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Research on the Integrated Development Pathways of Cross-border E-commerce and Characteristic Industrial Belts Based on an Ecosystem Model

Qiongqiong Zhang

Wenzhou Polytechnic, Wenzhou 325000, China

ABSTRACT

Against the backdrop of the escalating China-US trade war and the accelerated restructuring of global supply chains, the integrated development of cross-border e-commerce and characteristic industrial belts has become an important pathway to respond to external shocks and promote high-quality regional economic development. This study integrates business ecosystem theory and the Analytic Network Process (ANP) to construct a cross-border e-commerce ecosystem model comprising diverse populations, internal factors and external environment. Through Grounded theory and expert interviews, key internal factors and external environment influencing the integration of cross-border e-commerce and characteristic industrial belts have been identified. The ANP model quantifies the impact weights of each factor, revealing that credit risk management and platform services are the most critical driving factors. This study proposes policy recommendations including strengthening credit risk management and compliance capabilities, upgrading platform services and digital supply chains, promoting brand transformation of industrial belts, and deepening industry-education integration to cultivate composite talents. These findings provide theoretical references and decision-making support for regions with high foreign trade dependence to cope with trade frictions and achieve industrial belt transformation and upgrading.

KEYWORDS

Cross-border e-commerce; Characteristic industrial belt; Ecosystem mode; Trade war; Analytic Network Process (ANP)

1. INTRODUCTION

In recent years, cross-border e-commerce has become a new engine for China's foreign trade growth and an important driver of industrial upgrading. By leveraging the manufacturing base of specialized industrial clusters, enterprises in cross-border e-commerce have transitioned from "product export" to "brand export" and to "supply chain export". However, in 2025, the Trump administration further escalated tariff war against China, leading to a sharp increase in the comprehensive tax rate on Chinese goods exported to the United States. Cross-border e-commerce enterprises primarily targeting the U.S. market face severe challenges such as soaring costs, order losses, and profit margin compression. The trade war not only exacerbates international market uncertainty but also forces traditional industrial belts to transform from a "low-price, volume-driven" model to a "branding + digitalization" approach. In this context, the question of how to systematically build an integrated development ecosystem for cross-border e-commerce and characteristic industrial belts, identify key influencing factors, and design response pathways has become a major practical issue that local governments and enterprises urgently need to address.

Existing research has accumulated some findings on the relationship between cross-border e-commerce and industrial clusters. Li Fang et al. analyzed the synergistic relationship between cross-border e-commerce and industrial clusters from a system theory perspective [1]; Yang Lihua et al. examined the development status of cross-border e-commerce and manufacturing clusters in China [2]; Wei Dayu explored the industrial agglomeration issue in cross-border e-commerce comprehensive pilot zones [3]; Jin Zehu studied the promoting effect of digital trade on the high-quality development of the manufacturing industry [4]. However, most existing studies neglect two key points: first, research incorporating major external shocks such as trade wars into the analytical framework is notably scarce; second, quantitative modeling of the integrated development of cross-border e-commerce and characteristic industrial belts from an ecosystem perspective is lacking. Therefore, this study, based on business ecosystem theory, constructs a cross-border e-commerce ecosystem model against the background of the trade war and uses the Analytic Network Process (ANP) to quantify the weights of influencing factors, thereby proposing targeted policy recommendations.

2. THEORIES AND ASSUMPTIONS

2.1. Business Ecosystem Theory and Its Applicability

American scholar James F. Moore (1993) proposed the business ecosystem theory, arguing that enterprises are no longer isolated competitive entities but together with suppliers, customers, governments, and research institutions form an interdependent and co-evolving ecosystem [5]. The ecosystem model emphasizes that system actors achieve dynamic adaptability through resource flow, information sharing, and value co-creation. This theory has been widely applied in fields such as regional economy [6], platform economy [7], and industrial collaboration [8].

The integration of cross-border e-commerce and characteristic industrial belts is essentially a complex system involving multiple actors and elements. Introducing the ecosystem model into this field allows systematic analysis of the interactions among industrial belt enterprises, cross-border e-commerce platforms, governments, logistics and payment service providers, and research institutions, as well as the impact mechanisms of external environments (especially the trade war) on system operation. Based on this, this study constructs a cross-border e-commerce ecosystem model under the trade war background.

