including on-site inspections, emergency repairs, and regular maintenance to promptly resolve repair issues encountered by smallholder farmers during equipment use. This will completely eliminate their concerns about "not knowing how to repair" or "unaffordability of repairs," enabling smallholder farmers to use the equipment with confidence.

References

[1] Zhou Guangyi, Wang Boyang, Li Xinyu & Liu Aijia. (2024). Factors Influencing Farmers' Adoption of Plant Protection UAV Technology: An Empirical Analysis Based on the Theory of Planned Behavior. Shanxi Agricultural Economics, (09), 33-37+42.

[2] Zhao Zhiwei & Bo Hefei. (2025). Application and Challenges of Agricultural UAVs in Modern Agriculture. Seed Science and Technology, 43 (09), 183-185.

[3] Zhang Weili, Li Zhaojun, Ji Hongjie, Wang Yiming, Jin Qiaoru & Yang Rui. (2025). Accelerating the Implementation of Large-Scale Unmanned Agricultural Technology Service Models: AI Technology Overcoming the Greatest Obstacle to China's Green Agricultural Transformation. China Agricultural Comprehensive Development, (09), 4-7.

[4] Han Xiao, Lei Yatong, Zhen Tiejun & Huang Ying. (2022). Analysis of Factors Influencing Farmers' Sustained Adoption Intentions for Plant Protection Drones Based on TAM. Journal of Southwest University for Nationalities (Natural Science Edition), 48(03), 332-339.

[5] Li Dingding & Li Li. (2025). Analysis of Farmers' Adoption Intentions and Influencing Factors for Drone Spraying Technology. Agricultural Science and Technology & Information, (08), 108-113

[6] Wei Linjiao, Shi Yuhao & Dondrup Lhobu. (2025). Three-Dimensional Drivers of Drone Spraying Technology Adoption Behavior. Anhui Agricultural Sciences, 53(16), 242-250.

[7] Qi Xuexi. (2025). Exploration of Risk Management and Standardized Development for Agricultural Drones. New Rural Areas, (08), 11-12.

[8] Liu Shujing. (2024). Research on Agricultural Modernization Transformation Centered on Smallholder Farmers. Agricultural Economics, (10), 6-8.

Global Academic Frontiers, Vol. 4, Issue 1, 2026, pp. 22-35 Print ISSN 2995-5688 Online ISSN 2995-570X
DOI: https://doi.org/10.5281/zenodo.18936928

A Study on Foreign Trade Transformation under Dual-Dimensional Drivers: Empowering Industry with Yue Opera Culture—A Case of Shengzhou's Scarf and Tie Sector

Jiaying Zhang [1] Qiwei Pang [1*]

[1] School of International Economics and Trade, Ningbo University of Finance & Economics, Ningbo 315175, China
*Corresponding author Email: pangqw@nbufe.edu.cn
Received 30 January 2026; Accepted 4 March 2026; Published 10 March 2026

Abstract: Driven by the dual wheels of globalization and the national strategy for cultural advancement, the living inheritance of intangible cultural heritage (ICH) and the upgrading of local foreign trade industries have become core issues for achieving high-quality regional economic development. As a major ICH province in Zhejiang, the Shengzhou scarf and necktie industry serves as a core pillar of the local export economy. Yet, it faces development dilemmas such as intensifying international competition and severe product homogenization, with small and medium-sized enterprises (SMEs) particularly encountering a crisis of order loss. The deepening implementation of Zhejiang's ICH support policies and the transformation of the international textile market constitute a dual-dimensional driving force, propelling industrial transformation. Through methods such as literature research and case analysis, this paper explores the pathways for cultural empowerment under this dual-dimensional drive, identifies fusion points between Yue Opera culture and this industry, and ultimately constructs a practical pathway system for Yue Opera culture to empower industrial transformation. This provides a replicable model for the high-quality development of traditional foreign trade industries.

Keywords: ICH support; International market transformation; Foreign trade industry transformation; Cultural empowerment

1. Introduction

Amid the deepening advancement of economic globalization and the implementation of the national strategy for cultural advancement, the living inheritance of intangible cultural heritage (ICH) and the transformation and upgrading of local foreign trade industries have become core drivers and catalysts for promoting high-quality local economic development. As the birthplace of Yue Opera, Shengzhou possesses a profound cultural heritage and distinctive visual symbols of Yue Opera, offering rich cultural resources for industrial empowerment. Renowned as the "Home of China's Neckties" and the "Famous City for Chinese Silk and Knitted Apparel," the local scarf and necktie industry, after over forty years of development, has established a significant scale advantage, with an annual production capacity of 300 million neckties and 50 million silk scarves. Exports account for 65% of its total output, covering over 30 countries and regions, making it a core pillar of the local export economy.

In recent years, however, the Shengzhou scarf and necktie industry has encountered multifaceted developmental bottlenecks. The rise of Southeast Asian countries has gradually occupied the mid-to-low-end international market, placing unprecedented competitive pressure on domestic enterprises. Furthermore, over 80% of enterprises within the industry rely on "imitative design" as their core competitiveness, resulting in severe product homogenization, a lack of independent intellectual property rights, and insufficient cultural value-added,

failing to meet the core demand for cultural attributes and emotional experience in international markets. Affected by this, the industry's export growth rate declined from 12% (2022) to 5.3% (2024), with most SMEs facing survival pressures from order loss and profit decline.[1]

Against this backdrop, the continued deepening of Zhejiang Province’ s ICH support policies and the profound transformation of the international textile market present a "dual-dimensional drive" opportunity for industrial transformation and upgrading. On the policy front, Zhejiang has issued a series of measures for ICH protection and inheritance, establishing a robust talent cultivation system and promoting the deep integration of ICH with various industries, laying a solid foundation for the cultural empowerment of the scarf and necktie industry. On the market front, the international textile market exhibits trends towards "culturalization, personalization, and greening," with rising demand for products possessing both cultural connotation and green attributes, opening new space for industrial upgrading.

Leveraging the deep excavation and effective empowerment of Yue Opera culture can not only chart a broader development path for the transformation of Shengzhou’ s scarf and necktie export industry but also holds significant practical and theoretical value for promoting its "going global." Through the practice of empowering the export industry with Yue Opera, a distinctive Chinese ICH[2], we can better assist this traditional export industry in breaking through development bottlenecks and enhancing its core export competitiveness. Moreover, empowering the industry enables the living inheritance of this traditional cultural form. This study, against the dual background of the intrinsic drive of Yue Opera culture and the external impetus of Shengzhou’s scarf and necktie export industry, combines the core cultural connotations and unique visual symbols of Yue Opera. It deeply analyzes the industry's development dilemmas, systematically constructs a cultural empowerment transformation pathway addressing the cultural, market, and management contradictions it faces, providing in-depth practical reference for the industry's upgrading and the living inheritance of Yue Opera culture.

2. Literature Review, Core Concepts, and Theoretical Foundations

2.1. Literature Review

Against the backdrop of deepening cultural-economic integration and accelerated globalization, research on the integration of ICH and foreign trade industries has become a scholarly focus.[3] Its developmental trajectory has evolved alongside cultural-tourism integration and the digital economy, shifting from early-stage studies on static ICH preservation and singular foreign trade industry transformation towards exploring the fusion of living ICH inheritance and industrial empowerment.[4] Scholars domestically and internationally have conducted research on ICH inheritance, textile export industry upgrading, and cultural empowerment pathways, forming diverse theoretical outcomes and practical cases that lay the foundation for research on ICH empowering traditional foreign trade industry transformation.

As practical activities in the scarf and necktie industry deepen, foreign research has gradually shifted from pure theoretical exploration to more in-depth studies on industrial application. Studies in Europe, America, and East Asia on the integration of Chinese traditional culture and the textile industry have formed different research emphases, such as Europe's focus on fashion transformation of cultural symbols, America's on commercial application of cultural IP, and Japan and South Korea's on craftsmanship inheritance and detailed innovation.[5] Theories by scholars like Porter and Gereffi also provide important support for our understanding of cultural empowerment and value chain upgrading in the scarf and necktie industry. Domestic research, guided by policy and ideology, has diversified into areas like digital dissemination of ICH, cross-industry application of Yue Opera culture, and commercial conversion of textile ICH IP, achieving breakthroughs. Scholars have also identified cultural

empowerment as the core pathway for transforming traditional textile export industries, with cross-border e-commerce serving as a crucial carrier for cultural and creative product exports.[6]

Existing research still exhibits evident shortcomings. Foreign research on Chinese traditional culture often remains superficial, lacking targeted exploration of Yue Opera culture; design and research mostly stay at the level of pattern transplantation, with insufficient exploration of its integration with male accessories like neckties. While domestic research has formed mature models for ICH-textile industry integration, discussions are often macro-level, lacking in-depth, systematic studies on specific pathways for Yue Opera culture to empower the transformation of the Shengzhou scarf and necktie export industry. Based on this, this paper, against the background of the dual-dimensional drive, focuses on the Shengzhou scarf and necktie export industry, explores integration points between Yue Opera culture and the industry, constructs a systematic cultural empowerment transformation pathway, addresses gaps in existing research, and provides a replicable practical model for the high-quality development of traditional foreign trade industries.

2.2. Core Concept Definitions

2.2.1. Intangible Cultural Heritage (ICH)

Intangible Cultural Heritage refers to various traditional cultural expressions, along with objects and spaces associated with them, that are regarded as part of their cultural heritage by communities, groups, and, in some cases, individuals, and are transmitted from generation to generation.[7] Its core value lies in safeguarding cultural roots, enhancing national cultural identity, and providing a rich source of cultural wisdom for modern industrial innovation. It possesses three core characteristics: living inheritance, cultural uniqueness, and regional distinctiveness. Yue Opera, as a representative ICH of Zhejiang Province, is characterized by lyrical and melodious singing styles, forming three main vocal systems , and six main role types. Its performance integrates the artistic essence of Kunqu Opera and spoken drama. Its costumes, patterns, and classic repertoire stories possess distinct visual and cultural features, making it a high-quality cultural resource for industrial empowerment.[8]

2.2.2. Local Foreign Trade Industry Transformation

Local Foreign Trade Industry Transformation refers to the process whereby local governments or regions, through policy guidance, resource integration, and technological innovation, promote local export enterprises and industrial chains to adjust from traditional export models towards high value-added, diversified, and digitalized directions.[9] Its core objective is to break through the dilemmas of low added value and homogeneous competition in traditional foreign trade, enhance the core competitiveness of the regional export industry, adapt to changes in the global economic landscape and new international market demands, and achieve high-quality, sustainable development of the regional export economy.

2.2.3. ICH Cultural Empowerment

ICH Cultural Empowerment refers to the model whereby intangible cultural heritage, through living inheritance, innovative application, and resource integration, injects developmental impetus into economic, social, and cultural fields via pathways such as product innovation, brand building, marketing communication, and supply chain upgrading. Its core involves deeply integrating the connotations, symbols, and craftsmanship of ICH into the entire production, operation, and sales chain of the local foreign trade industry, providing cultural support, differentiated advantages, and value increment for industrial transformation, achieving a win-win situation of living ICH inheritance and high-quality industrial development.[10]

2.3. Theoretical Foundations

2.3.1. Comparative Advantage Theory

Proposed by David Ricardo in 1817, the Comparative Advantage Theory posits that countries should specialize in producing and exporting goods for which they have a lower relative opportunity cost, thereby achieving optimal resource allocation and maximum overall welfare through international trade.[11] This theory provides support for this paper: the Shengzhou scarf and necktie export industry can leverage the inherent comparative advantage of Yue Opera ICH culture, transforming its craftsmanship and cultural symbols into product differentiation features, breaking through the traditional trade model reliant on cost and scale, forming a unique cultural competitive advantage in the international market, and enhancing product pricing power and market share.

2.3.2. National Competitive Advantage Theory

Proposed by Michael Porter in 1990, the National Competitive Advantage Theory (Diamond Model) holds that the international competitiveness of a nation or region's industry depends on the synergistic interaction of six factors: factor conditions; demand conditions; related and supporting industries; firm strategy, structure, and rivalry; government; and chance.[12] This theory provides a systematic analytical framework for ICH empowering foreign trade industry transformation: relying on characteristic production factors formed by Yue Opera ICH craftsmanship and cultural talent, grasping the demand conditions of overseas cultural consumption upgrading, linking with related and supporting industries like cross-border e-commerce and cultural-creative design, leveraging Zhejiang’s ICH protection and export upgrading policies, seizing opportunities presented by international market transformation and digital economy development, and constructing the international competitive advantage of the Shengzhou scarf and necktie export industry through the synergistic fusion of these six factors.

2.3.3. Global Value Chain Theory

Proposed by Gary Gereffi and others around 2005, the Global Value Chain Theory points out that global industrial division of labor presents a hierarchy of "R&D and Design — Production and Manufacturing — Marketing and Branding," with high value-added segments concentrated at both ends of the chain, while production and manufacturing occupy a low-end, low value-added position. This theory clarifies the core direction for the transformation of the Shengzhou scarf and necktie export industry: relying on the advantages of Yue Opera ICH culture, breaking free from the predicament of singular production/manufacturing and low-end contract manufacturing, and extending towards upstream value chain segments (product R&D, culturally-empowered design) and downstream segments (brand operation, cross-cultural marketing), realizing a shift from "manufacturing" to "creation and branding," and enhancing the industry's position in the global value chain.

3. Current Status of Zhejiang’s ICH Support and International Market Transformation

3.1. Current Status of Zhejiang Province’s ICH Support

Through the in-depth advancement of constructing a diversified ICH policy system, continuously cultivating high-level ICH professionals, and integrating ICH cultural connotations into real-life production, Zhejiang has laid a solid foundation for the living inheritance of ICH on one side, and provided strong support for ICH-enabled industrial empowerment on the other. Driven by policies like the Zhejiang Province Intangible Cultural Heritage Protection Regulations, the province not only provides subsidies for provincial-level ICH inheritors but also actively promotes the establishment of digital platforms like the "Zhejiang ICH Culture Cloud," significantly enhancing ICH protection

work.[13] By establishing a four-tier inheritor system (national, provincial, municipal, county) and fully utilizing methods like university training programs and "ICH in Campus" activities, a large number of professional ICH talents have been cultivated. Meanwhile, projects to document ICH processes have been implemented. Based on deep integration, the exquisite cultural connotations of ICH have been incorporated into characteristic blocks. Particularly, with the promotion of over 11,000 ICH events in 2024, the lifestyle-ization and industrialization of ICH have been further advanced, building a richer platform for better integration of ICH with modern industries.

3.2. Current Status of International Market Transformation

Against the backdrop of deepening globalization and the gradual development of the digital economy, the international market for ICH products and textiles is undergoing profound transformation, exhibiting new characteristics such as diversification of traditional dissemination carriers, deepening technological innovation, and personalized product demand, creating new opportunities for ICH-enabled foreign trade industry transformation. ICH "going global" has broken through traditional exhibition and sales models, forming diverse communication channels like short videos, live streaming, cross-cultural performances, and international exhibitions, achieving a shift from static display to dynamic interaction, and deeply integrating cultural dissemination with trade sales.[14] By perfectly integrating digital technology with modern craftsmanship, it not only provides solid technical support for ICH craftsmanship innovation and industrialization but also greatly enhances production efficiency and product competitiveness while preserving the core skills of ICH, thereby creating an efficient, sustainable, and highly competitive new integrated development model of "culture + technology + brand." Along with continuous innovation in ICH products, the design is no longer singular but tightly grasps international market demands, integrating popular IP with profound Eastern cultural elements, continuously transforming towards personalization, fashion, and cultural-creativeness, thereby accurately meeting international consumer demand for ICH products and effectively releasing the cultural value-added they bring to the international market.

Table 1 Key data on the digitalization of intangible cultural heritage and cross-cultural communication:

Indicator Category	Specific Data or Case	Description and Significance
Digital Repository Access	The Digital Dunhuang Repository's global access reaches 23 million times	Reflects the fundamental role of digital technology in the static display and global dissemination of intangible cultural heritage.
Social Media Communication Effectiveness	Single-season playback volume of intangible cultural heritage live streams on TikTok exceeds 100 billion times	Reflects the enormous influence of short video or live stream formats in the dynamic, interactive dissemination of intangible cultural heritage.
Commercialization and Global Expansion Results	In 2023, overseas sales of Dunhuang-themed derivative products exceeded 40 million RMB	Demonstrates the driving effect of digital dissemination on the international sales of intangible cultural heritage products.
Forms of Technological Empowerment	VR/AR immersive experiences, and social media short videos/live streams	Lists the main technological pathways for the transformation of intangible cultural heritage from "static display" to "dynamic interaction".

3.3. Trends in International Textile Market Transformation

As of 2025, the international textile market is at a critical stage of structural restructuring, forming four core

transformation trends centered on green transition, digital and intelligent upgrading, regional pattern reconfiguration, and increased market concentration. These trends pose new requirements for the transformation and upgrading of traditional textile export industries while clarifying the development direction for ICH cultural empowerment of industries. Driven by global "dual carbon" goals, green transition has become an industry imperative, with the application proportion of sustainable materials increasing and the commercialization of green technologies accelerating. The implementation of mechanisms like the EU's Carbon Border Adjustment Mechanism (CBAM) makes carbon label certification and green compliance the foundation for enterprises to participate in international competition. Digital and intelligent technologies are profoundly reshaping industry development models.[15] On the production end, technologies like 5G and 3D virtual sampling enhance efficiency and shorten R&D cycles; on the sales end, cross-border e-commerce and live-streaming e-commerce optimize export structures, with flexible production becoming the core trend to adapt to fragmented and personalized market demands. The regional pattern and supply chain of the textile industry are rapidly reconfiguring. Asia remains the manufacturing core, with China moving towards high value-added segments of the global value chain, Southeast Asia undertaking mid-to-low-end production capacity, Europe focusing on high-end and technical textiles, and Africa becoming a new growth pole.[9] Simultaneously, industry market concentration continues to increase, with leading enterprises strengthening advantages through scale consolidation. Raw material price fluctuations accelerate industry consolidation, making it urgent for SMEs to rely on product differentiation and cultural value-added to achieve market breakthroughs. This also provides important market space for Yue Opera culture to empower the transformation of the Shengzhou scarf and necktie industry.

