Development Economics of China
2026, VOL. 10, NO. 1, 11-14
DOI: 10.47297/wspdecWSP2515-797303.20261001

A Study on the Innovative Development and Risk Prevention and Control of Modern Supply Chains in the Hainan Free Trade Zone

Yuxin Chen

Woosong University, Daejeon, 34606, Republic of Korea

ABSTRACT
Against the backdrop of profound adjustments in the global supply chain landscape, the Hainan Free Trade Zone, as a new frontier of opening-up, faces a situation where opportunities for transformation and upgrading coexist with risks and challenges in its supply chain system. While the hub functions of ports within the region continue to strengthen, digital connectivity capabilities still need improvement, and there are shortcomings in risk response capabilities. Therefore, this study will conduct an in-depth analysis of the path design for supply chain digital transformation and propose a plan for building a risk prevention and control system. The aim is to provide actionable strategic references for constructing an efficient and stable modern supply chain, thereby helping the Hainan Free Trade Port establish itself as a new high ground for an open economy.

KEYWORDS
Hainan free trade zone; Modern supply chain; Risk prevention and control; Regional coordination

1 Introduction

Leveraging its unique geographical location and inherent openness, the Hainan Free Trade Zone is actively building an international modern supply chain network. As distinctive industries within the zone—such as duty-free commerce, aviation logistics, and high-end manufacturing—develop rapidly, higher demands are placed on supply chain responsiveness and resource integration capabilities. Against this backdrop, deepening supply chain innovation holds significant importance for the development of the Hainan Free Trade Zone, as it not only impacts the operational efficiency of enterprises within the zone but also exerts a significant influence on the construction of the regional industrial ecosystem. At the same time, however, global trade fluctuations and frequent natural disasters pose potential risks to the modern supply chain in the Hainan Free Trade Zone. Furthermore, due to insufficient digital connectivity within the regional supply chain and imperfect risk early warning and collaborative prevention mechanisms, the full potential of supply chain innovation has not yet been realized. Accordingly, this study builds upon the foundation of modern supply chain development in the Hainan Free Trade Zone and, by integrating regional industrial characteristics, explores feasible pathways for supply chain innovation. The aim is to assist the Hainan Free Trade Zone in fully leveraging its role as a core node in the New Western Land-Sea Corridor and to promote high-quality regional economic development.

2 Fundamental Conditions Supporting the Innovative Development of Modern Supply Chains in the Hainan Free Trade Zone

2.1 Support from Geographical Location and Logistics Resources

The Hainan Free Trade Zone occupies a central transportation hub in the South China Sea. To the north, it is closely connected to the economic belt of mainland China, and to the south, it effectively reaches into the markets of Southeast Asian countries. At the same time, as the maritime gateway of the New Western Land-Sea Corridor, it serves as a strategic hub connecting inland and overseas markets in both directions. The region is home to multiple specialized ports equipped with deep-water berths and comprehensive port operation systems. Some ports can accommodate large vessels for round-the-clock operations. These ports form an efficient land transport system through the island's ring-road highway network and seamlessly connect with cross-sea railway corridors. In terms of air transport, the region's international airports have launched multiple cargo routes, creating a three-dimensional transport network integrating sea, land, and air [1].

In terms of logistics infrastructure, the region has established a large-scale modern warehousing network, comprising high-standard general warehouses and specialized cold-chain facilities. General-purpose warehouses typically employ high-rack structures and automated storage and retrieval systems, significantly enhancing storage density and cargo turnover rates; cold-chain warehouses are equipped with multi-temperature zone control systems, enabling zoned storage management for different product categories and meeting the special preservation requirements of tropical agricultural products and biological agents. In key logistics hub areas, specialized container yards and transhipment sites

are located behind the ports to facilitate efficient integration between maritime and rail transport.

2.2 Support from Distinctive Industries and Market Demand

The Hainan Free Trade Zone has established a diversified industrial structure centred on distinctive sectors such as tropical speciality agriculture, cross-border trade, port-adjacent industries, and the cultural and tourism sector. Tropical speciality agricultural production is characterised by distinct seasonal and time-sensitive requirements; tropical fruits and off-season vegetables must undergo standardised processes—including pre-cooling, grading, and cold-chain transportation—from harvest to sale. The transportation of products from deep-water aquaculture requires specialized refrigerated containers and special packaging, creating a dedicated cold chain corridor from offshore harvesting to consumer markets. Cross-border commodity circulation involves complex customs procedures and international transportation coordination, necessitating the establishment of efficient international procurement networks and customs clearance service systems.

Port-adjacent industries are also key demand drivers within the supply chain system. Oil, gas, and chemical enterprises in the region require stable raw material supply channels and specialised logistics support, while the transport of large-scale equipment necessitates professional loading plans and specialised transportation safeguards. The shipbuilding industry, which adopts a segmented manufacturing model, requires the establishment of efficient component circulation mechanisms between different shipyards [2]. These heavy industrial systems require customised supply chain solutions covering specialised services such as bulk material allocation, large-scale equipment transport, and multi-site coordination. In the cultural and tourism sector, the supply of consumer goods in resort areas exhibits distinct cyclical fluctuations, necessitating the establishment of a tiered warehousing network and flexible distribution mechanisms; tourism retail outlets require frequent, small-batch restocking, driving the adoption of a distribution model utilising forward warehouses within scenic areas.