2.2. Definition and Classification of Ecosystem Model Elements

Through systematic literature review and field research, this paper defines and classifies the elements of the cross-border e-commerce and characteristic industrial belt ecosystem model.

2.2.1. Ecosystem Members

The cross-border e-commerce and characteristic industrial belt ecosystem includes four major populations: keystone population, key population, supporting population, and parasitic population.

Key populations, serving as the core driving force of the entire ecosystem, include specialized industrial belt manufacturers (sellers) and overseas buyers (purchasers). Manufacturing enterprises provide product supply, manufacturing capabilities, and supply chain foundations, while overseas buyers provide market demand and order sources. The supply-demand matching and transactional interaction between them constitute the fundamental driving force of ecosystem operation.

The keystone population serves as the organizational and coordination center of the cross-border e-commerce ecosystem, namely cross-border e-commerce platforms such as Amazon, Alibaba International Station, Temu, and TikTok Shop. These platforms not only undertake information

transmission and transaction matching functions but also act as ecosystem "coordinators" and "facilitators", integrating resources and guiding the healthy development of the ecosystem.

The supporting population mainly includes cross-border logistics enterprises, cross-border payment institutions, network communication enterprises, and regulatory authorities such as customs. These are key supporting links for realizing cross-border e-commerce transactions. Logistics enterprises provide physical flow guarantees through warehousing and distribution, payment institutions provide financial support through fund settlement, and regulatory authorities provide institutional guarantees through policies such as customs clearance and tax rebates, collectively building a systematic support network for the ecosystem.

The parasitic population includes third-party service institutions providing specialized services such as translation, marketing, training, certification, data analysis, and software development. Although these populations are not essential for cross-border e-commerce transactions, they rely on other populations and provide services to them, thereby improving ecosystem operational efficiency and promoting more specialized and refined development.

2.2.2. Internal Factors

Internal factors are the intrinsic driving forces for the continuous operation and evolution of the cross-border e-commerce and characteristic industrial belt ecosystem. They are influenced by the external environment and directly affect the interaction and synergy efficiency among ecosystem members. These factors are interrelated and mutually reinforcing, collectively forming a dynamic support network. Six key dimensions are identified:

Credit Risk Management covers mechanisms such as government regulation, consumer complaint handling, platform supervision, and insurance protection. It effectively controls various risks in cross-border transactions and serves as the core safeguard for reducing transaction uncertainty.

Platform Services integrate comprehensive service platforms, public service platforms, and customs clearance service platforms, providing one-stop convenience for both buyers and sellers, and serving as a key carrier for improving transaction efficiency.

Cross-border Logistics facilitates the cross-border flow of goods, involving logistics informatization, electronic customs clearance, overseas warehouses, reverse logistics, etc. It is an indispensable channel for achieving cross-border e-commerce operational goals.

Cross-border Payment promotes the free cross-border flow of funds, covering electronic payment, cross-border investment and financing, and RMB internationalization, which helps reduce transaction settlement time and enhance the vitality of small and medium-sized enterprises.

Talent cultivation, which continuously supplies high-quality cross-border e-commerce talents to industrial belts through talent cultivation systems, innovation and entrepreneurship support systems, and talent service systems, serves as the intellectual source for the sustainable development of the ecosystem.

International online marketing, which focuses on product and brand building, marketing channel expansion, and market segmentation, helps manufacturing products go global and serves as the core means to enhance the brand influence and market competitiveness of the ecosystem.

These six dimensions do not exist in isolation but interact and synergize to drive cross-border e-commerce and characteristic industrial belts from simple connection to deep integration, achieving the ecological integration of product chains, supply chains, value chains, and innovation chains.

2.2.3. External Environment

The ecosystem environment includes six aspects: policy environment, economic environment, political environment, technological environment, socio-cultural environment, and natural geographical environment. National policy orientations in cross-border e-commerce pilot zones, tax

incentives, and customs clearance facilitation directly affect the level of support and the pathways for integrated development; the structural characteristics of local economies and dynamic demands for industrial upgrading give rise to differentiated integration forms and priority areas. The political environment, especially tariff barriers and geopolitical risks under the trade war background, is becoming a key variable affecting the integration of cross-border e-commerce and industrial belts, directly impacting corporate costs and market layouts. In terms of the technological environment, rapid developments in payment technology, logistics technology, big data, and artificial intelligence not only improve transaction efficiency but also drive industrial belts toward digital and intelligent transformation. The socio-cultural environment, including cross-cultural understanding, consumer preferences, and education levels, subtly influences corporate overseas strategies and talent reserves. The natural geographical environment affects logistics costs and timeliness through geographical distance and port conditions. These external environmental factors interact and change dynamically, jointly shaping the external conditions and evolutionary direction of the integrated development of cross-border e-commerce and characteristic industrial belts.