Table 2 Monthly Import and Export Data of Silk Scarves, Ties, and New Fabrics in China (2025)

Month	Silk Scarf & Tie Export (Million USD)	New Fabric Export Value (Million USD)	Import Value (Million USD)	Trade Balance (Million USD)
Jan	45.2	12.3	4.2	41.0
Feb	38.7	10.8	3.8	34.9
Mar	52.1	14.2	4.5	47.6
Apr	48.3	13.5	4.3	44.0
May	51.8	14.8	4.1	47.7
Jun	49.2	13.9	3.9	45.3
Jul	47.6	13.2	3.7	43.9
Aug	46.9	12.8	3.6	43.3
Sep	48.5	13.6	3.8	44.7
Oct	50.2	14.1	4.0	46.2
Nov	53.7	15.2	4.2	49.5
Dec	55.8	15.8	4.3	51.5

4. Development Dilemmas of the Shengzhou Scarf and Necktie Export Industry

Currently, the Shengzhou scarf and necktie industry occupies approximately 60% of the global market and 90% of the domestic market, establishing itself as a core production base. However, under the dual impact of profound

changes in the international market and inherent development contradictions, this leading high-tech industry has gradually fallen into a series of development dilemmas, including narrow profit margins, severe product homogenization, and volatile export demand. Even leading enterprises like Babei Group have had to actively explore breakthrough paths under this background, yet still face numerous challenges. These have become core pain points for the transformation and upgrading of this leading industry.

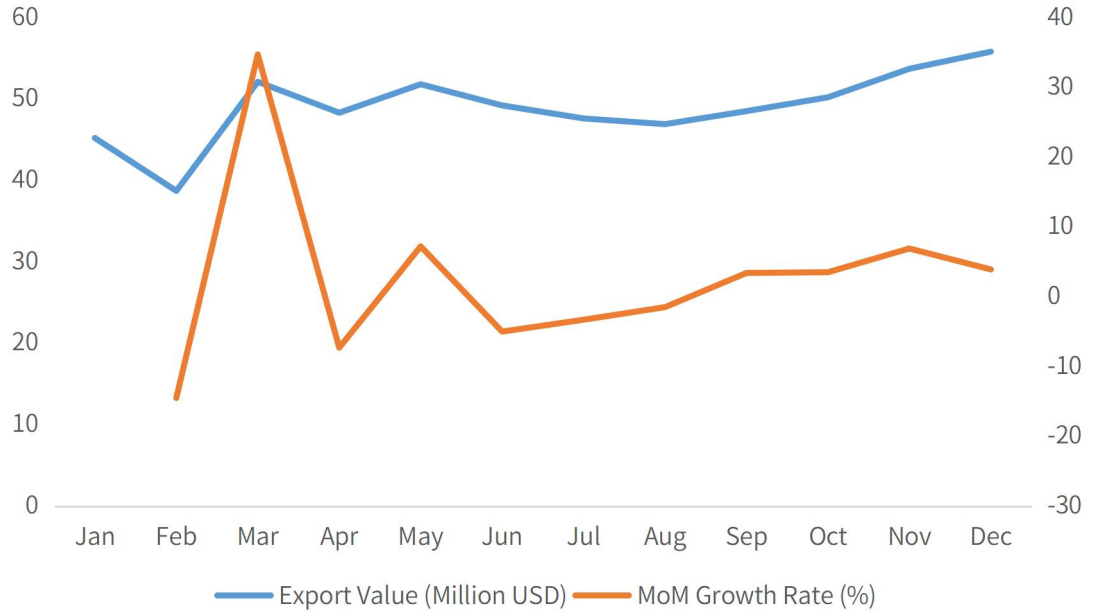

Figure 1. Monthly Trends of Export Value and Trade Balance in 2025

4.1. Narrow Profit Margins, Uncontrollable Raw Material Costs

From the perspective of Global Value Chain Theory, the Shengzhou scarf and necktie industry has long been dominated by contract manufacturing, positioned in the low value-added production and manufacturing segment of the mid-tier of the global value chain, with low technological content and product added value, resulting in extremely weak pricing power for enterprises in the international market. As an industry leader, Babei Group once engaged in nearly 20 days of negotiations with a US purchaser, ultimately achieving only a $0.10 increase per colored-woven necktie, a typical example of insufficient industry pricing power.

Simultaneously, the industry heavily depends on external raw materials, with over 90% of the raw silk used in Shengzhou sourced from outside the region. Traditional rural sericulture is significantly affected by seasons and natural conditions, with annual raw silk price volatility reaching up to 30%. Substantial fluctuations in raw material costs directly compress the export profit margins of enterprises.[16] Although Babei Group, after 7 years of R&D and an investment exceeding 500 million yuan, successfully developed factory-based silkworm rearing technology, becoming the only enterprise globally capable of full-cycle artificial feed silkworm rearing and achieving independent control over raw materials, most SMEs lack the capital and technical capability to break through the raw material bottleneck, leaving cost control issues unresolved.

4.2. Severe Product Homogenization, Absence in High-End Markets

According to the Intra-Industry Trade Theory, product differentiation is the core driver of intra-industry trade.[17] However, the number of enterprises in the Shengzhou scarf and necktie industry once exceeded a thousand, with the majority being SMEs and family workshops lacking independent R&D and design capabilities. Product styles and processes are highly similar, making it difficult to form product heterogeneity, unable to drive intra-industry trade

development through differentiation and economies of scale. Enterprises can only compete for market share in the mid-to-low end through price competition.

Following the 2008 global financial crisis, Southeast Asian countries seized orders by leveraging lower labor and raw material costs, further intensifying price competition domestically and causing a severe absence of the Shengzhou scarf and necktie industry in high-end markets. Although leading enterprises have begun to achieve breakthroughs through differentiation: McDirol focuses on the high-end silk printing field, avoiding mid-to-low-end price wars; Jiajia Necktie concentrates on R&D of eco-friendly fabrics, adapting to green consumption trends; Babei Group leverages its independent raw silk supply to expand products into home textiles, apparel, and even explores applications of silk protein in cosmetics and biomedicine, and collaborates with Yue Opera inheritors to jointly host Yue Opera Silk Scarf and Necktie Cultural Festivals, moving beyond the limitations of single necktie products. Overall, however, the industry's high-end transformation is still in its infancy, lacking independent intellectual property rights and high-end brands, and struggles to meet the demands of the international high-end market.

4.3. Volatile Export Demand, Hindered Traditional Channels

Against the backdrop of continuous global economic fluctuations and profound changes in increasingly mature consumer habits, the Shengzhou scarf and necktie export industry has gradually fallen into the dilemma of significant demand shocks. Based on a nearly 40% decline in Shengzhou's necktie export volume around 2019, with nearly half of enterprises forced to suspend production or transform due to order loss, the post-pandemic era saw a slow recovery in the global consumer market. This led to a continuous decline in export growth rates, placing enormous survival pressure on SMEs.[18]

Simultaneously, traditional offline export channels have been significantly impacted by new channels like cross-border e-commerce and live-streaming e-commerce, with international market orders showing a trend towards fragmentation. However, most SMEs in the Shengzhou scarf industry find it difficult to truly implement digital concepts across all aspects of their operations, lacking a genuine grasp of online operations, and are unable to effectively connect emerging online channels with increasingly fragmented order demands. Consequently, market expansion for enterprises reliant on traditional export channels has fallen into an increasingly severe predicament. Although leading enterprises in Shengzhou, in conjunction with the government, have established logistics centers integrating resources across R&D, warehousing, and logistics, significantly enhancing export circulation efficiency, and leveraged emerging e-commerce industrial parks to fully utilize online and offline sales channels (e.g., online orders accounting for 70% in some stores, especially for young-oriented categories like JK neckties, providing stable online sales), this has somewhat alleviated the pressure from the contraction of traditional export channels. Nevertheless, the digital transformation of SMEs still faces multiple obstacles in capital, technology, and talent, resulting in relatively slow overall progress in this transformation.

5. Industrial Transformation Pathways under the Dual-Dimensional Drive

Zhejiang Province boasts a solid foundation in the textile export industry, with its industrial scale accounting for a quarter of the nation's total and its export volume ranking first in the country for ten consecutive years. Under the dual drive of Zhejiang’ s ICH support policies and international market transformation, a model of industrial upgrading characterized by "cultural empowerment + market adaptation" has emerged.[19] Relying on this dual-dimensional drive, the Shengzhou scarf and necktie export industry, from the dimension of ICH support, solidifies the core of cultural empowerment, and from the dimension of international market transformation, expands industrial development tracks. Through the integration of these two dimensions, it constructs a systematic transformation pathway, providing a practical example for the upgrading and development of traditional textile

export industries.

5.1. ICH Support Dimension: From Craftsmanship Inheritance to Industrial Empowerment, Consolidating the Transformation Core

Leveraging Zhejiang Province’ s ICH support policies, deeply integrate the inheritance of Yue Opera cultural craftsmanship with the transformation and upgrading of the Shengzhou scarf and necktie industry. Consolidate the cultural empowerment core of industrial transformation from three aspects: policy foundation, craft revitalization, and digital empowerment, realizing the shift of Yue Opera culture from "static inheritance" to "dynamic empowerment".

Policy Support and Cluster Synergy as the Foundation: Construct a support system for ICH empowering the industry. Relying on policies like the *Zhejiang Province Modern Textile and Apparel Industry Cluster Construction Action Plan*, incorporate Yue Opera ICH craftsmanship into the top-level design for the transformation and upgrading of the Shengzhou scarf and necktie industry. Promote the linkage between the government, enterprises, industry associations, and ICH inheritors, forming a support system of "ICH Workshops + Industrial Clusters + Public Services." Establish a special fund for Yue Opera culture empowering industrial transformation, providing financial support for enterprise R&D of Yue Opera cultural elements and design talent cultivation. Build a public service platform for the integration of Yue Opera culture and industry, achieving the integration and sharing of ICH resources and industrial resources, reducing the cost of cultural empowerment for enterprises.

Craft Revitalization and Value Excavation: Fully unleash the industrial value of Yue Opera. By meticulously excavating the core visual elements of Yue Opera culture—the unique beauty of Yue Opera costume patterns, the artistic expression of classic colors, the charm of distinctive shapes—and integrating them with modern, fashionable design techniques, symbols from classic Yue Opera stories are incorporated into scarf and necktie product R&D, injecting new impetus into industrial development and enhancing product competitiveness. Simultaneously, by integrating traditional Yue Opera crafts like embroidery and weaving with modern textile technology, the cultural connotations of Yue Opera are better reflected, significantly enhancing the craft value-added of products. Leveraging certification systems like "Zhejiang Made," Yue Opera cultural elements are transformed into product premium points, better promoting product upgrading towards mid-to-high-end markets, and helping the scarf and necktie export industry break through the long-standing development dilemmas of product homogenization and low added value.

Digital Empowerment and Inheritance Upgrading: Promote the digitization of Yue Opera culture. Leveraging Zhejiang’ s digital economy advantages, a digital repository centered on Yue Opera cultural resources can be established, enabling the digital preservation and innovative design of Yue Opera patterns, craftsmanship, and stories. Yue Opera cultural elements can be promoted for standardized, scaled production through digital platforms like industrial "brains" and smart factories. While preserving the core essence of Yue Opera ICH craftsmanship, the international adaptability of Yue Opera products is enhanced. Simultaneously, through digital technologies like virtual reality/augmented reality and short videos, cross-cultural dissemination of Yue Opera culture is achieved, significantly improving international market recognition of Yue Opera culture, laying a solid foundation for the overseas expansion of Yue Opera culture-empowered products.

5.2. International Market Transformation Dimension: From Passive Adaptation to Active Leadership, Expanding Transformation Tracks

Adapting to the international textile market's transformation trends towards greening, digitalization, and personalization, expand industrial transformation tracks from three aspects: green transformation, channel

innovation, and demand adaptation, promoting the Shengzhou scarf and necktie industry's shift from passively adapting to international markets to actively leading market demand.

Responding to Trade Barriers, Advancing Green Transformation, Building Green Competitive Advantage: Addressing challenges like the EU's Carbon Border Adjustment Mechanism (CBAM) that pose "green trade barriers," efforts should focus on enhancing corporate carbon management capabilities and promoting carbon label certification for products, ensuring green compliance. Priority should be given to constructing energy-saving and carbon-reduction demonstration projects, promoting green technologies like recycled polyester and waterless dyeing, thereby increasing the green value-added of products. Simultaneously, firmly establishing the product label of "Yue Opera Culture + Green Textiles" better aligns with global sustainable consumption trends, elevating product international status and helping overcome a series of international "green trade barriers."

Promoting Channel Innovation, Deploying in Global Markets, Constructing a Digital Export Channel System: Relying on in-depth cooperation with cross-border e-commerce platforms like Amazon and Ozon, and close alignment with local platforms like Alibaba International Station and TikTok, effectively promote enterprises' online cross-border marketing layout. This adapts to the fragmented order demands of the international market while better introducing local advantageous resources to global markets. Simultaneously, through government-led initiatives like the "Thousand Groups, Ten Thousand Enterprises" market expansion campaign, organize enterprise participation in international large-scale textile exhibitions, cultural exhibitions, and other international events, building offline export channels, bringing new business opportunities. Furthermore, by fully utilizing integrated R&D, warehousing, and logistics resources, construct an export logistics center represented by Shengzhou's scarves and neckties,[20] enhancing export circulation efficiency and building a global marketing network centered on "online + offline."

Adapting to Market Demand, Advancing Product Upgrading, Creating International Cultural Products: By deeply exploring the international market demand for functional and intelligent textiles, increase investment in R&D of new fiber materials and smart textile technologies, pushing the practical functionality of scarves and neckties to new heights. According to the cultural and aesthetic preferences of different major target markets, promote the localization adaptation of Yue Opera cultural elements — simplifying Yue Opera patterns and enhancing fashion sense for the European market; deeply exploring Yue Opera cultural connotations and emphasizing craft details for the East Asian market. Also, explore more fusion points between Song Dynasty aesthetics and Yue Opera culture, developing creative products that combine national trend characteristics with international aesthetics, meeting the personalized and cultural demands of the international market.

5.3. Core Transformation Pathways of Dual-Dimensional Integration

The dual-dimensional drive of Zhejiang ’ s ICH support and international market transformation are not independent but deeply integrated and synergistic.[21] Through three core pathways — value reconstruction, chain upgrading, and ecosystem co-construction — achieve the dual-dimensional integration of ICH support and international market transformation, promote the systematic transformation of the Shengzhou scarf and necktie export industry empowered by Yue Opera culture, and build the industry's international core competitiveness.

Value Reconstruction Pathway: Form a value chain closed-loop of "ICH + Technology + Brand." Taking the integration of Yue Opera culture into product R&D as the core, enhance the cultural value-added of products.[22] Guided by international market demand, force the modernization and innovation of Yue Opera craftsmanship and the application of green technologies, enhancing the technological value-added of products. Centered on cultural storytelling, reshape corporate brand image, creating brands with both Yue Opera cultural distinctiveness and international influence, achieving the shift of products from "contract manufacturing" to "own brand." Ultimately,

form a value chain closed-loop of "ICH culture empowering product innovation — technological upgrading enhancing product competitiveness—brand building realizing value addition," promoting the industry's climb from the low end to the mid-to-high end of the global value chain.

Chain Upgrading Pathway: Connect the entire chain from ICH empowerment to export. Driven by the close integration of the upgrading system of "digital workshops — smart factories — future factories," comprehensively promote the digital transformation of the production and manufacturing segments of the Shengzhou scarf and necktie industry. Simultaneously, integrate diverse resources like Yue Opera ICH workshops, textile design enterprises, and export enterprises to connect the entire chain from ICH inheritance, to R&D and design, production and manufacturing, and cross-border export. Achieve precise matching of Yue Opera cultural resources, international market demand, and industrial supply chains, thereby reducing the impact of international market changes on industry costs and demand, and realizing faster market response speeds.

Ecosystem Co-construction Pathway: Foster a synergistic development ecosystem for ICH-empowered export industries.[23] At the policy level, strengthen initiatives like the "Whole-Chain Empowerment Partnership Plan," incorporating Yue Opera cultural element product R&D, ICH design talent cultivation, green technology application, and cross-border e-commerce deployment into the export industry support system, achieving seamless connection between ICH support policies, export upgrading policies, and green development policies. At the enterprise level, through the cultivation of specialized, sophisticated, distinctive, and innovative enterprises and single-product champions, foster a group of leading enterprises possessing both Yue Opera ICH inheritance capabilities and international competitiveness. Leverage the leading role of these enterprises to promote the synergistic development of SMEs. In the industry-university-research dimension, link universities, research institutions, and ICH inheritors to establish R&D platforms and talent cultivation bases for the integration of Yue Opera culture and the textile export industry, cultivating interdisciplinary talents with both Yue Opera cultural literacy and export operation capabilities, providing talent support for industrial transformation. Ultimately, form a synergistic development ecosystem of "policy + enterprises + industry-university-research + industry associations," achieving a win-win situation for the living inheritance of Yue Opera culture and the high-quality development of the Shengzhou scarf and necktie export industry.

6. Conclusion

Taking the Shengzhou necktie export industry as a case study, under the dual drive of Zhejiang’ s ICH support and ongoing international market transformation, this paper conducted a relatively in-depth analysis of the core cultural connotations and visual symbols of Yue Opera, deeply analyzed the various industrial development dilemmas it faces, and constructed a systematic cultural empowerment transformation pathway for these dilemmas. The study finds that the synergistic force of ICH support policies and international textile market transformation is a key prerequisite for ICH cultural empowerment of industrial transformation. The former lays a solid foundation of policy, talent, and scenarios for industrial development, while the latter indicates the direction for industrial culturalization and high-end upgrading. Yue Opera culture is highly compatible with the Shengzhou scarf and necktie industry. Its distinctive visual and cultural characteristics can provide rich elements for product R&D, and its cross-cultural communication potential can further help the industry build international cultural competitive advantages, solving the problems of homogenization and lack of added value.

The "value reconstruction—chain upgrading—ecosystem co-construction" under dual-dimensional integration is the core pathway for industrial transformation. The three, interconnected and synergistic, form a combined force for transformation: value reconstruction creates a "ICH + technology + brand" value chain closed-loop, promoting the industry's climb towards the mid-to-high end of the global value chain; chain upgrading connects the entire chain

from ICH inheritance to cross-border export, enhancing the industry's market response speed; ecosystem co-construction fosters a multi-stakeholder linkage ecosystem, providing comprehensive support for transformation. Shengzhou’s transformation practice has formed a replicable and promotable "Zhejiang Model." With ICH as the core gene, market demand as the guide, and policy and technology as support, it achieves a win-win situation for the living inheritance of ICH and the high-quality development of the export industry, providing an important reference for the transformation of similar domestic industries.