3 Strategies for Modern Supply Chain Risk Prevention and Control in the Hainan Free Trade Zone

3.1 Improving the Supply Chain Risk Early Warning Mechanism

The Hainan Free Trade Zone needs to build a dynamic monitoring network covering the entire supply chain process, continuously collecting data from key nodes—from customs declaration to final delivery. Data sources include the Customs Electronic Port System, port operation management platforms, and logistics tracking systems of supply chain enterprises, forming a multi-party information integration mechanism. For cold-chain food products susceptible to environmental factors, the system simultaneously records changes in warehouse temperature and humidity as well as refrigeration parameters in transport containers to ensure full traceability and control throughout the process. The system is pre-configured with basic screening rules to automatically detect common issues—such as goods remaining in customs supervision zones beyond standard time limits, abnormal temperature deviations from standard ranges during cold-chain transport, or duplicate deductions in cross-border payments—triggering preliminary warning signals. Building on this, a dedicated analysis team—comprising customs clearance experts and experienced logistics dispatchers—conducts in-depth weekly analysis of system data, focusing on complex risk factors such as connection disruptions caused by sudden changes in transport routes and funding gaps resulting from sharp fluctuations in international settlement exchange rates. For general logistics delay risks, we initiate contingency procedures to reroute shipments via alternative transport routes; for regional customs clearance bottlenecks, we activate contingency plans for alternative customs clearance channels; and for major supply chain disruptions, we escalate to execute multi-point diversion emergency plans. All response processes are documented with specific timelines and outcomes, which are then archived as case studies to enhance the overall risk resilience of the supply chain [3].

3.2 Establishing a Multi-Party Collaborative Prevention and Control System

Supply chain risk prevention and control in the Hainan Free Trade Zone requires collaboration among multiple stakeholders, with clearly defined responsibilities. Customs authorities are responsible for optimizing cargo inspection procedures and overseeing customs clearance processes; port operators must implement safety standards for cargo loading and unloading as well as site operation regulations; transport service providers must comply with technical requirements for vehicle maintenance and implement monitoring measures during transportation; and manufacturers and trading companies must improve their partner risk assessment systems and issue-reporting procedures, thereby forming a foundational prevention and control network. Coordination among these entities takes various forms of collaboration. A two-way data transmission channel has been established between customs supervision systems and port operation systems. When customs issues advance notifications regarding high-risk incoming containers, the port's on-

duty dispatch centre simultaneously activates specialised operational contingency plans. During the high-temperature and typhoon season, port operations departments proactively issue vessel berthing adjustment schedules, and logistics companies adjust their land transport connection timelines accordingly.

Industry associations organise monthly specialised risk prevention and control training sessions, inviting port safety management departments to explain operating standards for large-scale lifting equipment and emergency response protocols for sudden malfunctions, and arranging for dispatch managers from leading logistics companies to analyse case studies of cross-border transport incident resolutions. Regional joint supply chain risk prevention and control drills are conducted every six months, simulating typical risk scenarios. For example, when a vessel's mechanical failure causes cold-chain containers to be stranded at the terminal, customs immediately activates a special area quarantine plan and permits the transfer of goods to bonded cold storage, while the port urgently deploys dedicated transport equipment to complete container pickup and transport from the terminal. Relevant enterprises adjust their original distribution schedules during this process. Following the drill, an assessment report is compiled to identify gaps in coordination and handoffs during the response process, thereby providing support and safeguards for supply chain security in the Hainan Free Trade Zone.

3.3 Strengthening Supply Chain Risk Mitigation Capabilities

First, the Hainan Free Trade Zone must establish a systematic financial risk transfer mechanism and set up a regional supply chain security special fund. The fund's capital will be sourced from special allocations in the local government's annual budget, supplemented by proportional deposits from key port enterprises and large logistics companies, while encouraging manufacturing and trading firms to optionally join the planned deposit system. Fund operations will be managed by a third-party institution with risk management qualifications, and strict application and approval criteria will be established. When enterprises face major external shocks, they may submit detailed documentation of losses; upon rapid review, they may receive financial compensation of up to half the actual loss amount [4].

Second, establish a multi-tiered supply chain financial service mechanism and develop financing products tailored to the characteristics of trade within the free trade zone. These include logistics status financing, whereby transportation companies can use real-time data on containers in transit as collateral to apply for short-term working capital; warehouse receipt-integrated financing, where bonded warehouse operators must establish an electronic warehouse receipt registration platform, allowing trading enterprises to secure cross-bank collateralized financing using electronic warehouse receipts released by customs; and an order installment payment mechanism, enabling suppliers to conduct multi-level discounting and circulation of buyer-accepted orders through the Free Trade Zone Bill Trading Center.