Table 1. Elements of the Cross-border E-commerce Ecosystem Model

Main Category	Sub-category	Corresponding Nodes in Integration of Cross-border E-commerce and Industrial Belts
Ecosystem Members	Keystone population	Cross-border e-commerce platforms
	Key population	Industrial belt enterprises, overseas buyers
	Supporting population	Logistics enterprises, payment institutions, customs/tax authorities, telecom operators
	Parasitic population	Third-party service agencies
Internal Factors	Credit risk management	Government regulation, consumer complaints, platform supervision, insurance protection
	Platform services	Comprehensive service platform, public service platform, customs clearance platform
	Cross-border logistics	Logistics informatization, electronic customs clearance, overseas warehouses, reverse logistics
	Cross-border payment	Electronic payment, cross-border investment and financing, RMB internationalization
	Talent cultivation	Talent cultivation system, innovation & entrepreneurship support, talent service system
	International online marketing	Product & brand, marketing channels, market segmentation
External Environment	Policy environment	Cross-border e-commerce pilot zone policies, RCEP, 9810/9610 pilot programs
	Economic environment	Industrial belt structure, exchange rates, global market demand
	Technological environment	Digital technology, smart logistics, AI marketing
	Political environment	Trade war, tariff barriers, geopolitical risks
	Socio-cultural environment	Cross-cultural communication, consumer habits, education level
	Natural geography	Distance to major markets, port conditions

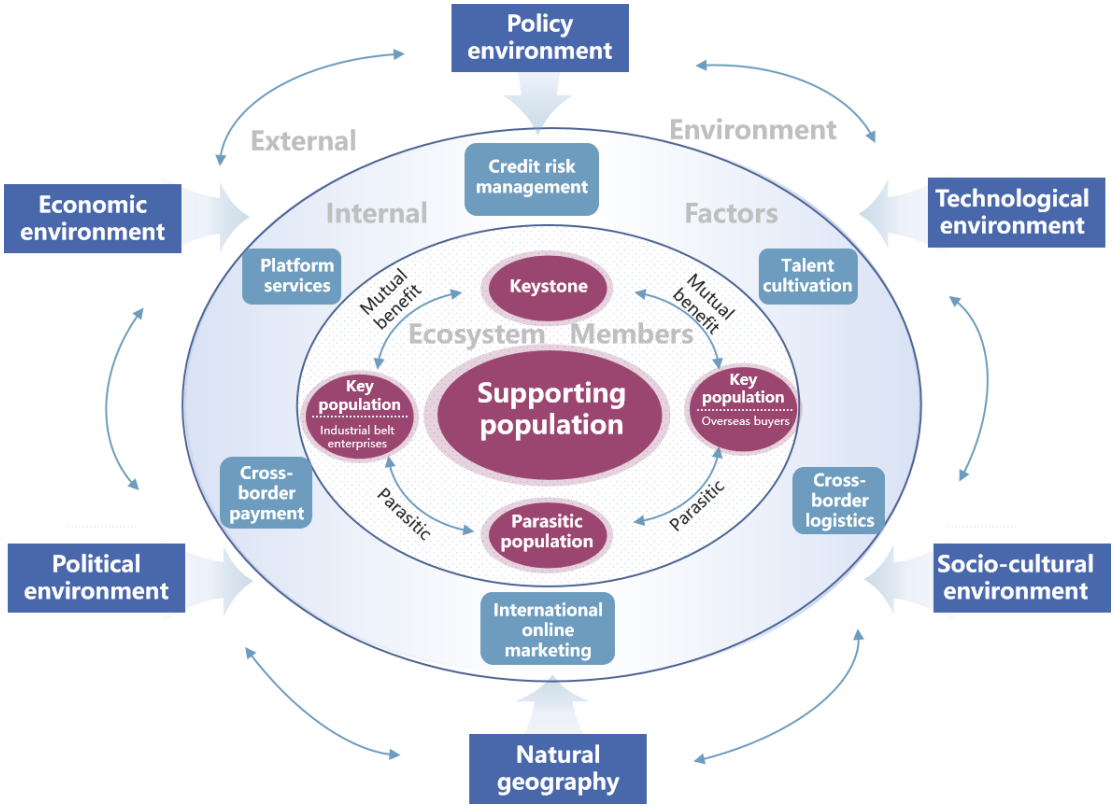

Figure 1. Cross-border E-commerce and Characteristic Industrial Belt Ecosystem Model under Trade War Background