Against the background of deepening Zhejiang’s ICH policies and the ongoing transformation of the international textile market, there remains broad development space for Yue Opera culture to empower the Shengzhou scarf and necktie industry. Future efforts can focus on three aspects to achieve higher-quality internationalized development. Deepen the dual-dimensional synergy between ICH and the market, promote policy integration and "ICH + technology" innovation, enhance international recognition of Yue Opera culture. Seize opportunities presented by free trade agreements to strategically position in the global value chain, promoting the climb of products towards high value-added segments, transforming Yue Opera culture into internationally recognized symbols and achieving localized innovation. Utilize industrial brains to integrate resources, cultivate interdisciplinary talents, promote the fusion of Yue Opera culture with cultural tourism and cultural-creative industries, creating a model of "Yue Opera Culture + Textile Export + Cultural Tourism." Ultimately, form a sustainable ecosystem of ICH inheritance, industrial development, and regional economic enhancement, aiding Zhejiang’s textile export industry in maintaining its global competitive advantage.

References

[1] Ghazi M. Magableh, et al. Supply Chains and the COVID‐19 Pandemic: A Comprehensive Framework[J]. European Management Review, 2021, 18(3): 363-382.

[2] Jialun Lian, et al. Research on Countermeasures for Promoting Wenzhou's Traditional Culture to "Go Global" and "Gain Popularity"[J]. Frontiers in Humanities and Social Sciences, 2025, 5(8): 116-121.

[3] Bilal Karim, Muhammad Arif, Zafar Ali Khan, et al. Integration of Pakistan’s Cultural Heritage Products into Global Value Chains: Challenges and Opportunities[J]. Journal of Business and Social Sciences, 2025, 2025(2):.

[4] Chuanchuan Yuan, Li Gan, Huili Zhuo, et al. Coupling Mechanisms and Development Patterns of Revitalizing Intangible Cultural Heritage by Integrating Cultural Tourism: The Case of Hunan Province, China[J]. Sustainability, 2022, 14(12): 6994.

[5] Greg Richards, Julie Wilson, et al. Developing creativity in tourist experiences: A solution to the serial reproduction of culture?[J]. Tourism Management, 2005, 27(6): 1209-1223.

[6] Mu Guo, et al. The Yiwu Model of China’s Exhibition Economy[J]. Provincial China, 2010, 2(1):.

[7] Dorothy Noyes, et al. Traditional Culture: How Does it Work?[J]. Museum Anthropology Review (Indiana University), 2011, 5: 39-47.

[8] Ying Zhao, Phiphat Sornyai, et al. Education and Literacy in Yue Opera: Historical Development in Shaoxing, Zhejiang Province, China[J]. International journal of education and literacy studies, 2024, 12(1): 96-105.

[9] Liena Kano, Eric W. K. Tsang, Henry Wai‐chung Yeung, et al. Global value chains: A review of the multi-disciplinary literature[J]. Journal of International Business Studies, 2020, 51(4): 577-622.

[10] Mohsin Shafi, Katarzyna Szopik-Depczyńska, Katarzyna Cheba, et al. INNOVATION IN TRADITIONAL HANDICRAFT COMPANIES TOWARDS SUSTAINABLE DEVELOPMENT. A SYSTEMATIC LITERATURE REVIEW[J]. Technological and Economic Development of Economy, 2022, 28(6): 1589-1621.

[11] Gene M. Grossman, Elhanan Helpman, Grossman, Gene M., et al. Technology and Trade[J]. RePEc: Research Papers in Economics, 1994, 3: 1279-1337.

[12] Byoungho Jin, Hwy‐Chang Moon, et al. The diamond approach to the competitiveness of Korea's apparel industry[J]. Journal of Fashion Marketing and Management, 2006, 10(2): 195-208.

[13] Anne E. McLaren, et al. Eco-sites, Song Traditions and Cultural Heritage in the Lower Yangzi Delta[J]. Asian Studies Review, 2011, 35(4): 457-475.

[14] Reto Felix, Philipp A. Rauschnabel, Chris Hinsch, et al. Elements of strategic social media marketing: A holistic framework[J]. Journal of Business Research, 2016, 70: 118-126.

[15] Pang, Q., Cai, L., Wang, X., & Fang, M. (2024). Digital transformation as the fuel for sailing toward sustainable success: the roles of coordination mechanisms and social norms. Journal of Enterprise Information Management, 37(3), 1069-1096.

[16] Olga Petricević, David J. Teece, et al. The structural reshaping of globalization: Implications for strategic sectors, profiting from innovation, and the multinational enterprise[J]. Journal of International Business Studies, 2019, 50(9): 1487-1512.

[17] Mitsuyo Ando, et al. Fragmentation and vertical intra-industry trade in East Asia[J]. The North American Journal of Economics and Finance, 2006, 17(3): 257-281.

[18] Pang, Q., Lai, P. L., Su, M., Xing, J., & Fang, M. (2025). Talk is cheap; Show me the code: managing the sustainable performance of shipping firms through big data analytics. Maritime Policy & Management, 1-16.

[19] Christiaan Grootaert,Deepa Narayan,Veronica Nyhan Jones,Michael Woolcock. , Measuring Social Capital[M]. , World Bank working paper, , (2004).

[20] Pang, Q., Wang, M., Yao, J., & Fang, M. (2026). Employees' perceived respect and performance in Logistics 4.0: a dyadic perspective of the congruence between employee voice and supervisor listening. International Journal of Physical Distribution & Logistics Management, 56(2), 224-248.

[21] Yue Zhang, Mingqing Han, Weiwei Chen, et al. The strategy of digital scenic area planning from the perspective of intangible cultural heritage protection[J]. EURASIP Journal on Image and Video Processing, 2018, 2018(1):.

[22] Mengmeng Wang, et al. The Realization Way of the Fusion Development of Folk Art and Tourism[J]. Frontiers in Art Research, 2021, 3(3):.

[23] Wen Wang, Shiqi Wang, Ye-Shan Li, et al. Assessing the sustainability and competitiveness of tourism economies in China's Chengdu-Chongqing metropolitan area[J]. Environmental Science and Pollution Research, 2022, 29(44): 66960-66978.

Global Academic Frontiers, Vol. 4, Issue 1, 2026, pp. 36-43 Print ISSN 2995-5688 Online ISSN 2995-570X
DOI: https://doi.org/10.5281/zenodo.18937019

A Comparative Study of the English Translations of Idioms in the Novel *Guisheng* from the Perspective of Translator Behavior Criticism

Zhu Keyan [1*]

[1] College of Foreign Language, Hengyang Normal University, Hengyang, Hunan Province, China
*Corresponding author Email: Cara09500@163.com
Received 16 November 2025; Accepted 16 January 2026; Published 10 March 2026

Abstract: Shen Congwen's literary works are renowned for their distinctive Xiangxi (West Hunan) setting, with idioms serving as a defining characteristic of his novels. The novel *Guisheng* stands as a quintessential example of his style, rich in local expressions that pose significant challenges for translators. This study conducts a comparative analysis of the English translations by Gladys Yang and Jeffrey C. Kinkley, examining their approaches from both intra-translational and extra-translational dimensions, with a specific focus on the rendition of two-part allegorical sayings, common sayings, and nicknames. The findings indicate that, from an intra-translational perspective, Gladys Yang consistently adopts a reader-oriented approach. She effectively conveys the original meaning while ensuring the fluency and accessibility of the target text, often simplifying complex cultural references to enhance readability. This approach achieves a notable balance between "truth-seeking" (adherence to the source text) and "utility-attaining" (serviceability for the target reader). In contrast, Jeffrey C. Kinkley prioritizes maximum fidelity to the source text, leaning decisively toward the "truth-seeking" end of the spectrum by meticulously preserving the original structure, linguistic features, and cultural imagery, even at the expense of immediate reader comprehension. From an extra-translational perspective, the study explores the translators' professional roles, translation philosophies, and the substantial influence of patronage systems. It demonstrates that translator behaviors and translation strategies were shaped and constrained by a complex interplay of subjective and objective factors. Yang's position with China's Foreign Languages Press and Kinkley's academic background emerge as crucial determinants in their respective approaches, highlighting how institutional contexts and personal scholarly commitments fundamentally guided their translation decisions and ultimately shaped the reception of Shen Congwen's work in the English-speaking world.

Keywords: Translator Behavior Criticism; *Guisheng*; English translations comparison; Idioms

1. Introduction

The subjectivity of translators has gained significant attention in translation studies following the "cultural turn." The focus has shifted from linguistic conversion at the textual level to the cultural influences on translation, and further to the translators themselves, who were once hidden behind the text. This evolution highlights the growing recognition of translators' importance and confirms their central role. In the translation process, translators' education, social influences, and personal factors can lead to distinct tendencies and variations in their translated texts. These objective and subjective factors also shape translators' behaviors, a concept known as "translator behavior." This concept can be defined broadly or narrowly. Broadly, it includes both linguistic translation actions and social non-translation actions beyond the act of translating. Narrowly, it refers solely to translation actions performed within the scope of the translator's identity and role[1].

Shen Congwen's literary construction of the Xiangxi world is characterized by its rich, distinctive, and naturally vivid language, which is particularly prominent in representative novels such as *The Border Town*, *Xiaoxiao*, and *Guisheng*. *Guisheng*, a short story written by Shen Congwen in 1937, depicts the love tragedy between Guisheng, a youth from the lower strata of society, and Jin Feng, the daughter of a grocery store owner at the bridgehead. The story is notable for its abundant use of culturally loaded expressions, including two-part allegorical sayings, common sayings and nicknames, all of which reflect the strong local flavor of Xiangxi.

Vernacular refers to all orally transmitted, concise, and popular expressions with local characteristics, circulating among the people and reflecting, to some extent, the local customs, traditions, and cultural practices[2]. Undoubtedly, vernacular is an inseparable part of Shen Congwen's works. Its rich connotations and strong local color pose challenges for accurate transmission into the target language. Therefore, in the process of English translation, translators must handle dialects with care, striving to convey their original essence and cultural authenticity. At the same time, translators also need to consider the target-language readers, ensuring that the translated dialects communicate the original meaning without causing reading difficulties. The translators' inclinations and chosen strategies in this process can be analyzed using the "truth-seeking and utility-attaining" continuum evaluation mechanism within the framework of Translator Behavior Criticism. This study compares the translations by Gladys Yang (1981) and Jeffrey C. Kinkley (1995) to analyze their intra-translational and extra-translational behaviors in translating idioms. Through this analysis, the characteristics of translator behavior are summarized to clarify the social constraints influencing such behavior.

2. Analysis of Intra-Translational Behavior: The "Truth-Seeking and Utility-Attaining" Continuum Evaluation Mechanism

The concept of translator behavior primarily involves the translator's pursuit of fidelity and pragmatic adaptation in language, with a focus on the linguistic aspects of translation itself, such as the conveyance of style, rhetorical devices, syntax, vocabulary, as well as the specific translation strategies and methods employed. Translator constantly navigates between "fidelity" and "pragmatic adaptation". They may lean toward "fidelity" by orienting themselves toward the source text/author or toward "pragmatic adaptation" by prioritizing the reader/society. Alternatively, they may strive to maintain an ideal balance between these two poles, harmonizing the "linguistic" and "social" dimensions[3]. When oriented toward the source text/author, the translator emphasizes the accurate transmission of the original meaning, tending toward fidelity. When oriented toward the reader/society, the translator centers on the reader, aiming for clarity, readability, adherence to target language conventions, and meeting reader expectations, thus leaning toward pragmatic adaptation. Both approaches describe the translator's choices in translation strategies and methods, interpreting the tendencies in their behavior.

This study applies the translation strategies of culture-specific Items proposed by Spanish scholar Aixela[4] to identify and analyze the translation strategies for idioms in *Guisheng*. The methods primarily employed in this paper include: orthographic adaptation; linguistic translation; intratextual gloss; absolute universalization; autonomous creation; and deletion. Among these, orthographic adaptation, linguistic translation, and intratextual gloss fall under conservation strategies, reflecting a translator behavior tendency toward the "fidelity" end of the spectrum. Absolute universalization, autonomous creation, and deletion belong to substitution strategies, indicating a tendency toward the "pragmatic adaptation" end. In the text, Gladys Yang frequently employs methods such as deletion and autonomous creation, making her translation more reader-oriented. In contrast, Jeffrey C. Kinkley predominantly uses linguistic translation and intratextual gloss, focusing on conveying the original meaning and serving the author and source text.

This paper selects idioms from the novel *Guisheng*, including two-part allegorical sayings, common sayings and nicknames as research cases. Idioms are a crucial reflection of the novel's linguistic style. The dual-segment structure of two-part allegorical sayings, the metaphorical nature of common sayings, and the regional

characteristics of nicknames, along with the numerous culture-specific terms contained within these idioms, create a translation conflict between "fidelity" and "pragmatic adaptation." When handling such translation challenges posed by idioms, the two translators clearly demonstrate their choices of translation methods and behavioral tendencies. Therefore, by analyzing the two-part allegorical sayings, common sayings and nicknames in the text, this study compares and examines the translator behaviors of Gladys Yang and Jeffrey C. Kinkley, summarizes the characteristics of their approach, and delves into the social determinants underlying their actions.

2.1 Two-part allegorical saying

Two-part allegorical saying often consist of two parts: the first part acts as a riddle, while the second part conveys the actual meaning. Closely tied to everyday life, two-part allegorical saying reflects working people's observations and humorous perspectives, expressing profound ideas through concise and vivid language. In the novel *Guisheng*, the author employs several two-part allegorical saying that carry distinct local flavor and rustic charm. The two translators adopted different approaches when rendering these expressions.

Example 1: 热米打粑粑，一切得趁早

Gladys Yang's translation: Strike while the iron's hot. No more delay[5].

Kinkley's translation: Shape your baba biscuits while the rice is still hot[6]!

Example 2: 花脚狗不是白面猫，各有各的脾气

Gladys Yang's translation: People are made differently.

Kinkley's translation: A spotted-leg dog's not a white-faced cat. Each has his own temper.

Example 3: 天上野鸭子各处飞，捞到手的就是菜

Gladys Yang's translation: Wild ducks fly all over the sky, but only good archers can have them.

Kinkley's translation: Wild ducks fill the sky; reach up anywhere, and you can pull down a tasty morsel for yourself.

In comparing the translations of two-part allegorical saying, from the perspective of conveying the original meaning, Gladys Yang tends to generalize the overall meaning. She primarily translating the latter part of the two-part allegorical saying while downplaying the detailed and specific descriptions in the first part. In Example 1, the original Chinese sentence blends folklore and philosophy, incorporating the concrete scene of folk labor. "粑粑" (a type of biscuit) represents the daily sustenance of rural people, while Gladys Yang's translation applies autonomous creation to replaces the original cultural items. Although this conveys the intended meaning, it overlooks the original imagery. In Example 2, the original Chinese sentence uses the contrasting patterns of two animals as a metaphor for differences in individual character. But her translation only the implied meaning of the two-part allegorical saying and delates the unique expression and cultural connotations. However, her translations are more fluent and readable, making it easier for target-language readers to accept and understand the original meaning. These adaptations indicate that her translation strategies and methods lean more toward the "utility-attaining" end, prioritizing the reader's experience.

In contrast, Kinkley focuses on convey the original meaning and specific imagery, he tends to use the linguistic translation method. For example, in Example 1, he directly translates "热米打粑粑" (Shape your baba biscuits while the rice is still hot), preserving the original meaning and imagery more completely. Example 2 further highlights the differences in the translators' approaches. Kinkley translates terms like "花脚狗" (spotted-leg dog) and "白面猫" (white-faced cat), which describe animals with specific physical features in rustic language, conveying the original expressions into the target language. However, in his effort to remain faithful to the original, the word order and phrasing sometimes appear unnatural and do not conform to English conventions. For instance, in Example 3, Kinkley retains the original expression, but the translation may be difficult for target-language readers to comprehend. To some extent, he sacrifices fluency and readability in favor of preserving the original style, leaning more toward the "truth-seeking" end.

2.2 Common Sayings

Common sayings are linguistic units created by the masses and circulated in colloquial speech, characterized by their oral and popular nature[7]. The novel *Guisheng* contains many amusing local sayings. The two translations differ significantly in their treatment of these sayings. To enhance reader comprehension and acceptability, Gladys Yang generally adopts a "utility-first" approach. In contrast, Jeffrey Kinkley employs a foreignizing strategy, maintaining sentence structures largely equivalent to the Chinese original to highlight the rustic flavor of the text, thus leaning toward the "truth-seeking" end of the "truth-seeking and utility-attaining" continuum.

Example 4: 两手一肩，快乐神仙

Gladys Yang's translation: With strong shoulders and hands, you can live on the fat of the land.

Kinkley's translation: With strong arms and a good bod', you can be as happy as a little god.

Example 5: 牛肉炒韭菜，各人心里爱

Gladys Yang's translation: Each to his own fancy.

Kinkley's translation: Some like leeks, and some like meat; it all depends on what's your treat.

Example 6: 认货不认人

Gladys Yang's translation: She has eyes, but hasn't seen through him.

Kinkley's translation: Good things they can see fine; it's good people they're blind to.

Example 7: 命里注定它要来，门板挡不住；命里注定它要去，索子链子缚不住。

Gladys Yang's translation: If something's fated, there's no way of stopping it with a gate or keeping it back with a chain.

Kinkley's translation: These people are rich without a lick of work; their fortune's in their fate. If your fate tells the money to come, even a door plank won't block it.

In translating common sayings, Gladys Yang's versions are notably more concise and often use English equivalents to convey the original meaning. When translating "快乐神仙," Gladys Yang use absolute universalization method, explicates the intended meaning clearly. Kinkley retains the original imagery and literal phrasing. The former is easier to accept and understand but diminishes the vividness and imagery, reducing the cultural distinctiveness. The latter better preserves the original charm and local flavor.

In Example 6, Gladys Yang deviates from the original imagery and meaning. The saying "认货不认人," which implies "judging things by their intrinsic value rather than personal relationships," is translated as "hasn't seen through him," fully adopting English expressions and thought patterns. This translation delates the original expression and results in a vague meaning that significantly diverges from the original. Kinkley's translation more accurately conveys the original intent with higher fidelity, maintaining the original sentence structure while considering reader comprehension, thus meeting both "truth-seeking" and "utility-attaining" standards.

In Example 7, Gladys Yang accurately conveys the core idea of "the inevitability of fate," translating "门板" and "索子链子" as "gate" and "chain" respectively, demonstrating high fidelity. Kinkley, however, overly emphasizes the original sentence structure and style, causing the translation to deviate from the core theme of fate's unchangeability. The latter part of his translation reverts to the original meaning but appears loose, incoherent, and logically fragmented. In common saying translation, Gladys Yang's tend to use intratextual gloss, absolute universalization and deletion methods. Her version better achieves the balance between truth-seeking and utility-attaining. Kinkley's overly literal approach compromises both the original meaning and the readability of the translation, leaning more toward the "truth-seeking" end.