Third, strengthen the development of emergency logistics systems. Regular medical supplies should be replenished every six months, and emergency response equipment should undergo annual maintenance and inspection. Upon the issuance of a natural disaster warning, the Emergency Command Centre will immediately activate the corresponding response plan and mobilise the reserve resources closest to the disaster site to provide the first wave of assistance. Emergency transport vehicles, after being certified with a unified identification mark, will be granted priority passage; where necessary, traffic management authorities will open dedicated routes to provide strong support for ensuring the stable operation of the supply chain.

4 Support Measures to Promote the High-Quality Development of Modern Supply Chains in the Hainan Free Trade Port

4.1 Cultivating a Professional Workforce

The Hainan Free Trade Zone must establish a systematic talent development framework to meet the demands of modern supply chain development. The integration of educational resources will follow a practical-oriented approach: the Supply Chain Management program will incorporate simulation training modules for port operations; the Logistics Information program will add experimental units on blockchain traceability technology; and risk prevention and control courses will include sessions analyzing real-world crisis cases. On-campus training centres will prioritise access to practical equipment for partner enterprises, while corporate production bases will regularly accept students for on-site rotational training. The Curriculum Evaluation Committee, composed of education experts and key technical personnel from enterprises, will revise teaching content each academic year based on industrial technology trends to ensure the timely updating of talent knowledge structures. Concurrently, efforts will be strengthened to build talent recruitment and incentive mechanisms [5]. For high-end supply chain talent, a tiered support program will be designed, providing dedicated research start-up funds for intelligent logistics technology projects, transitional housing facilities tailored to family needs, and special channels for technical title recognition within the Free Trade Zone, among other substantive

supports. To enhance the capabilities of current employees, enterprises have established tiered training systems. Leading enterprises are required to organise quarterly sessions where key personnel share their experience in overseas warehouse operations and management, while small and medium-sized enterprises are guided to conduct regular operational drills on digital freight forwarding platforms. This ensures the synchronised upgrading of skills across all levels of personnel, thereby providing stronger support for the high-quality development of the Free Trade Zone ' s modern supply chain.

4.2 Deepening Regional Collaborative Partnerships

The Hainan Free Trade Zone should focus on advancing strategic coordination mechanisms with the Guangdong-Hong Kong-Macao Greater Bay Area and establish an institutionalised coordination working group to centrally manage cooperative affairs. Cross-regional resource allocation plans should cover collaboration in key sectors, including the implementation of shared container allocation plans among port clusters in both zones, real-time exchange of empty container distribution data through information systems, and the establishment of complementary capacity response mechanisms between manufacturing bases. At the same time, the use of standardised loading unit equipment should be promoted among key logistics hubs to eliminate the need for mid-transit transhipment; Customs authorities in cities along the route should jointly develop an electronic seal mutual recognition system to enable "inspect once, pass through" for cross-provincial transport, thereby effectively enhancing the operational efficiency of the entire supply chain. The construction of a regional coordination platform should be based on information technology, developing an open supply chain data exchange hub where participants share information on transport capacity and market volatility analysis reports according to their respective permissions. These collaborative safeguards will significantly enhance the stability and sustainable development capabilities of industrial chains in the international competitive environment.

5 Conclusion

The development of a modern supply chain system in the Hainan Free Trade Zone requires balancing innovation and risk management, optimising digital infrastructure, promoting transparent management across the entire logistics chain, strengthening multimodal transport hub functions to improve resource circulation efficiency, and cultivating a specialised talent pool to support high-end operations. Concurrently, a full-cycle risk management framework must be established to effectively address natural disasters, market fluctuations, and operational disruptions, thereby ensuring supply chain security and stability. In the future, the Hainan Free Trade Zone must further deepen the development of talent cultivation mechanisms, enhance the resilience of international logistics networks, and gradually build a modern supply chain ecosystem capable of competing internationally through technological empowerment and institutional optimisation.

About the Author

Yuxin Chen, PhD candidate (Class of 2024); Research Focus: Free Trade Zone Supply Chains.

References

[1] M. B., & Zhao, Y. (2025). The sustainability of economic and business practices through legal cooperation in the era of the Hainan free trade port and southeast Asian nations. Sustainability, 17(5), 2050.

[2] Ma Y., Mao M., Xie Z., Mao S., Wang Y., Chen Y., ... & Wu, L. (2025). Spatiotemporal Dynamics and Simulation of Landscape Ecological Risk and Ecological Zoning Under the Construction of Free Trade Pilot Zones: A Case Study of Hainan Island, China. Land, 14(5), 940.

[3] Dong Q., & Bian Z. (2024). Meeting international economic and trade rules: A case study of Hainan free trade port, China. World Customs Journal, 18(1), 81-99.

[4] Yang J., Zhang X., & Yang X. (2022). Evaluation of the Development Potential of Hainan Free Trade Port Industrial Chain Driven by the Internet of Things Distribution Mechanism. Computational Intelligence and Neuroscience, 2022(1), 8146926.

[5] Usman K. (2020). China's Special Economic Zones, Hainan Province New Free Trade Zone: Review of Policies that Minimize the Regional Gap. Journal of Management and Economic Studies, 2(2), 99-111.