3. ANALYSIS AND RESULTS

To systematically analyze the complex interdependencies and feedback relationships among multiple factors in the cross-border e-commerce ecosystem and scientifically quantify their comprehensive impact weights, this study adopts the Analytic Network Process (ANP) [9]. ANP is an effective tool for complex system decision-making. Its core advantage lies in overcoming the limitation of traditional AHP which requires factors to be independent, allowing and quantifying the network-like mutual influence relationships among factors. Through a rigorous mathematical process, this method transforms expert empirical judgments into quantitative descriptions of complex network relationships, effectively revealing the true influence of each element within the system, thus providing explanatory decision-making basis for identifying key driving paths and optimizing system structures. ANP has been widely applied in research areas involving complex feedback relationships, such as influencing factor analysis [10] and system evaluation [11].

3.1. ANP Model Construction

The main factors influencing the integrated development of cross-border e-commerce and characteristic industrial belts are the ecosystem environment and internal factors. The environmental factors of the ecosystem are largely macro-level conditions, which tend to change slowly and with difficulty; therefore, this study assumes that the environmental factors are independent of each other and can serve as the criterion layer of the network structure model. Natural geographical environmental factors are immutable and thus excluded from the criterion layer of the network structure model. Internal factors directly affect members of the cross-border e-commerce and industrial belt ecosystem, and these factors are closely related and mutually influential, thus forming the network layer of the network structure model. Through data review and expert opinions, this study

ultimately determines the interaction matrix and constructs the network structure model, as shown in Figure 2.