2.3 Nicknames

Nicknames in literary works are often closely linked to characters' images and personalities. They are summaries formed by others through long-term interaction and observation, capable of accurately and intuitively reflecting a person's characteristics in a certain aspect. Authors use well-chosen nicknames to quickly shape character portrayals and convey their own evaluative attitudes toward the characters. In the novel *Guisheng*, the nicknames often carry a strong sense of the era and rustic flavor, with some closely tied to the cultural and historical

background of the story. The two translators demonstrate distinct preferences and strategies in their approaches to translating these nicknames.

Example 8: 癞子

Gladys Yang’s translation: Imp

Kinkley’s translation: Scabby

Example 9: 鸭毛伯伯

Gladys Yang’s translation: Uncle Yamao

Kinkley’s translation: Uncle Duck

Example 10: 卖油郎

Gladys Yang’s translation: Oil-vendor in the old story who won a courtesan’s heart

Kinkley’s translation: Oil peddler

Example 11: 杨半痴

Gladys Yang’s translation: Yang Banchi

Kinkley’s translation: Half idiot Yang

Example 12: 王财主

Gladys Yang’s translation: Moneybags Wang

Kinkley’s translation: Rich man Wang in town

Example 13: 观音

Gladys Yang’s translation: Guanyin

Kinkley’s translation: Guanyin, the goddess of mercy

Based on the translations of multiple nicknames, it can be observed that Gladys Yang’s approach achieves a better balance between the standards of truth-seeking and utility-attaining. For example, the nickname “癞子” was given because the character has a lively disposition in the original text. Gladys Yang uses autonomous creation method. She opts for the neutral term “Imp,” which describes someone lively, clever, or even mischievous. This aligns with the original text’s use of the nickname to imply personality traits. In contrast, Kinkley translates it literally as “Scabby,” describing an unhealthy skin condition. This fails to achieve the author’s purpose of using the nickname to implied personality traits, not only inaccurately conveying the original meaning but also potentially misleading readers.

In terms of translation methods for nicknames, Gladys Yang frequently employs orthographic adaptation, such as “Uncle Yamao” “Yang Banchi” and “Guanyin.” These nicknames carry rich cultural connotations and require contextual understanding from the original text, making them difficult to explain concisely. Orthographic adaptation preserves the conciseness of the original nicknames. In comparison, Kinkley’s translation of “杨半痴” as “Half idiot Yang” uses linguistic translation. While this allows readers to grasp part of the nickname’s meaning, it still fails to fully and accurately convey the cultural implications. Readers may not understand that “杨半痴” refers to a fortune-teller in a rural setting. Similarly, “Guanyin” in the original text is used to describe the heroine’s beauty, likening her appearance to that of the Goddess. Although Kinkley translation helps readers recognize the cultural background of the goddess, it does not convey the intended meaning of beauty. This could lead to misinterpretations of the character’s image, reflecting a translation behavior leaning toward the truth-seeking end.

The nickname “卖油郎” alludes to a literary allusion from Feng Menglong’s *Stories to Awaken the World*, which tells the story of an oil seller from a humble background who wins the heart of a celebrated courtesan. It represents a young man from a poor family who achieves a fortunate marriage, carrying a teasing connotation. In the text, it refers to a young laborer working in Jin Feng’s household, who might become her marriage partner. Gladys Yang’s translation employs intratextual gloss method, fully explains the cultural connotations of the cultural item, incorporating background story and emotional context. This not only sparks readers’ interest but

also strikes a balance between truth-seeking and utility-attaining, making the original meaning accessible while ensuring readability. In contrast, Kinkley's translation provides only the literal meaning (the oil peddler) without supplementary information, losing the symbolic meaning of the original. Readers are unable to grasp the deeper cultural implications or fully understand the text's intended message, reflecting a tendency toward the truth-seeking end.

3. Extra-Translational Factors Influencing Translator Behavior

The comparative analysis of the translated texts reveals that Gladys Yang demonstrates a stronger reader-oriented focus, frequently employing domestication strategies and striving to balance "truth-seeking" and "utility-attaining" within the evaluation framework. In contrast, Kinkley places greater emphasis on conveying the original text's structure and style, serving the author's voice and leaning more toward the "truth-seeking" end. However, translation does not occur in a vacuum; translators are inevitably influenced by multiple external factors during the process. Extra-translational behavior refers to the study of a translation's utility beyond the text itself, it means the extent to which the translation serves society. It addresses the relationship between the translation and society, focusing on the various factors that constrain and shape translator behavior[8]. The extra-translational behaviors of the two translators will be analyzed primarily from the perspectives of their roles, translation philosophies, and patronage factors.

First, the two translators held distinct identities beyond their roles as translators. Translators with different educational backgrounds and social identities often produce translations with varying characteristics. Gladys Yang had extensive translation experience, having collaborated with Yang Xianyi on numerous works by Chinese writers and produced many independent translations. Kinkley, on the other hand, conducted in-depth research and interviews on Shen Congwen himself. From his doctoral dissertation to his 1987 biography *The Odyssey of Shen Congwen*, Kinkley developed a profound understanding of Shen Congwen's style and works. Consequently, the two translators exhibited different tendencies when translating idioms in *Guisheng*.

Second, the two translators held different translation philosophies. Previous research generally agrees that Gladys Yang's independent translations prioritize acceptability, featuring fluent, natural language and strong readability[9]. In her solo translations, she often simplified or omitted Chinese cultural elements to avoid complexity and obscurity. In contrast, Kinkley viewed his target readers as scholars or students with certain cultural backgrounds and knowledge reserves. Thus, he aimed to preserve the original text as much as possible, minimizing omissions. In Kinkley's translations, idioms are often rendered literally with annotations. He placed great emphasis on conveying the original style and the unique language of the author.

Third, the two translators operated under different patronage influences. The theory of translation as rewriting posits that the production of translations is constrained by three factors: poetics, ideology, and patronage. According to Lefevere, patronage refers to "something like the powers that can further or hinder the reading, writing, and rewriting of literature." The two translators were influenced by the institutions or patrons they were associated with. For instance, Gladys Yang worked for the Foreign Languages Press in China, which, to some extent, represented official translations and carried the responsibility of disseminating Chinese culture. Her translations were thus subject to certain constraints. Kinkley, however, was not a professional translator and had greater autonomy in selecting works to translate. His translation of *Guisheng* was included in *Imperfect Paradise*, published by the University of Hawaii Press, which primarily targets academics, students, and universities. As a result, Kinkley's translation placed greater emphasis on the original work and served the author's voice.

4. Conclusion

Shen Congwen's unique pastoral style has endeared him to readers, with the extensive use of vernacular language in his works serving as a vital manifestation of this style. From the perspective of Translator Behavior Criticism, this study conducted a comparative analysis of the English translations of such idioms Gladys Yang's and Jeffrey C. Kinkley's English translations.

General target-language readers are typically less concerned with the precise transmission of idioms and more focused on the artistic, literary, and aesthetic value of the translated work[10]. Consequently, Gladys Yang prioritized the acceptability of her translation, tailoring her efforts to the average target-language reader. For instance, in translating two-part allegorical sayings, she often employed deletion, conveying only the implied meaning to facilitate reader comprehension. Her diction is concise and idiomatic, aligning with English conventions while accurately conveying the original meaning in an accessible manner. Evaluated by the "truth-seeking and utility-attaining" framework, her approach strikes a balance between the two ends.

In contrast, Jeffrey C. Kinkley emphasized the transmission of the original text's structure, style, and cultural connotations. His word choice and expressions tend to be more complex and less constrained, leaning more toward the truth-seeking end. His translation requires readers to possess a certain level of background knowledge to fully understand, making it more suitable for target readers who aim to learn indirectly from the translation or engage in translation studies.

The analysis of extra-translational behavior primarily examined factors such as the translators' roles, their translation philosophies, and patronage. Gladys Yang was a professional translator, while Jeffrey C. Kinkley was an academic researcher with deep expertise on Shen Congwen. Their differing professional identities shaped distinct tendencies in their translation approaches. Furthermore, their translations were influenced by both subjective factors, such as their personal translation philosophies, and objective factors, including patronage.

This comparative study of the two English translations of the novel *Guisheng* reveals that translating idioms involves not only linguistic transformation but is also the result of multiple social factors. Translators should balance their different roles, considering both linguistic and social dimensions, to achieve an equilibrium between truth-seeking and utility-attaining.

Competing Interests Statement

All authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Zhou, L. (2013). ‘Translation action’ and ‘translator behavior’ in translator behavior criticism. *Foreign Languages Research*, (6), 72-76.

[2] Zhou, L. (2016). The translation of ‘vernacular language’ and its critical studies. *Foreign Languages Research*, 33(4), 77-82.

[3] Zhou, L. (2010). Translator’s behavior and the “truth-seeking – pragmatism” continuum evaluation model: A study of translator’s behavior (Part One). *Foreign Language Education*, 31(1), 93-97.

[4] Aixela, J. (1996). Culture-specific Items in Translation. In R. Alvatez & M. Vidal (Ed.), *Translation, Power, Subversion* (pp. 52-78). Clevedon: Multilingual Matters.

[5] Shen, C. (1981). *The border town and other stories* (G. Yang, Trans.). Beijing: Chinese Literature Press.

[6] Shen, C. (1995). *Imperfect paradise* (J. C. Kinkley, Trans.). Honolulu: University of Hawai’i Press.

[7] Feng, Q. (2014). The rhetoric of common sayings in A dream of red mansions and their English translation. *Studies on “A Dream of Red Mansions”*, (1), 286-305.

[8] Zhou, L. (2025). Revisiting ‘extra-translation’ studies in translator behavior research. Journal of Beijing International Studies University, 47(2), 31-42.

[9] Yu, J., & Liu, X. (2019). Telling China’s stories through translation: A study of Gladys Yang’s English translations of contemporary Chinese literature. *Chinese Translators Journal*, 40(6), 109-116.

[10] Chen, J. (2024). A humanistic approach to the English translation of Chinese vernacular language: With comments on A critical study of the English translation of Chinese vernacular language. *Shandong Foreign Language Teaching*, 45(2), 126-133.

Global Academic Frontiers, Vol. 4, Issue 1, 2026, pp. 44-57 Print ISSN 2995-5688 Online ISSN 2995-570X
DOI: https://doi.org/10.5281/zenodo.18937123

Research and Analysis on Polypropylene Fiber Orientation Crystallization Technology and Its Impact on Material Strength Properties

Guoxi Lv [1]、Jiawei Jiang [1]、Yue Zhu [1]、Hongbin Xiong [1*]

[1] College of International Economics & Trade,Ningbo University of Finance & Economics,Ningbo,315175,China
*Corresponding author Email: hongbin1111@163.com
Received 19 November 2025; Accepted 16 January 2026; Published 10 March 2026

Abstract: Polypropylene (PP) fiber is widely used in textiles, medical applications, geotechnical construction, and composite materials due to its excellent characteristics such as light weight, low cost, and chemical resistance. The final performance of the fiber, especially mechanical properties like strength and modulus, largely depends on its internal microstructure, including crystallinity, crystal morphology, and the degree of molecular chain orientation. Orientation crystallization technology is a key means to regulate the microstructure of polypropylene fibers, thereby significantly enhancing their mechanical properties. This paper systematically reviews the technical principles and development of inducing orientation crystallization in polypropylene fibers through processes such as high-speed spinning and electrospinning. First, the paper elaborates on the crystallographic fundamentals of polypropylene, including crystal forms, crystallization kinetics, and their relationship with molecular chain structure. Secondly, it focuses on analyzing the induction mechanisms of flow fields and stretch fields during spinning on polypropylene molecular chain orientation, nucleation, and crystal growth, discussing the influence of molecular weight and its distribution, and spinning process parameters (such as spinning speed, cooling conditions) on orientation crystallization behavior. Subsequently, the paper summarizes various methods used to characterize the crystalline structure and mechanical properties of polypropylene fibers, such as density gradient column, inverse gas chromatography, X-ray diffraction, and mechanical testing. Based on existing literature research, this paper deeply discusses the formation conditions of the highly oriented shish-kebab structure and its decisive contribution to fiber strength. The results indicate that by optimizing the orientation crystallization process, the crystallinity and crystal orientation of polypropylene fibers can be effectively improved, leading to an order of magnitude increase in tensile strength and elastic modulus. Finally, this paper prospects future research directions for polypropylene fiber orientation crystallization technology, such as multi-component system induced crystallization and green processing technologies.

Keywords: Polypropylene fiber; Orientation crystallization; Strength properties; Crystallinity

1. Introduction

1.1 Research Background and Significance

Polypropylene (PP), as one of the most widely produced general-purpose plastics globally, finds greatly expanded value space in its fiber form. From everyday non-wovens and carpet backing to high-performance geotextiles, filter materials, and composite reinforcements, polypropylene fibers play an indispensable role. However, the mechanical properties, especially strength and modulus, of polypropylene fibers produced by

conventional methods, lag behind traditional synthetic fibers like nylon and polyester, as well as increasingly prominent high-performance fibers, which limits their application in high-end fields. [1]

The fundamental factors determining the properties of polymer materials are their microstructure. For semi-crystalline polypropylene, crystallization behavior — including crystallinity, crystal morphology (such as spherulites, shish-kebab), and crystal orientation—is the core affecting its mechanical properties, thermal properties, and dimensional stability. From Figure 1, the characteristic Maltese cross extinction pattern of polypropylene spherulites under polarized light microscopy between crossed polarizers can be observed. Among these, the orientation of molecular chains and crystals is the key bridge connecting processing technology and final fiber performance. [2] During the fiber spinning process, by applying high-speed stretching or shear to the melt or solution, randomly coiled molecular chains can be aligned along the fiber axis and crystallize in this oriented state, forming a highly ordered crystal structure. This "orientation crystallization" process can effectively transfer the high strength and high modulus in the direction of the strong covalent bond backbone of the molecular chains to the macroscopic fiber, thereby achieving a leap in mechanical properties. [3]

Therefore, in-depth research on the orientation crystallization technology of polypropylene fibers, revealing the entire process from molecular chain motion, nucleation, growth to the formation of a stable oriented structure, and precisely establishing the structure-property relationship between process, structure, and performance, has extremely important scientific significance and engineering value. [4]This can not only provide theoretical guidance and technical pathways for developing high-strength, high-modulus polypropylene fibers but also actively promote the high value-added utilization of polypropylene materials and expand their application boundaries.

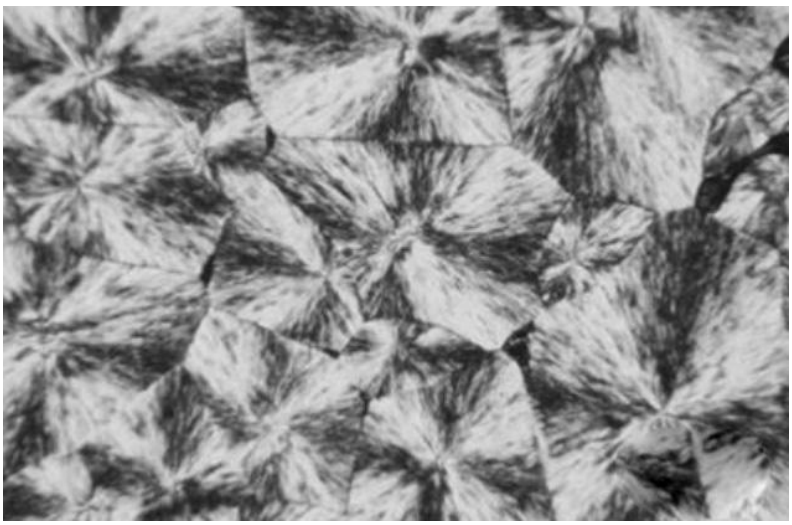

Figure 1 Polarized Light Micrograph of Polypropylene Spherulites

1.2 Domestic and International Research Status

Research on the crystallization and orientation of polypropylene fibers has a long history and continues to deepen with the development of characterization techniques and theoretical models.

In terms of crystallinity characterization, early research focused on developing and applying various measurement methods. Wu Jinhui systematically discussed the feasibility and accuracy of using the density gradient column method to determine the crystallinity of polypropylene fibers, providing basic data support for subsequent research. Fang Shubin, Cai Zhengying, and others pioneered the application of Inverse Gas Chromatography (IGC) for the direct determination of polypropylene fiber crystallinity, and detailed the influence of experimental conditions on the determination results, demonstrating the unique advantages of IGC technology in studying the surface physical properties of polymers. [5]

Regarding the influence of spinning process on crystallization, Lu Fumin's classic research deeply analyzed the profound impact of the molecular weight and molecular weight distribution of the raw material resin on the crystallization behavior of the melt on the spin line during high-speed spinning. [6]This study clearly pointed out that lower molecular weight and narrower molecular weight distribution are conducive to accelerating crystallization kinetics, which has important guiding significance for raw material selection and process optimization in industrial production.

In terms of crystal structure and transformation behavior, Zhang Xiuqin et al. studied the crystallization transformation behavior of syndiotactic polypropylene (sPP) fibers with different initial structures during melting, revealing the influence of thermal history on the stability of complex crystal forms (such as Form I and Form II). Liu Shuangyang et al. successfully prepared isotactic polypropylene (iPP) fibers using electrospinning technology and observed the phenomenon of fibers inducing crystallization in the homogeneous matrix (i.e., the "self-reinforcement" effect), providing new ideas for preparing high-performance PP materials through microstructure design. Figure 2 shows the crystallization transformation process of syndiotactic polypropylene (sPP) fibers with initial structure during melting. [7]

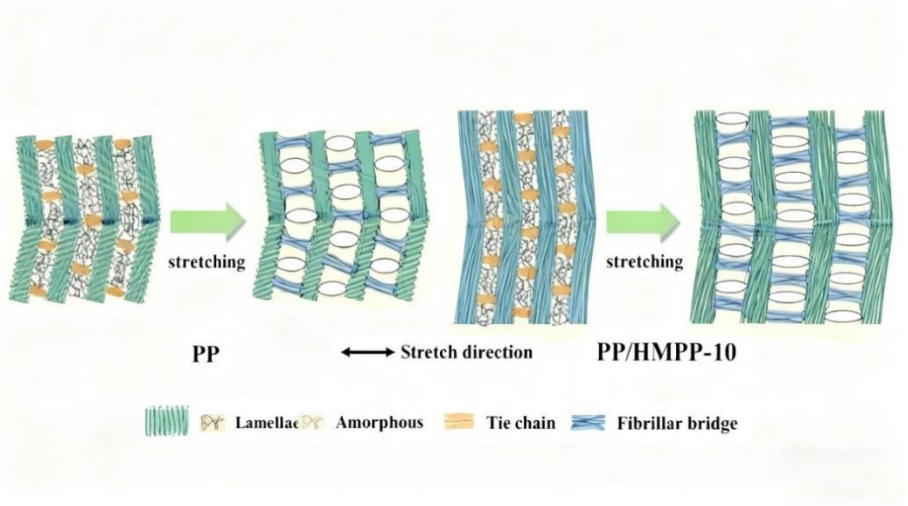

Figure 2 Crystalline transition process of syndiotactic polypropylene (sPP) fibers with initial structure during melting

Furthermore, reports from the industry show technological trends in developing ultra-high crystalline polypropylene fibers and films, reflecting the market's urgent demand for high-performance polypropylene products. In recent years, several graduate theses have also deepened the understanding of the crystallization behavior, kinetics, and microstructure evolution during deformation of polypropylene and its alloys from different perspectives, indicating that research in this field is developing in a more refined and in-depth direction. [8]

1.3 Main Research Content of This Paper

This paper aims to provide a systematic review and summary of orientation crystallization technology for polypropylene fibers and its impact on strength properties. Centering around this theme, this paper will develop the following content:

Systematically elaborate the basic theory of polypropylene crystallization, including its polymorphism, crystallization kinetics and thermodynamics, to lay the theoretical foundation for understanding orientation crystallization. [9]

Deeply analyze the principles, processes, and mechanisms of major orientation crystallization technologies (focusing on high-speed spinning and electrospinning) for inducing molecular chain orientation and the formation of specific crystal structures.

Summarize the key factors affecting orientation crystallization, including the polymer's own structural

parameters (molecular weight, tacticity) and external process parameters (spinning speed, draw ratio, cooling rate, etc.).

Systematically review characterization methods for the crystalline structure and mechanical properties of polypropylene fibers, and focus on discussing the intrinsic relationship between oriented crystalline structures (especially the shish-kebab structure) and fiber strength and modulus. [10]

Based on summarizing existing research results, prospect the future development trends and research directions of polypropylene fiber orientation crystallization technology.

2. Theoretical Basis of Polypropylene Crystallization

To understand orientation crystallization technology, it is essential first to grasp the basic principles of polypropylene crystallization. The crystallization behavior of polypropylene is far more complex than that of many other polymers, mainly due to the specificity of its chain structure and rich polymorphism.

2.1 Molecular Chain Structure and Polymorphism of Polypropylene

The monomer of polypropylene is propylene, which has chiral carbon atoms in its molecular chain. Depending on the spatial arrangement of methyl groups, it can be divided into isotactic (iPP), syndiotactic (sPP), and atactic (aPP) types. Among them, isotactic polypropylene (iPP) with high stereoregularity is the easiest to crystallize and is the main raw material for fiber production. Isotactic polypropylene is known to exist in multiple crystal forms such as α, β, γ, and δ (smectic).

The α form is the most common and stable monoclinic crystal structure, with molecular chains adopting a 3/1 helical conformation. [11]

The β form is hexagonal and usually forms under specific nucleating agents or temperature gradient fields; its mechanical properties (such as toughness) differ from the α form.

The γ form mainly appears under low molecular weight or high-pressure conditions and belongs to the triclinic crystal system.

The δ form (smectic) is a metastable crystal form, usually formed under cold drawing or quenching conditions, and transforms into the α form upon heating.

Different spinning and post-treatment processes promote the formation and transformation of different crystal forms. Research by Zhang Xiuqin et al. on syndiotactic polypropylene also shows that sPP similarly has different forms such as Form I and Form II, and its transformation behavior during melting strongly depends on the initial crystallization history. [12]

Table 1 Summary of Characteristics of α, β, γ, and δ (Smectic) Crystal Forms of Isotactic Polypropylene

Characteristic	α form (Alpha Form)	β form (Beta Form)	γ form (Gamma Form)	δ form (Delta Form, Smectic)
Crystal System	Monoclinic	Hexagonal	Triclinic	Smectic (Metastable)
Chain Conformation	3/1 Helix	3/1 Helix	3/1 Helix	Disordered 3/1 Helix
Stability	Most Stable Thermodynamic Form	Metastable	Stable, occurs under specific conditions	Metastable, transforms readily

Main Formation Conditions	Conventional cooling from melt	Specific nucleating agents (e.g., γ -quinacridone) or temperature gradient fields	Low MW iPP, High-pressure conditions	Rapid Quenching, Cold Drawing
Typical Morphology	Spherulites, Bundle Crystals, "Kebab" Lamellae in Shish-Kebab	Spherical or Polygonal Structures	Crossed Lamellar Structure	Initial Ordered Structure in Amorphous Regions
Mechanical Properties	High Rigidity and Strength, Good Overall Mechanical Properties	Typically better toughness than α form, but lower stiffness and strength	Hardness and stiffness between α and β	Poor mechanical properties, soft and easily deformed
Thermal Behavior	Melting Point: 160-165°C	Melting Point: 140-155°C, lower than α form	Melting Point: ~150°C	Transforms to α form upon heating (~70°C+)

2.2 Crystallization Kinetics and Thermodynamics

The polymer crystallization process includes two stages: nucleation and growth. From Figure 3, the two stages of polymer nucleation and growth under polarized light microscopy can be seen.

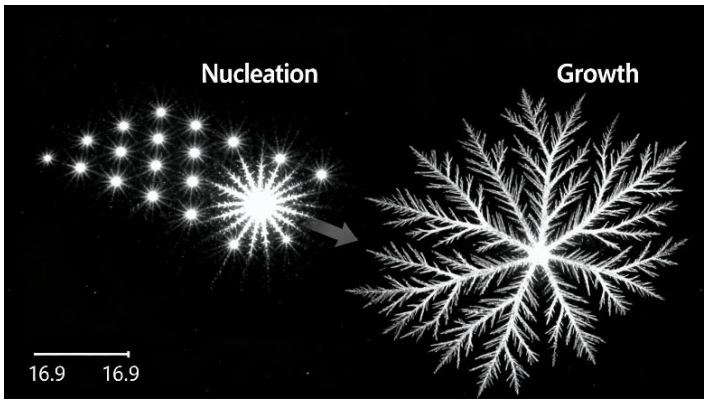

Figure 3 Process of nucleation and growth in polymer crystallization

Nucleation: Divided into homogeneous nucleation and heterogeneous nucleation. In fiber spinning, due to the presence of foreign impurities, heterogeneous nucleation dominates. However, under strong flow or stretch fields, unique flow-induced nucleation occurs. Stretched and oriented molecular chain bundles can act as nucleation sites, greatly increasing the nucleation density. [13]

Growth: The crystal growth rate is closely related to temperature, with a maximum crystallization temperature. The Avrami equation is often used to describe the kinetics of the isothermal crystallization process.

On the spin line, crystallization occurs under non-isothermal, non-equilibrium conditions with velocity and temperature gradients, making the kinetic process more complex. Figure 4 shows a schematic diagram of polymer crystallization under non-isothermal conditions with rising temperature changes. Research by Lu Fumin clearly

shows that the molecular weight of the resin directly affects the viscoelasticity of the melt, thereby influencing the deformation history and crystallization rate on the spin line. [14] The low molecular weight portion usually plays a "plasticizing" role, facilitating chain segment movement and crystallization, while the ultra-high molecular weight portion is crucial for forming stable oriented structures.

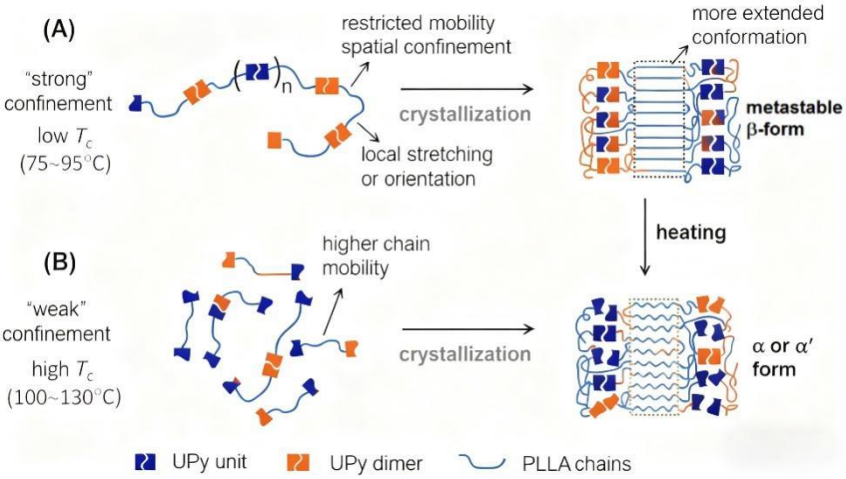

Figure 4 Process of polymer crystallization under non-isothermal, non-equilibrium conditions with velocity and temperature gradients

2.3 Coupling Effect of Orientation and Crystallization

"Orientation" in this context specifically refers to the preferential arrangement of molecular chains or crystallites in space. Under quiescent conditions, iPP melt crystallization usually forms isotropic spherulites. However, during the spinning process, the melt or solution is subjected to shear within the spinneret channels and subsequent stretch deformation, leading to the disentanglement and extension-orientation of molecular chains along the flow direction (fiber axis). [15]This oriented state has two crucial effects on crystallization:

Reducing the nucleation barrier: Highly extended molecular chain segments reduce the critical size required to form stable crystal nuclei, thereby significantly increasing the nucleation rate and density.

Guiding crystal growth: Crystals tend to grow epitaxially on the oriented molecular chains ("Shish"), forming a "shish-kebab" structure where lamellae attach laterally centered on the fiber axis. This structure is a typical feature of highly oriented crystallization and can transfer stress extremely effectively.

The induced crystallization phenomenon observed by Liu Shuangyang et al. in electrospun iPP fibers is essentially due to the pre-formed fibers (with higher orientation) providing a heterogeneous nucleation template for the subsequently crystallizing matrix, guiding the matrix molecules to undergo epitaxial crystallization on them, forming a strong and tough structure penetrating the interface. [16]

3. Orientation Crystallization Technology for Polypropylene Fibers

Orientation crystallization technology is not an independent process but runs through specific fiber preparation processes. This chapter will focus on two key technologies that can effectively induce polypropylene orientation crystallization: high-speed melt spinning and electrospinning.

3.1 High-Speed Melt Spinning Technology

High-speed melt spinning is the most mainstream technology for the industrial production of high-strength polypropylene fibers. The process is as follows: Polypropylene chips are melted, precisely conveyed by a metering pump, extruded through a spinneret to form melt streams, which are rapidly cooled and solidified under the flow

field generated by high-speed winding (usually speeds above 3000 m/min), forming as-spun fibers.

3.1.1 Process Principle and Orientation Crystallization Process

In high-speed spinning, orientation crystallization occurs mainly in two regions:

Shear zone inside the spinneret channel: The melt undergoes intense shear flow inside the channel, causing preliminary molecular chain orientation. However, this shear orientation partially recovers at the die swell due to relaxation effects.

Stretch zone on the spin line: This is the key region for forming stable oriented structures. High-speed winding creates a continuous uniaxia flow field on the not yet fully solidified melt streams. This flow field further extends and orients the molecular chains on one hand, and greatly promotes the occurrence of Flow-Induced Crystallization (FIC) on the other hand. As the temperature drops, the melt rapidly nucleates and crystallizes in a highly oriented state, "freezing" the oriented "liquid" or "semi-solid" structure, forming fibers containing a large number of shish-kebab structures. [17]

Lu Fumin's research profoundly revealed the complexity of this process. He pointed out that the crystallization behavior on the spin line is the result of the coupling of temperature, velocity, and stress fields. For resins with a wide molecular weight distribution, the low molecular weight portion crystallizes first, potentially hindering the full orientation of the high molecular weight chain segments, while the high molecular weight portion, due to its long-chain entanglement network, is crucial for withstanding high spinning stress and forming stable oriented structures. Therefore, optimizing the molecular weight distribution is one of the cores for achieving high-strength spinning.

3.1.2 Influence of Process Parameters on Orientation Crystallization

Spinning speed: This is the most critical factor. As the spinning speed increases, the tensile stress and strain rate on the spin line increase, the molecular chain orientation degree significantly improves, the crystallization rate accelerates, and crystallinity also increases. [18]When the speed exceeds a certain critical value, the crystalline structure and morphology of the fiber undergo a qualitative leap, transitioning from being dominated by spherulites to being dominated by shish-kebab.

Cooling conditions: The cooling rate affects the crystallization temperature and process. Too fast cooling may lead to the formation of imperfect smectic crystals, while too slow cooling allows more time for molecular chain relaxation, which is not conducive to maintaining high orientation. Precise control of cooling air temperature, velocity, and position is needed to balance high-speed orientation and sufficient crystallization.

Melt temperature: A higher melt temperature means a lower initial entanglement degree of molecular chains at the exit and a longer relaxation time, which is beneficial for subsequent orientation. But excessively high temperatures can cause degradation.

3.2 Electrospinning Technology

Electrospinning is a technology that uses high-voltage electrostatic force to prepare micro-nano scale fibers. Although its output is low, it has unique advantages in preparing ultrafine fibers, special structure fibers, and studying fundamental crystallization behavior.

3.2.1 Process Principle and Characteristics

The process is as follows: The polypropylene solution or melt becomes charged under a high-voltage electrostatic field (usually several kV to tens of kV), forming a jet at the Taylor cone at the end of the spinneret.

[19]This jet undergoes severe whipping instability in the electric field, is rapidly stretched to the nanoscale, while the solvent evaporates or the melt cools, finally forming a non-woven fiber mat on the collecting device.

3.2.2 Orientation Crystallization Mechanism in Electrospinning

In electrospinning, the strain rate experienced by the jet is extremely high (can reach 10^4 ~ 10^6 s^-1), much higher than traditional melt spinning. This extreme stretching condition provides an ideal environment for high orientation of molecular chains and flow-induced crystallization.

Strong electric field stretching: The extremely high strain rate causes molecular chains to be strongly stretched in a very short time, with almost no time for relaxation, thus being "frozen" in a highly oriented state.

Rapid solvent evaporation/cooling: The rapidity of the process inhibits the formation of large-sized spherulites, forcing crystallization to occur in highly confined nano spaces, usually forming oriented microcrystals or shish-kebab structures.

The research by Liu Shuangyang et al., "Electrospun Isotactic Polypropylene Fibers Inducing Crystallization of Homogeneous Matrix," precisely utilized this high orientation and surface characteristic of electrospun fibers. They found that electrospun iPP fibers could act as efficient nucleating agents, inducing the surrounding unoriented iPP matrix to undergo epitaxial crystallization on their surface, forming a transcrystalline structure. This "self-induced" crystallization effect from fiber to matrix achieves strong bonding between fiber and matrix at the micro scale, is an effective strategy for preparing self-reinforced polypropylene composites, and significantly improves the overall mechanical properties of the material. [20]

3.3 Other Auxiliary Orientation Techniques

In addition to the two main techniques mentioned above, there are some post-treatment or auxiliary methods that can further enhance orientation crystallization:

Hot Drawing: Subjecting the as-spun fiber to multi-stage hot drawing above the glass transition temperature and below the melting point can further orient the molecular chains in the amorphous regions and promote the slip, rotation, and reorganization of existing microcrystals, forming more perfect, higher orientation degree crystal structures. [21] This is a key post-process for improving fiber strength and modulus.

Solid State Extrusion: Extruding the polymer solid from a die at a temperature below the melting point under great pressure, forcing molecular chains and crystals to undergo high orientation in the solid state.

4. Characterization of Oriented Crystalline Structure and Performance Correlation

To establish the structure-property relationship between the orientation crystallization process and the final fiber strength properties, precise characterization of the fiber's microstructure is essential.

4.1 Characterization Methods for Crystallinity

Crystallinity is an important parameter measuring the proportion of the crystalline part in a polymer. For polypropylene fibers, researchers have developed and applied various methods.

Density Gradient Column Method: Wu Jinhui studied this method in detail. Its principle is based on the different densities of crystalline and amorphous regions (crystalline density of iPP is about 0.936 g/cm^3, amorphous density is about 0.856 g/cm^3). By measuring the suspension position of the fiber in the density gradient column, its density can be calculated, and then the crystallinity can be calculated according to the two-phase model formula. This method has simple equipment, but the accuracy is affected by the stability of the gradient column and sample porosity. [22]

Inverse Gas Chromatography (IGC): Fang Shubin, Cai Zhengying and others were pioneers in applying this

method to PP fiber research. IGC is a technique for characterizing the physical and chemical properties of solid surfaces. They used polypropylene fiber as the chromatographic stationary phase, and through the adsorption and dissolution behavior of probe molecules in it, calculated the crystallinity of the fiber. Its unique advantage is the ability to probe the crystallinity of the fiber surface, which is the key area for interaction with the external environment (such as interfacial bonding). Cai Zhengying and others also specifically studied the influence of experimental conditions such as carrier gas velocity and probe molecule type on the determination results, establishing the reliability of the method.

Differential Scanning Calorimetry (DSC): By measuring the melting enthalpy of the fiber during heating, and comparing it with the theoretical melting enthalpy of 100% crystalline polypropylene, the crystallinity can be obtained. This method is fast and convenient and is one of the most commonly used methods today. [23] It can simultaneously provide information such as melting temperature and crystallization temperature.

Wide-Angle X-Ray Diffraction (WAXD): WAXD is an authoritative method for studying crystal structure. The diffraction pattern can not only be used to calculate crystallinity but, more importantly, can distinguish different crystal forms and quantitatively analyze the crystal orientation degree.

4.2 Characterization of Crystal Morphology and Orientation

Wide-Angle X-Ray Diffraction (WAXD): By rotating the fiber sample perpendicular to the X-ray beam, a two-dimensional diffraction pattern can be obtained. The crystal orientation factor (Hermans orientation factor) along the fiber axis direction can be accurately calculated based on the azimuthal width of the diffraction arcs; the closer its value is to 1, the higher the orientation degree.

Small-Angle X-Ray Scattering (SAXS): SAXS is used to study structures on the scale of tens to hundreds of nanometers and is an ideal tool for observing the long-period structure of "Shish" (fibrillar crystals) and "Kebab" (lamellae) in the shish-kebab structure. By analyzing the shape and intensity of the scattering pattern, the arrangement, thickness, and long period of the lamellae can be inferred.

Polarized Light Microscopy (PLM) and Scanning Electron Microscopy (SEM): PLM can visually observe large-scale crystal morphologies such as spherulites. SEM, especially after etching the fiber (e.g., using potassium permanganate to etch away the amorphous regions), can directly observe fine crystal topological structures such as shish-kebab.