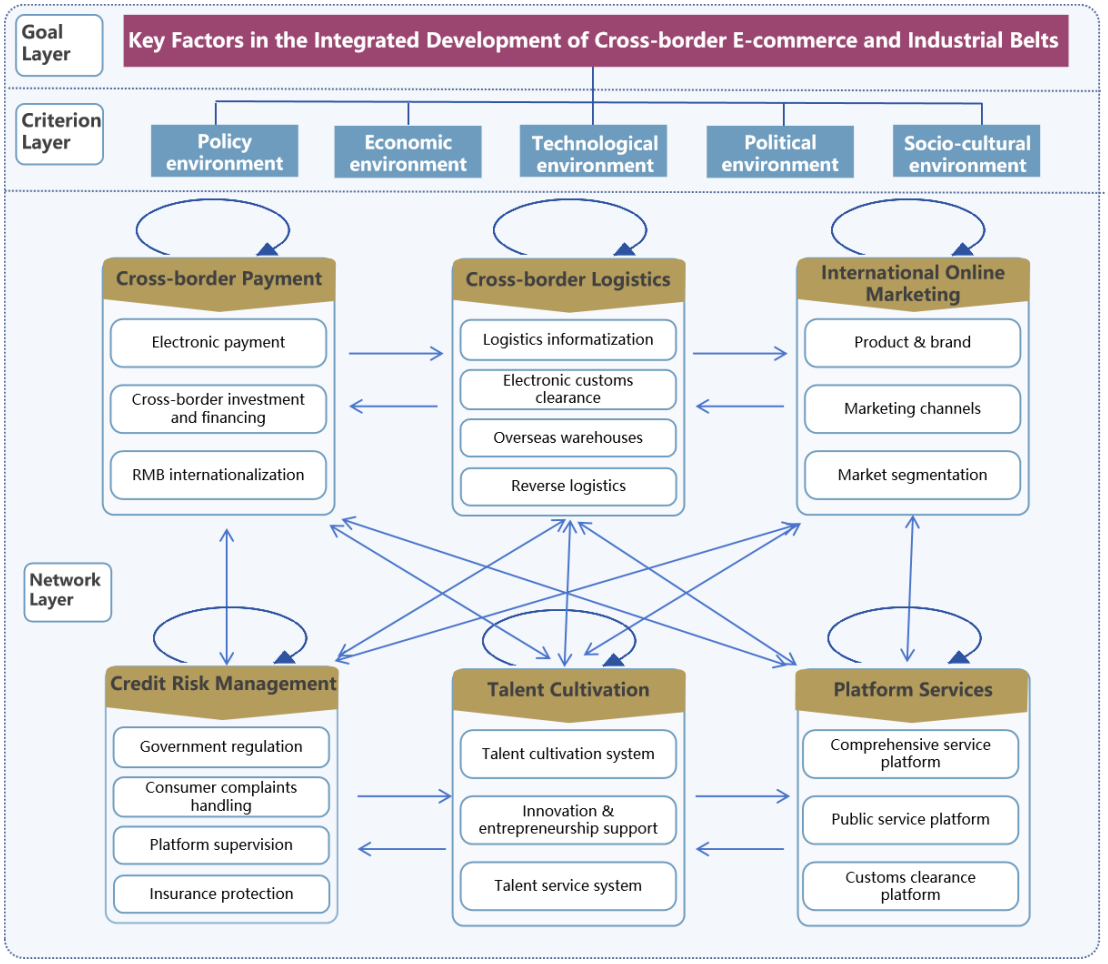

Figure 2. ANP Model of Key Factors in the Integrated Development of Cross-border E-commerce and Industrial Belts

3.2. Model Calculation Results and Key Factor Analysis

Based on the ANP calculation results, the most critical internal factors influencing the integrated development of cross-border e-commerce and specialized industrial belts are, in descending order of importance: government regulation, integrated service platforms, electronic payment, consumer complaint handling, and logistics informatization, which is tied with the talent cultivation system.

From the external environment perspective, the policy environment has the highest weight, followed by the economic environment, with the political environment ranking third. This highlights that under the trade war background, the direct impact of the political environment on integrated development has surpassed that of the technological and socio-cultural environments. Notably, within credit risk management, the conditional weight of the political environment on government regulation reaches 0.210, indicating that external political shocks significantly amplify the importance of compliance and risk control.

Table 2. Importance Ranking of Factors Influencing the Integrated Development of Cross-border E-commerce and Characteristic Industrial Belts under Trade War Background

External Environment (Weight)		Policy (0.422)	Economic (0.242)	Political (0.181)	Technological (0.106)	Socio-cultural (0.049)	Composite Weight	Overall Rank
Credit Risk Management (0.243)	Government regulation	0.178	0.063	0.204	0.094	0.117	0.141	1
	Consumer complaints handling	0.083	0.028	0.057	0.052	0.048	0.064	4
	Platform supervision	0.039	0.011	0.029	0.019	0.020	0.029	15
	Insurance protection	0.007	0.003	0.012	0.007	0.006	0.007	20
Platform Services (0.236)	Comprehensive service platform	0.154	0.147	0.099	0.085	0.123	0.130	2
	Public service platform	0.062	0.042	0.043	0.026	0.028	0.050	10
	Customs clearance platform	0.059	0.047	0.051	0.034	0.047	0.051	8
Cross-border Logistics (0.151)	Logistics informatization	0.049	0.055	0.049	0.069	0.037	0.056	5
	Electronic customs clearance	0.046	0.045	0.047	0.052	0.032	0.047	12
	Overseas warehouses	0.028	0.029	0.034	0.021	0.040	0.030	14
	Reverse logistics	0.021	0.017	0.019	0.009	0.021	0.019	18
Cross-border Payment (0.146)	Electronic payment	0.063	0.079	0.059	0.125	0.064	0.070	3
	Cross-border investment and financing	0.035	0.083	0.036	0.032	0.037	0.050	10
	RMB internationalization	0.024	0.015	0.024	0.047	0.031	0.025	16
Talent Cultivation (0.120)	Talent cultivation system	0.044	0.059	0.049	0.098	0.134	0.056	5
	Innovation & entrepreneurship support	0.035	0.058	0.046	0.079	0.069	0.051	8
	Talent service system	0.015	0.003	0.010	0.020	0.004	0.012	19
International Online Marketing (0.104)	Product & brand	0.022	0.098	0.079	0.069	0.093	0.054	7
	Marketing channels	0.013	0.059	0.047	0.030	0.036	0.032	13
	Market segmentation	0.014	0.049	0.020	0.025	0.008	0.021	17