Table 2 Summary of Features for Common Crystalline Morphology Testing Techniques

Testing Technique	Core Testing Method	Main Research Content / Application Scenario	Key Analysis Results / Judgment Basis
Wide-Angle X-Ray Diffraction (WAXD)	Rotate fiber sample perpendicular to X-ray beam, obtain 2D diffraction pattern	Orientation characteristics of fiber crystals along the fiber axis	Calculate Hermans orientation factor; value closer to 1 indicates higher crystal orientation degree
Small-Angle X-Ray Scattering (SAXS)	Irradiate sample with small-angle X-rays, capture scattering signals	Structures at tens to hundreds of nanometers scale; observing long-period structure of "Shish" (fibril) and "Kebab" (lamellae) in shish-kebab	Analyze scattering pattern shape and intensity; infer lamellae arrangement, thickness, and long period

Polarized Light Microscopy (PLM)	Directly observe sample using polarized light imaging	Morphological features of large-sized crystals like spherulites	Intuitively presents the macroscopic morphology of large-sized crystals
Scanning Electron Microscopy (SEM)	Image via electron beam scanning after etching fiber (e.g., using $KMnO_4$ to etch amorphous regions)	Fine crystal topological structures such as shish-kebab	Directly observe the micro fine structure of etched fiber; clearly reveals the topological morphology of crystals

4.3 Mechanical Property Testing

The strength properties of fibers are mainly evaluated through single filament or multifilament tensile tests, obtaining key indicators including:

Tensile Strength: The maximum stress borne by the fiber at break, commonly in units of cN/dtex or GPa.

Initial Modulus: The slope of the initial linear part of the stress-strain curve, reflecting the fiber's ability to resist deformation, a measure of stiffness.

Elongation at Break: The strain at which the fiber breaks.

4.4 Structure-Property Relationship between Oriented Crystalline Structure and Strength Properties

A large number of studies, including all the references mentioned above, clearly point to a core rule: a highly developed oriented crystalline structure is the fundamental guarantee for obtaining high-strength, high-modulus polypropylene fibers.

Role of Crystallinity: Increased crystallinity means that molecular chains form strong lattice structures through regular arrangement, which can bear loads more effectively. The goal of "ultra-high crystallinity" in reports from Sinopec is precisely to pursue higher mechanical properties. [24] Qian Li's research on the evolution of the microstructure during the deformation of impact polypropylene also showed that the evolution of the crystalline phase directly affects the material's yield and hardening behavior.

Decisive Role of Crystal Orientation: This is the essence of orientation crystallization technology. When crystals (especially their molecular chain axes) are highly aligned along the fiber axis, external loads can directly act on the strong covalent bond backbone, rather than first breaking the weaker van der Waals forces or disentangling entanglements. This causes the fiber to exhibit extremely high strength and modulus in the axial direction.

Strengthening Mechanism of Shish-Kebab Structure: The shish-kebab structure is an ideal micro-model for high-performance fibers. The "Shish" (fibrillar crystal) is formed by highly extended molecular chain bundles, which run through along the fiber axis direction, providing extremely high axial modulus and strength. The "Kebab" (lamellae) act like piers, connecting and stabilizing adjacent Shish, and bearing part of the load. This "rigid yet flexible" hierarchical structure gives the fiber high strength while also possessing certain toughness. The perfection and density of the internal shish-kebab structure formed by high-speed spinning or electrospinning directly determine the upper limit of its final mechanical properties.

Comprehensive Influence: Research by Shangguan Yonggang on polypropylene alloys and Quan Yannan on the induced crystallization behavior of isotactic polypropylene both show that crystallization behavior (including nucleation, growth, and final morphology) is a complex process affected by multiple synergistic factors. [25] The optimized orientation crystallization process, under the premise of determining the molecular chain structure, precisely controls the external fields (flow field, temperature field) to synergistically improve the fiber's crystallinity,

crystal perfection, and orientation degree, thereby maximizing the intrinsic mechanical potential of polypropylene. Experiments have proven that through such technologies, the strength of polypropylene fibers can be increased from the conventional 3-5 cN/dtex to over 10 cN/dtex, and the modulus can even achieve orders of magnitude growth.

5. Conclusion and Outlook

5.1 Main Conclusions

This paper systematically reviews the orientation crystallization technology of polypropylene fibers and its impact on strength properties. Based on existing literature research, the following main conclusions can be drawn:

Orientation crystallization is the core pathway to enhance the strength of polypropylene fibers. By inducing molecular chain orientation through the flow and stretch fields during the spinning process and facilitating crystallization in this state, the mechanical limitations of conventional spherulitic structures can be overcome. This enables the formation of highly ordered crystal structures, such as shish-kebab, thereby translating the high intrinsic strength along the molecular chain direction into superior macroscopic fiber performance.

High-speed melt spinning and electrospinning are two effective orientation crystallization technologies. High-speed spinning achieves macro-scale orientation and crystallization of molecular chains through the elongational flow field generated by high winding speeds, making it suitable for the industrial production of high-performance fibers. In contrast, electrospinning utilizes high-voltage electrostatic fields to generate extremely high stretching strain rates, enabling extreme molecular orientation at the nanoscale. This method is particularly suitable for producing ultrafine fibers and conducting fundamental research, while its resulting products can effectively induce matrix crystallization, enabling the fabrication of self-reinforced composites.

The polymer's own structure and process parameters jointly determine the orientation crystallization effect. The resin's molecular weight and its distribution, and tacticity are intrinsic determining factors. External process parameters such as spinning speed, cooling conditions, and draw ratio, through coupling with intrinsic factors, finely regulate the kinetics of orientation crystallization and the final formed microstructure.

Characterization techniques are the bridge connecting structure and performance. Density gradient column, DSC, and IGC can be used for crystallinity analysis, while WAXD/SAXS are indispensable tools for studying crystal orientation and shish-kebab structure. Mechanical property testing ultimately quantifies the performance improvement brought by orientation crystallization. Research shows that the increase in crystallinity and, especially, the great improvement in crystal orientation degree are the fundamental reasons for fibers to obtain high strength and high modulus.

The formation and perfection of the shish-kebab structure is the key to obtaining ultra-high strength properties. This special structure generated by flow-induced crystallization achieves efficient stress transfer in the direction of the covalent bond backbone, and is the microstructural blueprint for developing the next generation of ultra-high strength polypropylene fibers in the future.

5.2 Future Outlook

Although research on orientation crystallization of polypropylene fibers has achieved fruitful results, there are still many areas worthy of in-depth exploration:

Orientation Crystallization in Multi-component and Composite Systems: Future research can pay more attention to the crystallization behavior of polypropylene blended with other polymers (such as polyethylene, polyamide) or composite systems with nano-fillers (such as carbon nanotubes, graphene, nano-cellulose) under orientation fields. These heterogeneous components may act as efficient heterogeneous nucleating agents, or even

participate in constructing more complex hybrid oriented structures (such as using CNTs as templates for "Shish"), potentially synergistically enhancing both the strength and functionality (e.g., electrical and thermal conductivity) of the fibers.

Green and Sustainable Processing Technologies: Current electrospinning still largely uses organic solvents. Developing environmentally friendly polypropylene melt electrospinning technology, or water-based electrospinning using green solvents, is an important future direction. Meanwhile, the recycling and reuse of processed waste polypropylene products, and restoring or even enhancing their mechanical properties through orientation crystallization technology, have huge environmental and economic value.

Deepening Application of In-situ and Multi-scale Characterization Techniques: Using advanced methods such as synchrotron radiation X-ray sources to conduct in-situ, real-time characterization of the orientation crystallization process on the spin line will be able to directly capture the formation moment of "Shish" and the growth kinetics of "Kebab," providing the most direct experimental evidence for establishing more accurate theoretical models. Combined with molecular simulation, the mechanism of orientation nucleation can be understood from the atomic/molecular scale.

Intelligent Structure Design for Specific Applications: Based on the precise control of orientation crystallization, intelligent polypropylene fibers with gradient structures, skin-core structures, or stimulus-responsive crystal form transitions can be designed. For example, utilizing the volume change accompanying the transition from β form to α form may lead to the development of new sensing or actuating fibers.

In summary, the orientation crystallization technology of polypropylene fibers is a vibrant and promising research field. Through multidisciplinary integration and continuously deepening the understanding of the structure-property relationship between process, structure, and performance, it will surely promote polypropylene fibers towards a new stage of higher performance and functionality, expanding their broader application space in the national economy and high-tech fields.

References

[1] Han M ,Jeon C ,Ju H , et al. Morphological and microstructural development of polyacrylonitrile-based carbon fibers through controlled coagulation conditions [J]. Polymer, 2025, 341 129285-129285. DOI:10.1016/J.POLYMER.2025.129285.

[2] Mishra B ,Jena S S . Structural transition in weak polyelectrolyte solution of polyacrylic acid with simultaneous influence of backbone charge density and polymer concentration [J]. Polymer, 2025, 341 129302-129302. DOI:10.1016/J.POLYMER.2025.129302.

[3] Wang W X ,Mao L C ,Ke J Z , et al. Analysis of strength enhancement mechanism of polyacrylonitrile fiber concrete based on multiscale approach [J]. Construction and Building Materials, 2025, 502 144405-144405. DOI:10.1016/J.CONBUILDMAT.2025.144405.

[4] Ponsi F ,Bassoli E ,Mazzotti C , et al. Temperature effect on the tensile constitutive parameters of fiber reinforced concrete [J]. Construction and Building Materials, 2025, 501 144385-144385. DOI:10.1016/J.CONBUILDMAT.2025.144385.

[5] Fereidooni M ,Yazdanpanah M ,Shaikh R R , et al. Mechanistic insights into the photocatalytic degradation of polypropylene microfibers with black TiOX/ZnO S-scheme heterostructures: Formation of ether and hydroxyl functional groups [J]. Journal of Environmental Chemical Engineering, 2025, 13 (6): 120197-120197. DOI:10.1016/J.JECE.2025.120197.

[6] Panta J ,Nguyen K Q P ,Famakinwa T , et al. Sustainable recycled coloured polypropylene using fused granulate fabrication: Influences of pigments, copolymer composition and morphology on material properties [J]. Sustainable Materials and Technologies, 2025, 46 e01752-e01752. DOI:10.1016/J.SUSMAT.2025.E01752.

[7] Wu S ,Moudden H ,Gao Y . Preparation and X-ray Shielding Performance of Gd_2O_3/Bi_2O_3/WO_3 Modified Polypropylene Fiber Fabrics [J]. Fibers and Polymers, 2025, (prepublish): 1-10. DOI:10.1007/S12221-025-01247-X.

[8] Mohamed M A ,Tayeh A B ,Aisheh A I Y , et al. Production of novel reinforcing rods of waste polyester, polypropylene, and cotton as alternatives to reinforcement steel rods [J]. REVIEWS ON ADVANCED MATERIALS SCIENCE, 2025, 64 (1): 20250167-20250167. DOI:10.1515/RAMS-2025-0167.

[9] He H ,Wan J ,Liang X . Preparation of styrene-modified polyacrylate emulsion and its application in water-repellent finishing of polyester fabrics [J]. Journal of Coatings Technology and Research, 2025, (prepublish): 1-11. DOI:10.1007/S11998-025-01167-8.

[10] Zhao S ,Xu Z ,Sun J , et al. Investigation of thermal, mechanical and microstructural properties of polypropylene manufactured via multi jet fusion [J]. Journal of Manufacturing Processes, 2025, 155 1086-1096. DOI:10.1016/J.JMAPRO.2025.10.068.

[11] Gerritzen J ,Gröger B ,Zscheyge M , et al. 3D viscoelastic plastic model coupled with a continuum damage formulation for fiber reinforced polymers [J]. Materials & Design, 2025, 260 114969-114969. DOI:10.1016/J.MATDES.2025.114969.

[12] Li R ,Chen Y ,Rao D , et al. Breaking the flame retardancy-mechanical property dilemma in polypropylene composites with simultaneously imparted high thermal conductivity [J]. Chemical Engineering Journal, 2025, 525 170051-170051. DOI:10.1016/J.CEJ.2025.170051.

[13] Chen B ,Hou L ,Yan G R , et al. Flexural Performance and Flexural Toughness Evaluation Method of High-Strength Engineered Cementitious Composites [J]. Buildings, 2025, 15 (21): 4003-4003. DOI:10.3390/BUILDINGS15214003.

[14] Zhang Q ,Li C ,Li G , et al. The Effect of Modification with Nano-Alumina, Nano-Silica, and Polypropylene Fiber on the Frost Resistance of Concrete [J]. Buildings, 2025, 15 (21): 4002-4002. DOI:10.3390/BUILDINGS15214002.

[15] Zou X ,Shi Y ,Lu H , et al. Research on the Impact Performance of Polypropylene Fiber-Reinforced Concrete Composite Wall Panels [J]. Buildings, 2025, 15 (21): 3983-3983. DOI:10.3390/BUILDINGS15213983.

[16] Szymańska J ,Ostrowski A ,Paukszta D . Influence of xylite fibers, reprocessing and free radicals on the properties and structure of polypropylen compoesites [J]. Journal of Polymer Research, 2025, 32 (11): 413-413. DOI:10.1007/S10965-025-04627-2.
[17] Yuan J M ,Zhang F Y . Nucleating agents for polypropylene: a comprehensive review of mechanisms, efficiency, and future perspectives [J]. Journal of Thermal Analysis and Calorimetry, 2025, (prepublish): 1-20. DOI:10.1007/S10973-025-14931-0.
[18] Zhang H ,Cao D ,Wang H . Effect of Polypropylene Fiber on Drying Shrinkage of Geopolymer Concrete and Bond with BFRP Bar [J]. Journal of Materials Engineering and Performance, 2025, (prepublish): 1-23. DOI:10.1007/S11665-025-12561-Z.
[19] Adamu M ,Labib A W ,Haruna I S , et al. Optimizing the fresh and hardened properties of sustainable hybrid date palm and polypropylene fibers using response surface methodology [J]. Sustainable Chemistry and Pharmacy, 2025, 48 102243-102243. DOI:10.1016/J.SCP.2025.102243.
[20] Ahmadi H ,Aghdam H K M ,Pishvari M . Micromechanical study of clay stabilized with nano-Al2O3 particles and reinforced by polypropylene short micro-fibers [J]. Materials & Design, 2025, 260 114982-114982. DOI:10.1016/J.MATDES.2025.114982.
[21] Zhang W ,Cai W ,Chen J , et al. Surface enrichment behavior and properties of polypropylene-grafted poly(hexamethylene guanidine) modified ultrahigh molecular weight polyethylene fibers [J]. Polymer Testing, 2025, 152 109008-109008. DOI:10.1016/J.POLYMERTESTING.2025.109008.
[22] Jin F W ,Xu D W . Effects of fiber and particle shape on the critical state line [J]. Geotextiles and Geomembranes, 2026, 54 (1): 129-135. DOI:10.1016/J.GEOTEXMEM.2025.10.004.
[23] Qiu X ,Wang C ,Gu L , et al. Reactive polyacrylate-modified WPUA IPN coatings covalently integrated with PP-g-NH_2 for strong adhesion to expanded polypropylene [J]. Progress in Organic Coatings, 2026, 211 109719-109719. DOI:10.1016/J.PORGCOAT.2025.109719.
[24] Yaseen H M ,Hashim S F S ,Dawood T E , et al. Impact and abrasion behavior of roller compacted concrete reinforced with different types of fibers [J]. Open Engineering, 2025, 15 (1): 20250107-20250107. DOI:10.1515/ENG-2025-0107.
[25] Mustafayeva F ,Kakhramanov N ,Ismayilov I , et al. Influence of Different Type of Compatibilizers on Structural Features and Physical-Mechanical Properties of Nanocomposites Based on Polypropylene Random Copolymer [J]. Polymer Science, Series A, 2025, 67 (2): 4-4. DOI:10.1134/S0965545X24601163.

Global Academic Frontiers, Vol. 4, Issue 1, 2026, pp. 58-74 Print ISSN 2995-5688 Online ISSN 2995-570X
DOI: https://doi.org/10.5281/zenodo.18937254

Research on Cultural Communication Strategies and Cross-Border Development Paths for New Chinese-Style Children's Wear

Jiayi Ruan [1], Chengen Li [1*], Sixian Lu [2]

[1] College of International Economics & Trade,Ningbo University of Finance & Economics, Ningbo,315175, China
[2] Ningbo University of Finance & Economics, Ningbo,315175, China
*Corresponding author Email:35101060@qq.com
Received 5 January 2026; Accepted 6 February 2026; Published 10 March 2026

Abstract: As a representative carrier that integrates traditional Chinese culture with contemporary design, new Chinese-style Children's wear has become an important medium for disseminating Chinese culture internationally, supported by the rise of the “Guochao” (China Chic) trend and the rapid development of cross-border e-commerce. Drawing upon cultural communication theory, brand internationalization theory, and digital trade theory, this study systematically analyzes the cultural communication mechanisms and market expansion paths of new Chinese-style children's wear in the process of going global. From four dimensions—cultural symbol innovation, cross-border channel adaptation, digital communication, and technological empowerment—the research investigates how this category leverages cultural value and cross-border innovation to realize the transformation from product export to cultural identity transmission.

By examining the overseas practices of leading brands such as Balabala, Youlan, and Li Ning Kids, this study summarizes successful experiences and challenges, and proposes differentiated strategies informed by cultural confidence, offering theoretical and practical insights for the internationalization of children's wear brands. The findings suggest that the global expansion of new Chinese-style children's wear is not merely a commercial activity but a process of transmitting cultural soft power. Going forward, efforts should focus on constructing a children's wear cultural database, enhancing the digital cross-border ecosystem, and strengthening international educational cooperation to transition from “products going global” to “values going global.”

Keywords: New Chinese-style children's wear; Cultural going global; Cross-border e-commerce; Cultural communication; Children's wear brands; Cultural symbols

1. Introduction

1.1 Research Background and Significance

In recent years, the resurgence of traditional Chinese culture and the rise of the Guochao (China-chic) movement have significantly reshaped China’s fashion landscape. New Chinese-style apparel, which synthesizes traditional aesthetics with contemporary design logic, has rapidly expanded within the domestic market and increasingly penetrated global markets via cross-border e-commerce channels. Industry statistics indicate that, in 2023, the market size of new Chinese-style apparel exceeded RMB 1 billion, registering a compound annual growth rate of more than 100% over the preceding three years. Within this broader trend, children’s wear—drawing upon traditional motifs, embroidery techniques, and modern functional design—has emerged as an important vehicle for cultural transmission.

The accelerated development of global digital trade has provided Chinese children’s wear brands with unprecedented opportunities for international expansion. In 2023, China’s cross-border e-commerce exports of apparel continued to grow, with children’s wear achieving rapid market penetration in Southeast Asia, Europe, and the United States. Southeast Asia, due to its cultural proximity and demographic structure, accounted for nearly 90% of exports, whereas Western markets displayed stronger demand for high-end, design-oriented products. Notably, Chinese brands such as Bosideng and HLA have demonstrated that internationalized branding and professionalized operations can substantially enhance brand equity and global recognition.