4. CONCLUSIONS AND RECOMMENDATIONS

4.1. Research Conclusion

Based on business ecosystem theory and collaborative innovation theory, this study constructs a cross-border e-commerce and characteristic industrial belt ecosystem model comprising diverse populations, internal factors and external environment under the trade war background, and uses the Analytic Network Process (ANP) to quantitatively analyze the key factors influencing the synergistic development of cross-border e-commerce and characteristic industrial belts. The main conclusions are as follows:

(1) Grounded theory research reveals that the cross-border e-commerce and characteristic industrial belt integration ecosystem comprises a keystone population (referring to cross-border e-commerce platforms), a key population (including industrial belt enterprises and overseas buyers), a supporting population (including logistics, payment, and regulatory authorities), and a parasitic population (including third-party services). This ecosystem is directly influenced by internal factors such as credit risk management, platform services, cross-border logistics, cross-border payment, talent cultivation, and international online marketing, and indirectly affected by external environments including policy environment, economic environment, political environment, technological environment, socio-cultural environment, and natural geographical environment.

(2) The ANP model calculations indicate that government regulation, comprehensive service platforms, electronic payment, consumer complaint handling, logistics informatization, and the talent cultivation system are the most critical factors currently influencing integrated development. The external environmental factors, ranked by weight, are as follows: policy environment, economic environment, political environment, technological environment, and socio-cultural environment. The significant impact of the political environment (trade war factor) suggests that external political shocks have surpassed technological and socio-cultural factors to become the third-largest driving force.

(3) Traditional industrial belts are required to shift from a “low-price, volume-based” strategy toward a “branding and digitalization” paradigm. By strengthening credit risk management, upgrading platform and logistics services, promoting brand transformation, and deepening industry-education integration, they can build risk-resistant ecosystem resilience. Governments, enterprises, industry organizations, and universities should collaborate to address the long-term challenges of the trade war.

4.2. Policy Suggestion

Based on the above ANP model conclusions, the following policy recommendations are proposed to promote the integrated development of cross-border e-commerce and characteristic industrial belts under the trade war background:

4.2.1. Strengthen Credit Risk Management and Compliance Capability Building

The trade war has led to a sharp rise in tariff barriers and regulatory uncertainty. Governments should enhance information sharing among customs, taxation, and foreign exchange authorities, establish real-time tariff warning and credit risk monitoring platforms, and provide export credit insurance subsidies to hedge political risks. Meanwhile, the government should guide enterprises to standardize platform operations and establish a rapid consumer complaint response mechanism to safeguard brand reputation. Enterprises should be encouraged to actively explore alternative markets such as those along the Belt and Road and RCEP member countries, thereby reducing dependence on a single market.

4.2.2. Upgrade Platform Services and Cross-border Logistics to Build Digital Supply Chains

Comprehensive service platforms should integrate one-stop services including customs clearance, foreign exchange settlement, tax rebates, and financing to reduce enterprise compliance costs. For the logistics sector, integrated service platforms should support enterprises in establishing public overseas warehouses, especially in emerging markets such as ASEAN, the Middle East, and Latin America, promote the "9810" model for cross-border e-commerce exports via overseas warehouses, and utilize logistics informatization systems to achieve real-time tracking. The government can provide special subsidies for overseas warehouse construction to shorten enterprises' capital turnover cycles.

4.2.3. Promote Digitalization and Branding Transformation of Industrial Belts to Enhance Risk Resilience

Traditional industrial belts urgently need to transform from OEM/ODM to OBM. The government should establish special funds for digital transformation of industrial belts, support enterprises in using emerging platforms such as TikTok and Temu for live streaming e-commerce and short video marketing, build independent websites, and carry out big data product selection and precision marketing. Encourage industry associations to take the lead in formulating cross-border e-commerce standards for industrial belts, organize enterprises to participate in overseas exhibitions and digital marketing activities, and promote the collective export of regional manufacturing brands.

4.2.4. Deepen Industry-Education Integration to Cultivate Composite Cross-border E-commerce Talents

Local universities should cooperate with leading enterprises in industrial belts to launch order classes for cross-border e-commerce and industrial belts, cultivating composite talents who understand foreign languages, platform operations, product craftsmanship, and supply chain management. Local universities should also set up an industry mentor pool, bringing in corporate operations directors and heads of overseas markets to teach in the classroom. In the context of the trade war, local universities should add micro-specializations or elective courses such as International Economic and Trade Rules,

Tariff Planning, and Geopolitical Risk Management to enhance practitioners' compliance and response capabilities.

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