Despite these favorable conditions, the overseas expansion of new Chinese-style children’s wear remains constrained by several structural challenges. These include cultural distance and the risk of symbolic misinterpretation, product homogenization, rising supply chain and fulfillment costs, and insufficient localization strategies. Consequently, how to integrate cultural narratives, product innovation, and cross-border channel strategies to construct a sustainable competitive advantage in a volatile global environment has become an urgent question for both industry practitioners and academic researchers.

Against this background, the study of how new Chinese-style children’s wear can effectively participate in global markets, function as a carrier of cultural soft power, and facilitate cultural identity construction holds significant theoretical and practical value. It not only contributes to understanding the global dissemination of contemporary Chinese culture but also provides insights into China’s participation in global digital trade and cultural industries.

1.2 Research Questions and Analytical Framework

Focusing on the global expansion and cultural communication of new Chinese-style children’s wear, this study raises the following core research questions:

1. How can new Chinese-style children’s wear achieve effective cross-cultural transmission of cultural meanings through cultural symbol innovation and narrative reconstruction?
2. How can refined cross-border channel operations facilitate both market expansion and brand-building?
3. How can digital communication technologies and technological empowerment enhance cultural dissemination and operational efficiency?
4. What key challenges do brands encounter during overseas expansion, and how can these be addressed through policy support and industry collaboration?

To answer these questions, this study constructs a comprehensive analytical framework that integrates theoretical analysis, current status review, problem identification, strategy formulation, case verification, and policy recommendations. The analysis is structured around four dimensions:

- Cultural Symbol Innovation
- Cross-Border Channel Adaptation
- Digital Communication and Media Technologies
- Technological Empowerment and Systemic Support

This framework enables a multi-level investigation into how cultural content, market mechanisms, and digital technologies jointly shape the internationalization pathways of new Chinese-style children’s wear.

2.Cultural Connotations and Current Status of New Chinese-Style Children’s Wear

2.1 Cultural Connotations of New Chinese-Style Children’s Wear

New Chinese-style children’s wear represents a contemporary reinterpretation of traditional Chinese dress forms, integrating classical aesthetics, intangible cultural heritage techniques, and modern functional design. This category derives its cultural richness from three core dimensions: the modern adaptation of traditional silhouettes,

the inheritance and innovation of traditional craftsmanship, and the contemporary translation of cultural symbols.

(1) Modern Adaptation of Traditional Silhouettes

New Chinese-style children's wear preserves key traditional structures—such as stand-up collars, pankou (frog buttons), and mǎmiànqún (horse-face skirts)—while embedding modern ergonomic and functional refinements. For example:

- Adjustable stand-up collars improve comfort and accommodate children's varying age groups.
- A-line reinterpretations of the horse-face skirt enhance mobility and playability.
- Replacing traditional pankou with snap buttons or Velcro facilitates independent dressing for younger children.

Such adaptations retain the visual logic of traditional Chinese garments while aligning with contemporary standards of comfort, safety, and children's daily activity needs.

(2) Inheritance and Innovation of Intangible Cultural Heritage Techniques

Brands frequently integrate techniques such as Suzhou embroidery (Suzhou Xiu), seed embroidery (dazi xiu), and kesi silk weaving, merging craftsmanship with simplified modern design. For instance, the brand "Hiembroid" incorporates classical patterns such as intertwined peonies and jiangya haishui (stylized ocean wave motifs) using muted color palettes consistent with global aesthetic preferences. This synthesis enhances both the cultural and artistic value of children's wear, positioning these products as culturally expressive rather than purely functional.

(3) Contemporary Translation of Cultural Symbols

New Chinese-style children's wear selectively extracts cultural symbols with universal positive connotations—such as bamboo (fortitude), lotus (purity), and cloud motifs (auspiciousness)—and reinterprets them through contemporary graphic and material languages. This process rejuvenates traditional symbols and enhances cross-cultural communicability, enabling global audiences to engage with these motifs through accessible visual narratives.

2.2 Market Size and Emerging Trends in the Overseas Expansion of New Chinese-Style Children's Wear

2.2.1 Domestic Market Landscape

In 2023, the domestic market for new Chinese-style children's wear exceeded RMB 1 billion, maintaining a three-year compound annual growth rate of over 100%. Projections indicate that the market size will reach RMB 2 billion by 2025, with annual growth rates stabilizing above 30%. New Chinese-style children's wear has become a key segment driven by post-80s and post-90s parents who prioritize both cultural identity and aesthetic refinement in children's clothing.

2.2.2 Cross-Border E-Commerce Export Dynamics

Children's wear accounted for roughly 25% of China's cross-border e-commerce apparel exports in 2023, a growth rate outpacing that of the overall apparel sector. Southeast Asia dominated with approximately 90% of exports due to cultural proximity, whereas Europe and North America accounted for around 8%, yet commanded significantly higher average order values and stronger premium potential.

The rise of platform-led trade ecosystems—such as TikTok Shop, Shopee, and Amazon Global—has accelerated the diffusion of new Chinese-style products worldwide.

2.2.3 Regional Market Characteristics

(a) Southeast Asian Market

Southeast Asian consumers, particularly those in Indonesia, Malaysia, and Thailand, exhibit strong affinity for Chinese aesthetics due to cultural familiarity and the presence of considerable Chinese diaspora communities.

Consumer preferences center on:

- festival-themed apparel (e.g., Lunar New Year collections),
- parent-child coordinated outfits,
- breathable, lightweight fabrics suited to tropical climates.

Sales strategies emphasize a hybrid model combining Lazada/Shopee flagship stores with offline pop-up experiences, forming a "content seeding + experiential retail" closed loop.

(b) European and North American Markets

Western consumers tend to emphasize sustainability, comfort, and minimalist design. While curiosity toward Chinese cultural elements is growing, effective cultural storytelling and aesthetic contextualization remain essential to reducing "cultural discount."

New Chinese-style children's wear in Western markets often leverages:

- Amazon FBA, Etsy boutiques,
- refined product photography and brand storytelling,
- higher willingness-to-pay and premium positioning.

(c) Emerging Markets (Middle East, Latin America)

These markets demonstrate increasing receptivity to culturally distinctive children's apparel but require adjustments in pricing strategies, climate-appropriate materials, and culturally sensitive designs.

2.3 Representative Brands in the Overseas Expansion of New Chinese-Style Children's Wear

(1) Balabala: Localization-First Strategy in Southeast Asia

Balabala, as a leading domestic children's wear brand, implements deeply localized marketing strategies tailored to major Southeast Asian markets. Key approaches include:

- developing festival-specific collections for Ramadan, Eid al-Fitr, and Songkran;
- collaborating with local KOLs to create native-language content;
- integrating TikTok Shop livestreaming with offline pop-up stores.

This approach demonstrates that effective localization—culturally, linguistically, and commercially—is crucial for expanding into culturally proximate markets.

(2) Youlan: Sustainability and Cultural Minimalism for Western Markets

Youlan adopts a differentiated positioning centered on "eco-friendly and comfortable," utilizing bamboo fiber and organic cotton to align with Western sustainability norms. The brand employs:

- minimalist reinterpretations of Chinese cultural elements,
- TikTok content emphasizing material quality and craftsmanship,
- collaborations with parenting influencers to build trust.

This case illustrates the potential of aligning universal values (sustainability) with cultural storytelling to reduce cultural discount and enhance brand premium.

(3) Li Ning Kids: High-End Cultural Branding Through Global Fashion Platforms

Li Ning Kids advances cultural internationalization by integrating Chinese visual symbols—such as ink-wash motifs and calligraphic prints—with sportswear functionality. Its strategic actions include:

- showcasing collections at New York and Paris Fashion Weeks;
- leveraging global fashion media to amplify cultural narratives;
- collaborating with artists and animation IPs to expand cultural relevance.

This case highlights the effectiveness of coupling high-end fashion platforms with cultural innovation to reshape global perceptions of Chinese children's wear.

3.Core Challenges in the Overseas Expansion of New Chinese-Style Children's Wear

3.1 Cultural Distance and Risks of Symbolic Misinterpretation

Cultural distance constitutes a primary challenge for the international expansion of new Chinese-style children’ s wear. The direct transplantation of traditional Chinese motifs into foreign markets may lead to cultural discount, misinterpretation, or even cultural conflict. Motifs that are auspicious in Chinese cultural contexts—such as dragons or phoenixes—can carry religious or political sensitivities in certain regions. Similarly, color symbolism varies cross-culturally: colors associated with celebration in China may connote mourning or taboo elsewhere.

(1) Cultural Discount

Cultural discount refers to the depreciation in value experienced by cultural products when they cross cultural boundaries due to varying interpretive frameworks. Without adequate explanatory narratives or contextualization, international consumers may fail to grasp the cultural meanings embedded in traditional motifs, diminishing the perceived value of the products and weakening brand identity.

(2) Symbolic Misinterpretation

Certain motifs may generate unintended negative associations in specific cultural or religious contexts. For example:

- Animal motifs may conflict with religious sensitivities (e.g., certain Islamic contexts).
- Color symbolism (e.g., white representing purity in China but associated with mourning in some Western cultures).
- Mythological symbols may be misunderstood or oversimplified without proper narrative framing.

Therefore, brands must engage in pre-market cultural research, ensuring the cultural safety and interpretive clarity of design elements.

3.2 Homogeneous Competition and Weak Brand Differentiation

The sector currently suffers from significant product homogenization. Many brands replicate similar design patterns, color palettes, and symbolic elements, leading to undifferentiated market offerings. As a result, price competition intensifies and profit margins erode.

(1) Design Homogenization

Numerous new Chinese-style children’ s wear brands rely heavily on widely available traditional motifs without meaningful reinterpretation. This results in:

- visually indistinguishable collections,
- limited brand recognition,
- reduced consumer loyalty and low repurchase rates.

The absence of original design weakens long-term competitiveness and inhibits the formation of sustainable brand equity.

(2) Lack of Cultural Narrative and Brand Storytelling

A considerable number of brands fail to articulate coherent brand narratives that connect products to cultural meaning. Consequently:

- consumers evaluate products primarily based on price and appearance,
- emotional connection and cultural identification remain weak,
- brands struggle to justify premium pricing.

To overcome this, brands must establish culturally grounded storytelling strategies that reinforce identity, authenticity, and value perception.

3.3 High Supply Chain and Fulfillment Costs

The overseas expansion of new Chinese-style children’ s wear is heavily constrained by escalating supply chain

and logistics costs. Children’ s wear, characterized by high variability in size, seasonal turnover, and relatively high return rates, further intensifies operational pressure.

(1) Rising Cross-Border Logistics and Volatility

International logistics costs remain sensitive to:

- exchange rate fluctuations,
- tariff and trade policy changes,
- energy prices,
- regional geopolitical uncertainties.

High return rates—stemming from size mismatches or expectation gaps—further increase fulfillment costs.

(2) Insufficient Supply Chain Flexibility

Many emerging brands rely on traditional large-batch production models, which struggle to meet the small-batch, multi-SKU, fast-iteration requirements of cross-border e-commerce. Typical challenges include:

- slow response to market demand fluctuations,
- limited production flexibility,
- higher inventory risks,
- inability to support customized product offerings.

Building a flexible, data-integrated supply chain has thus become a critical requirement for global competitiveness.

3.4 Insufficient Localization in Overseas Markets

Localization deficiencies represent a widespread challenge across Chinese brands entering global markets. Without a deep understanding of local consumer behavior, climate patterns, regulatory environments, and cultural norms, brands may encounter mismatches between product design and market expectations.

(1) Divergence in Consumer Preferences

Major differences in consumption habits include:

- Southeast Asian markets prioritize breathability and lightweight materials due to tropical climates.
- Western markets emphasize sustainability, organic materials, and minimalism.
- Middle Eastern markets may require modest design adaptations due to cultural norms.

Brands that fail to align with these expectations risk suboptimal sales performance.

(2) Climate-Specific Adaptation Gaps

Climatic conditions significantly influence preferred materials, garment thickness, and design structure. Misalignment between product attributes and environmental requirements often leads to low conversion rates and high returns.

(3) Lack of Localization in Marketing Content

Many brands rely on direct translations of Chinese marketing content, which often results in:

- culturally incongruent messaging,
- weakened emotional resonance,
- reduced communication effectiveness.

Effective localization requires culturally contextualized narratives, native-language communication, and local influencer engagement.

4.Strategies for Overseas Expansion and Cultural Communication of New Chinese-Style Children’ s Wear

4.1 Innovation of Cultural Symbols and Reconstruction of Narrative Frameworks

4.1.1 Establishing a Dedicated Cultural Symbol System for Children's Wear

To enhance the cross-cultural communicability of new Chinese-style children's wear, it is essential to construct a systematic cultural symbol library specifically tailored to children's apparel. This library should selectively extract traditional elements with universal positive connotations—such as bamboo (fortitude), lotus (purity), and cloud motifs (auspiciousness)—while avoiding culturally sensitive or contextually ambiguous patterns.

(1) Universal Symbol Extraction

Symbols that resonate across cultural boundaries serve as effective vehicles for cross-cultural communication. Motifs with widely recognized positive associations reduce the risk of cultural discount and facilitate intuitive understanding among international consumers. These elements can anchor the brand's visual identity and simultaneously enhance cultural expressiveness without overwhelming foreign audiences.

(2) Avoidance of Culturally Sensitive Patterns

Brands must systematically evaluate the cultural, religious, and socio-political sensitivities of target markets. Certain mythological creatures, colors, or symbolic patterns may evoke conflicting interpretations. Conducting cultural-sensitivity audits and pre-market research ensures that design choices align with local cultural norms while maintaining the authenticity of Chinese cultural expression.

(3) Application of Augmented Reality (AR) to Enhance Cultural Interpretation

AR technology provides an interactive medium for decoding cultural symbols. By scanning garment patterns via mobile devices, consumers can access multimedia narratives detailing the origin, craftsmanship, and cultural significance of specific motifs. This not only enhances consumer engagement but also transforms children's wear into an educational interface that strengthens cultural immersion and experiential learning.

4.1.2 Emotional Storytelling and Scenario-Based Cultural Communication

Cultural narratives embedded in products play a critical role in shaping brand identity and consumer perception. For new Chinese-style children's wear, emotionally resonant storytelling and scenario-based marketing serve as indispensable tools for constructing cultural meaning and generating cross-cultural empathy.

(1) Cultural Storytelling Through Digital Media

Short-form video platforms and key opinion leaders (KOLs) can narrate cultural stories behind design elements—such as the significance of the Twenty-Four Solar Terms—thus enabling consumers to emotionally connect with the symbolic meaning of the garments. These narratives bridge cultural gaps by transforming abstract symbols into relatable stories.

(2) Scenario-Based Marketing to Enhance Cultural Immersion

Product lines designed for specific scenarios—such as Lunar New Year celebrations, family gatherings, or school ceremonies—anchor cultural meaning within everyday practices. Scenario-based marketing not only reinforces the cultural utility of children's wear but also enhances emotional relevance and practical applicability.

(3) Parent–Child Co-Wearing and Interactive Experience Design

Developing coordinated parent–child outfits fosters intergenerational cultural identity-making. Such designs encourage parents and children to co-experience cultural aesthetics, strengthening both familial bonds and the cultural symbolic value of the garments. Parent–child participation amplifies brand recall and enhances cultural embedment in daily life.

4.2 Refined Cross-Border Channel Operations

4.2.1 Platform Coordination and Differentiated Market Operations

New Chinese-style children's wear must adopt platform-specific strategies based on the attributes and consumer behavior dynamics of different global regions.

(1) Southeast Asia: Social Commerce and Localized Operations

Platforms such as TikTok Shop, Shopee, and Lazada dominate the Southeast Asian digital ecosystem. Effective strategies include:

- partnerships with local KOLs and micro-influencers,
- localized content using native languages,
- integration of local payment and logistic systems.

This approach enables culturally congruent engagement with consumers and enhances conversion rates in culturally familiar markets.

(2) Europe and North America: Amazon and Boutique Platforms

For Western markets, Amazon FBA and Etsy offer structured logistics and high-quality consumer bases. Strategies should emphasize:

- minimalist yet culturally expressive designs,
- premium positioning supported by refined design language,
- storytelling that contextualizes Chinese aesthetics within universal values such as sustainability or craftsmanship.

(3) Emerging Markets: Adaptability and Market Entry Flexibility

Middle Eastern and Latin American markets require flexible pricing strategies, sensitivity to cultural norms, and adaptation to local climatic conditions. Leveraging regional influencers and collaborating with localized marketplaces accelerates initial market penetration.

4.2.2 Experience Enhancement and Omnichannel Integration

Building an integrated omni-channel system enhances consumer engagement, strengthens brand loyalty, and improves overall shopping experience.

(1) Virtual Try-On Technologies

Virtual fitting rooms allow consumers to visualize garment fit and styling effects in real time, reducing uncertainty and return rates. This technology is especially effective in size-sensitive categories such as children’ s wear.

(2) Offline Pop-Up Stores for Immersive Cultural Experiences

Pop-up spaces can incorporate:

- traditional festival themes,
- interactive cultural workshops,
- live demonstrations of craft techniques.

These immersive experiences reinforce cultural identity and create emotional touchpoints that cannot be replicated online.

(3) Unified Omnichannel Membership Ecosystem

By integrating consumer data across online and offline channels, brands can establish a unified membership system that supports:

- personalized recommendations,
- cross-channel rewards,
- targeted promotional strategies,
- enhanced retention and repurchase rates.

4.3 Digital Communication and Technology-Driven Empowerment

4.3.1 Short-Video Ecosystems and Livestream Commerce

Short-video platforms have become critical tools for global cultural dissemination and consumer engagement.

(1) Multi-Layered Content Matrix

Brands can build a layered content structure composed of:

- official brand accounts,
- KOL and influencer collaborations,
- user-generated content (UGC).

This matrix enhances multi-directional communication and increases consumer touchpoints.

(2) Livestream Commerce for Accelerated Conversion

Livestreaming facilitates real-time interaction and contextualized explanations of garment features, cultural symbolism, and craftsmanship. Participation of designers, artisans, or child development experts may enhance trust and elevate the perceived cultural value of the products.

(3) Encouraging User-Generated Content

Engaging consumers through challenges, contests, and experiential sharing cultivates organic brand advocacy. UGC amplifies reach and reinforces community-based cultural diffusion.

4.3.2 AI-Enabled Customization and Data-Driven Operations

AI technologies provide robust analytical and customization capabilities for children’ s wear brands.

(1) AI-Driven Customization (C2M)

AI can analyze demographic data, body measurements, cultural preferences, and style inclinations to support:

- personalized size recommendations,
- custom pattern selection,
- on-demand production.

This reduces inventory pressure while enhancing consumer satisfaction.

(2) Data-Driven Product Development

Big-data analysis of global consumer behavior, regional cultural preferences, and competitor dynamics helps optimize product line planning, color selection, and size distribution.

(3) Precision Marketing

Algorithmic recommendation models enhance advertising efficiency by connecting culturally relevant content with appropriate user segments in different markets.

4.3.3 Green Supply Chains and Sustainability-Oriented Innovation

Sustainability is increasingly important in global apparel markets.

(1) Use of Environmentally Friendly Materials

Brands can utilize bamboo fiber, organic cotton, and recycled textiles to align with global environmental standards, as exemplified by Youlan’ s eco-centric product strategy.

(2) Adoption of Green Production Processes

Implementing low-water dyeing technologies, environmentally friendly pigments, and energy-efficient production systems reduces carbon emissions and environmental impact.

(3) Circular Economy Models

Exploring recycling programs, second-hand trading platforms, and rental models extends product life cycles and reinforces sustainable brand identity.

4.4 Policy Support and Industry-Level Collaboration

4.4.1 Governmental Support Mechanisms

Governmental departments can play a key role in facilitating internationalization through:

- cross-border e-commerce subsidies,
- streamlined customs procedures,
- enhanced intellectual property protection,
- cultural-export program integration.

Supporting participation in international exhibitions, fashion weeks, and cultural forums enhances global visibility for Chinese children’ s wear.

4.4.2 Industry Collaboration and Shared Infrastructure

A collaborative industry environment can reduce costs and strengthen collective competitiveness.

(1) Establishment of Industry Standards

Developing design guidelines, safety standards, and environmental certification frameworks increases trust and reduces consumer risk perceptions.

(2) Creation of Public Design Resource Platforms

Shared platforms hosting:

- pattern libraries,
- silhouette databases,
- digital design resources,
- material innovation databases

can improve design efficiency and foster innovation across the industry.

(3) Industry–Academia–Research Collaboration

Partnerships between brands, universities, and research institutions enable:

- culturally grounded design research,
- advanced material development,
- cross-cultural consumer studies.

These collaborations support long-term innovation and global strategic capability.

5.Case Analyses and Practical Implications

5.1 Balabala: Deep Localization in Southeast Asian Markets

Balabala, one of China’ s leading children’ s wear brands, demonstrates a comprehensive localization strategy that effectively aligns product offerings and communication approaches with the cultural, religious, and consumer behavior characteristics of Southeast Asian markets. Its experience illustrates how cultural adaptation and market-specific strategies can jointly enhance cross-border competitiveness.

(1) Market Strategy: Cultural Adaptation Through Festival-Oriented Design

Balabala systematically analyzes the unique cultural and religious landscapes of major Southeast Asian markets such as Indonesia, Malaysia, and Thailand. The brand develops festival-specific collections—including those for Ramadan, Eid al-Fitr, and Songkran—integrating modesty-oriented silhouettes, breathable fabrics, and culturally aligned motifs. This dual strategy of “cultural adaptation + festival marketing” significantly improves resonance among local consumers.

(2) Channel Strategy: Digital-First Engagement and Experiential Retail

The brand adopts an omni-platform strategy:

- Establishing flagship stores on Lazada and Shopee
- Implementing TikTok Shop livestream commerce
- Deploying offline pop-up stores in high-traffic commercial zones

This hybrid model of “online awareness-building + offline experiential verification” enhances trust and

accelerates purchase decisions. Livestream formats featuring try-on demonstrations, parent–child interactions, and cultural storytelling further reinforce user engagement.

(3) Practical Implications

Balabala's experience demonstrates that successful overseas expansion of new Chinese-style children's wear requires:

- deep localization rather than superficial cultural translation,
- fine-grained segmentation aligned with religious and festival cycles,
- ecosystem-based channel orchestration combining social commerce and offline interaction.

This case confirms the importance of culturally embedded product strategies and localized marketing infrastructures for Southeast Asian markets.

5.2 Youlan: Dual Positioning of Sustainability and Cultural Minimalism in Western Markets

Youlan adopts a differentiated brand strategy that aligns with Western consumers' preferences for sustainability, comfort, and minimalist aesthetics. Unlike brands that emphasize ornate traditional motifs, Youlan emphasizes understated reinterpretations that subtly communicate Chinese cultural identity.

(1) Product Strategy: Eco-Friendly Materials and Minimalist Aesthetics

Youlan's brand identity centers around "eco-friendly + comfortable." The brand employs bamboo fiber, organic cotton, and sustainable dyeing processes, aligning itself with growing Western interest in:

- environmentally conscious consumption,
- natural and hypoallergenic materials,
- minimalist and functional design.

Traditional Chinese elements are incorporated through simplified motifs and soft color palettes, avoiding cultural overload and improving cross-cultural acceptance.

(2) Content Strategy: Transparency and Trust Building Through Digital Media

Youlan leverages TikTok and YouTube to produce content that emphasizes:

- material transparency (e.g., fiber origin, production processes),
- craftsmanship demonstrations,
- real-life wearability shared by parenting influencers.

This reinforces authenticity and enhances consumer trust in both quality and cultural sincerity.

(3) Practical Implications

Youlan's success demonstrates that:

- combining universal values (sustainability) with cultural expressiveness significantly reduces cultural discount,
- minimalist reinterpretations can enhance aesthetic compatibility with Western markets,
- content transparency is essential for building trust in global markets increasingly concerned with ethical consumption.

This case highlights the value of cultural minimalism and sustainability-driven branding in high-end Western markets.

5.3 Li Ning Kids: High-End Cultural Branding Through Global Fashion Platforms

Li Ning Kids represents a high-end cultural branding model that leverages global fashion platforms to reconfigure the global perception of Chinese children's wear. Rather than competing solely within the mass market, the brand positions itself as a culturally innovative and fashion-oriented entity.

(1) International Fashion Week Exposure: Cultural Innovation on Global Stages

By showcasing collections at major international fashion events such as New York and Paris Fashion Weeks, Li

Ning Kids presents design narratives that combine:

- Chinese ink-wash aesthetics,
- calligraphic visual elements,
- functional sportswear technologies.

This strategy elevates Chinese cultural imagery from traditional craft-based associations to contemporary, fashion-forward expressions.

(2) Cross-Sector Collaborations and IP-Based Cultural Expansion

The brand collaborates with animation IPs, contemporary artists, and youth culture designers to produce culturally hybrid collections that appeal to young global consumers. These cross-disciplinary collaborations:

- expand brand cultural relevance,
- enhance fashion appeal,
- promote cultural "breakthrough" beyond traditional categorizations.

(3) Practical Implications

The Li Ning Kids case demonstrates that:

- presenting new Chinese-style aesthetics on global fashion stages positions Chinese brands at the forefront of cultural creativity rather than traditionalism;
- cross-sector collaboration can enrich cultural narratives and broaden audience reach;
- high-end cultural branding enables price premium and enhances global symbolic capital.

This case underscores the potential of integrating cultural innovation with fashion-based global communication channels.

5.4 Synthesis of Case Insights

Across the three representative brands, several cross-cutting insights emerge:

(1) Cultural Strategies Must Be Market-Specific

Different regions require distinct cultural translation strategies:

- Southeast Asia → cultural familiarity + festival adaptation
- Western markets → sustainability + minimalist cultural design
- Global fashion markets → high-end cultural innovation

This validates the need for contextualized cultural communication rather than one-size-fits-all approaches.

(2) Digital Platforms Are Central to Cultural Transmission

Successful brands utilize:

- short-video ecosystems,
- livestream commerce,
- influencer networks,
- transparency-centered content.

Digital media not only sells products but also educates consumers and constructs cultural meaning.

(3) Localization Is a Structural Capability, Not a Tactic

Localization is reflected in:

- product design,
- supply chain flexibility,
- language adaptation,
- narrative framing,
- channel orchestration.

Sustained overseas success requires localization to be embedded into the organizational structure rather than executed as isolated marketing efforts.

(4) Cultural Innovation Enhances Brand Premium and Reduces Cultural Discount

By transforming traditional Chinese elements into globally legible design languages, brands can shift consumer perception from "ethnic specialty products" to "high-end cultural fashion," increasing symbolic capital and pricing power.

6.Conclusion and Future Directions

6.1 Research Conclusions

Drawing upon cultural communication theory, brand internationalization theory, and digital trade theory, this study systematically examined the cultural communication mechanisms and global market expansion pathways of new Chinese-style children's wear. The major conclusions are as follows:

(1) New Chinese-style children's wear has become a significant medium of contemporary Chinese cultural export.

By integrating traditional silhouettes, intangible cultural heritage techniques, and modern aesthetic principles, new Chinese-style children's wear enables cultural meanings to be reencoded and transmitted across cultural boundaries. The domestic market surpassed RMB 1 billion in 2023 and is projected to reach RMB 2 billion by 2025, reflecting its rapid growth and strong cultural-commercial potential.

(2) Cross-border e-commerce serves as a critical infrastructure for global expansion.

In 2023, children's wear accounted for approximately 25% of China's cross-border apparel exports, outpacing overall sector growth. Southeast Asia contributes nearly 90% of total exports due to cultural affinity, while Europe and North America—though smaller in scale—offer higher unit prices and strong potential for premium positioning. The rise of platform ecosystems (e.g., TikTok Shop, Shopee, Amazon) accelerates cultural diffusion and commercial scalability.

(3) Cultural communication and brand-building are the core sources of competitive advantage.

Successful cases—such as Balabala, Youlan, and Li Ning Kids—demonstrate that emotional storytelling, localized operations, sustainability alignment, and high-end cultural innovation can effectively reduce cultural discount, enhance symbolic value, and strengthen global brand identity.

(4) Policy frameworks and industry collaboration constitute essential external support.

Governmental measures—such as cross-border trade facilitation, intellectual property protection, and cultural export initiatives—provide foundational support for brand internationalization. Industry-level collaboration, including design standardization, resource-sharing platforms, and industry–academia partnerships, enhances overall sector competitiveness.

6.2 Theoretical Contributions and Practical Implications

(1) Theoretical Contributions

This study makes three main contributions to existing literature:

a. Integration of cultural communication theory with apparel internationalization research

By bridging cultural semiotics with design studies and global marketing theory, the study constructs a cultural symbol–narrative–market adaptation framework tailored to children's wear, enriching cross-disciplinary research on cultural products.

b. Expansion of brand internationalization theory into the domain of cultural-fashion hybrid goods

Through analysis of differentiated market-entry strategies and localization mechanisms, the study contributes to understanding how culturally embedded products navigate global markets.

c. Advancement of digital trade scholarship through the lens of culturally expressive apparel

The research highlights the roles of short-video ecosystems, livestream commerce, AI-driven customization, and digital storytelling in shaping cross-cultural consumption patterns.

(2) Practical Implications

The findings provide actionable guidance for practitioners:

a. Cultural Symbol Innovation

Brands should build dedicated symbol libraries, apply AR-based interpretive technologies, and develop culturally coherent narratives to enhance cross-cultural meaning-making.

b. Market-Specific Cross-Border Strategies

Different regional markets require distinct operational models:

- Southeast Asia → cultural affinity + festival adaptation
- Europe & U.S. → sustainability + minimalist cultural reinterpretation
- Global fashion markets → high-end cultural branding

c. Technological Empowerment

AI-driven customization (C2M), big-data analytics, and virtual try-on technologies support refined operations, reduce inventory risks, and improve consumer satisfaction.

d. Sustainability as a Value Proposition

Green supply chains, eco-friendly materials, and circular economy models enhance global competitiveness and align with global sustainability norms.

6.3 Research Limitations and Future Prospects

Despite its contributions, this study has several limitations:

(1) Limited empirical data

The analysis relies primarily on qualitative methods, including case studies and literature review. Large-scale quantitative data and cross-country surveys are needed to validate the identified patterns.

(2) Absence of a systematic cultural acceptance assessment model

While cultural discount and symbolic misinterpretation are discussed, the study does not construct a comprehensive quantitative model for evaluating cultural acceptance across different regions.

(3) Insufficient differentiation across regional cultural clusters

More granular analyses—such as between Northern vs. Southern Europe, or between Muslim-majority vs. multicultural Southeast Asian markets—could deepen understanding of cultural adaptation mechanisms.

(4) Lack of longitudinal assessment

The study does not evaluate the long-term outcomes of policy interventions or the sustainability of internationalization strategies over time.

6.4 Future Research Directions

Future research may be extended in the following directions:

(1) Development of a global cultural database for new Chinese-style children’ s wear

Such a database could support design standardization while enabling innovation through structured cultural resources.

(2) Exploration of blockchain and digital governance mechanisms

Technologies such as blockchain could protect design copyrights, support traceability, and reinforce trust within cross-border ecosystems.

(3) Strengthening international educational cooperation

Through cultural workshops, museum collaborations, and children’ s cultural-exchange programs, the symbolic value of Chinese children’ s wear can evolve beyond product-level diffusion toward value-level cultural transmission.

(4) Quantitative studies on cross-cultural aesthetic perception

Using surveys, psychometric methods, or eye-tracking experiments, future research can measure how international consumers perceive traditional Chinese motifs, improving data-driven design decisions.

Conclusion: Through cultural empowerment, digital innovation, and strategic adaptation, new Chinese-style children’ s wear has strong potential to become a prominent medium of contemporary Chinese cultural export. As global consumer interest in cultural diversity, sustainability, and digital-native experiences continues to grow, Chinese children’ s wear brands are well positioned to achieve both commercial expansion and cultural influence in the international arena.

References

[1]Jia, X. Z. (2025). From “application of Chinese elements” to “construction of aesthetic system”: Cultural translation path of New Chinese-style clothing design. Decoration, (1), 56–61.

[2]Fang, H. (2024, June 5). Digital trade and innovation in cultural expression. Guangming Daily.

[3]Lu, M. H., & Yu, Z. J. (2024). Exploration and practice of “New Chinese-style” embroidered clothing. Craftsmanship and Artistry, (2), 34–38.

[4]Wang, J. (2025). Enhancing market competitiveness of clothing brands under e-commerce models. Chemical Fiber and Textile Technology, (3), 45–49.

[5]Nie, Y. H. (2024, November 20). Clothing brands rush to go global: Cross-border e-commerce platforms increase support. Securities Times.

[6]Gan, L., et al. (2025). Southeast Asian cross-border e-commerce clothing operation strategy based on cultural adaptation. Western Leather, (1), 78–82.

[7]Modern Silk Science and Technology. (2016). Practical application of traditional cultural elements in modern children’s clothing design. Modern Silk Science and Technology, (4), 23–26.

[8]Chen, B. J., Chen, J. S., Xiao, J., Qiu, H. Y., & Lie, Y. J. (2019). Export-oriented cross-border social e-commerce model in Southeast Asia: A case study of Foshan specialty children’s clothing. International Business & Trade, (2), 113–118.

[9]Feng, P. L. (2023). Digital marketing strategy of Chinese cross-border e-commerce enterprises in Southeast Asia: A case study of SHEIN [Doctoral dissertation, Hebei University of Economics and Business].

[10]Liu, Z. L., & Xiang, C. H. (2025). International marketing strategy and cultural communication of New Chinese-style clothing: Case study of Juzui at New York Fashion Week. Journal of Hunan International Economics University, (1), 45–50.

[11]Originality Documentation. (2025). Ten-year analysis of the children’s clothing industry in 2025: Multicultural and inclusive design industry report [Report].

[12]MBA Think Tank Documentation. (2024). Cross-border expansion strategies of Chinese-style children’s clothing brand stores (2025–2030) [Report].

[13]Brand Children’s Clothing Wholesale / Zhili Children’s Clothing Wholesale. (2025). Panorama of China’s children’s clothing foreign trade procurement 2025: From supply chain advantages to global opportunities [Report].

[14]Sichuan Provincial Department of Economy and Information Technology. (2025). Reply letter on Proposal No. 0741 of the Third Session of the 13th Sichuan Provincial Committee of the Chinese People’s Political Consultative Conference [Government document].

[15]Ministry of Industry and Information Technology, et al. (2025). Measures to enhance supply-demand adaptability of consumer goods and further promote consumption [Government document].

[16]Cheon, B. K., Christopoulos, G. I., & Hong, Y. Y(2016). Cultural Symbolism and Spatial Separation.Journal of Cross-Cultural Psychology, 47(10), 1109-1129.

[17]Yang, D. Y. J., Chen, X., Xu, J., Preston, J. L., & Chiu, C.Y. (2016).Understanding Exclusionary Reactions Toward a Foreign Culture. Journal of Cross-Cultural Psychology, 47(10), 1130-1148.

[18]Shi, Y., Shi, J., Luo, Y. L. L., & Cai, H. (2016).Polycultural Psychology. Journal of Cross-Cultural Psychology, 47(10), 1149-1168.

[19]Morris, M. W., Chiu, C. Y., & Liu, Z. (2015). Brand Concepts as Representations of Human Values: Do Cultural Congruity and Compatibility Between Values Matter? Annual Review of Psychology, 66, 249-275.

[20]Chiu, C. Y., Kwan, L. Y. Y., & Liou, S. (2013).Culturally Motivated Challenges to Innovations in Integrative Research: Theory and Solutions. Social Issues and Policy Review, 7(1), 1-28.

[21]Han, G., & Li, F. (2025). Digital Economy of Trading Partner Countries, Outward Investment, and Cross-Border

E-commerce Exports. Finance Research Letters, 85(Part B), 108034.
[22]Design and Culture. (2023). Design and Culture:The Journal of the Design Studies Forum, 15(1). Taylor & Francis.
[23]Adams, B., & Traganou, J. (Eds.). (2025). Design and Culture: Special Issue on Fashion and Cultural Identity. Taylor & Francis.
[24]Morris, D. (1977). Manwatching: A Field Guide to Human Behavior. Harry N. Abrams.
[25]Hollander, A. (1993). Seeing Through Clothes.University of California Press.
[26]Barnard, M. (2002). Fashion as Communication.Routledge.
[27]Kawamura,Y. (2005). Fashion-ology: AnIntroduction to Fashion Studies. Berg Publishers.
[28]Entwistle, J. (2000). The Fashioned Body: Fashion, Dress and Modern Social Theory. Polity Press.
[29]Crane, D. (2000). Fashion and Its Social Agendas:Class, Gender, and Identity in Clothing. University of Chicago Press.
[30]Wilson, E. (2003). Adorned in Dreams: Fashion and Modernity. I.B. Tauris.

Global Academic Frontiers

Volume 4 • Issue 1 • March 2026

ISSN 2995-5688

Free Copy