

Research on the Implementation Path of Integrated Industrial Chain Development in Hainan Free Trade Port

Shi Wang*

Hainan Vocational University of Science and Technology, Haikou, China

**Corresponding author*

Keywords: Hainan Free Trade Port, Industrial Chain Integration, Digital Empowerment, Green and Low-Carbon Development

Abstract: Against the backdrop of global industrial chain restructuring and the development of free trade ports, the Hainan Free Trade Port, as a crucial experimental zone for China's deepening reform and opening-up in the new era, holds significant strategic importance in terms of industrial chain development and integration. This study analyzes the industrial structure, key industrial layouts, and current state of industrial chain development in the Hainan Free Trade Port, evaluates the level of industrial chain integration, and explores key influencing factors from multiple dimensions including policy environment, market demand, technological innovation, talent education, infrastructure, and regional coordination. Based on this study, four implementation pathways are proposed: extending, supplementing, strengthening, and integrating industrial chains. The study emphasizes the importance of mechanism innovation, digital empowerment, and green low-carbon development in enhancing industrial chain synergy. Findings indicate that industrial chain integration not only optimizes regional industrial structures, boosts innovation capabilities, and enhances international competitiveness, but also fosters a modern industrial system that combines institutional innovation, technological advancement, and market openness. This study provides theoretical support and practical reference for China's free trade port development.

1. Introduction

In the context of globalization, the pandemic shock, rising trade protectionism, and intensifying technological competition have driven the restructuring of global industrial and supply chains. Countries are implementing "re-localization" and "regionalization" strategies to safeguard industrial chain security and enhance international competitiveness. As key vehicles for institutional innovation in open economies, free trade ports can effectively boost regional competitiveness and economic influence through institutional innovation and integrated industrial chain development. The practices of Singapore, Dubai, and Hong Kong China have validated this approach ^[1-3].

China has proposed a strategy to build high-standard free trade ports, exploring new institutional frameworks for open economies through systemic innovation. As a key experimental zone for reform and opening-up, the Hainan Free Trade Port aims to become a globally influential high-standard free trade port by 2035. However, Hainan's long-term reliance on tourism, real estate, and

tropical specialty agriculture has resulted in short industrial chains, insufficient core technologies, and poor integration between innovation and industrial chains, constraining high-quality economic development. Industrial chain integration emerges as a breakthrough point, requiring the construction of an open, innovative, and collaborative modern industrial system through extending, supplementing, strengthening, and integrating industrial chains.

Industrial chain integration emphasizes the linkage of upstream and downstream segments and cross-industry consolidation, which can optimize resource allocation, enhance added value and technological content, and foster an innovation ecosystem with multi-industry synergy. Against the backdrop of digital and green economic development, industrial chain integration in the Hainan Free Trade Port will help cultivate emerging industrial clusters, strengthen competitiveness, and achieve multi-chain coordination among "industrial chains, innovation chains, talent chains, policy chains, and supply chains," thereby enhancing economic resilience and openness^[4, 5].

This study aims to systematically analyze the current status, influencing factors, and implementation pathways of industrial chain integration in the Hainan Free Trade Port. It provides theoretical and practical references for industrial policy formulation, industrial structure optimization, and high-quality development, while offering insights for industrial transformation in other free trade zones.

2. Analysis of the Current Status of Industrial Chain Development in Hainan Free Trade Port

2.1 Industrial Structure and Key Industry Layout

Since the establishment of the Hainan Free Trade Port, its industrial structure has been continuously optimized, initially forming an industrial system centered on modern services, underpinned by modern agriculture, led by high-tech industries, and supported by shipping and logistics. Modern services serve as the pillar industry of the Hainan Free Trade Port, encompassing multiple sectors including tourism, finance, exhibitions, and information services. Tourism, as Hainan's traditional competitive industry, is accelerating its shift toward high-end, international, and diversified development. It has fostered new business models such as "tourism + culture," "tourism + wellness," and "tourism + sports," driving synergistic growth in related sectors including catering, accommodation, transportation, and retail. The financial sector has expanded under the impetus of free trade port policies, with emerging businesses like offshore finance, cross-border settlement, and shipping insurance gradually taking shape. The convention and exhibition industry, leveraging the development of international consumption hubs, has formed an international convention and exhibition economic circle centered on Haikou and Sanya, advancing the liberalization of service trade. Modern agriculture and tropical specialty high-efficiency agriculture serve as crucial foundations for ensuring Hainan's sustainable economic development. Capitalizing on its unique tropical resources, Hainan vigorously develops specialty industries such as tropical fruits, winter melons and vegetables, and southern seed breeding. It promotes deep integration between agriculture and processing, logistics, tourism, and other sectors, achieving a transformation from traditional agriculture to efficient, eco-friendly, and branded agriculture. High-tech industries serve as the core driver for Hainan's industrial transformation and upgrading, with strategic emerging sectors like pharmaceuticals and healthcare, internet information, new energy, and energy conservation/environmental protection receiving priority development. The pharmaceutical industry leverages policy advantages such as the Boao Lvcheng International Medical Tourism Pilot Zone to attract domestic and international pharmaceutical enterprises. The internet sector, centered on Haikou National Hi-Tech Industrial Development Zone, advances big data, blockchain, and smart city applications. The new energy industry is gradually establishing competitive advantages in photovoltaic power generation, new energy vehicles, and energy storage technologies. Shipping and

logistics, alongside port-based economies, serve as vital pillars for Hainan's integration into global industrial chains. The Yangpu Economic Development Zone, as a nationally designated port-based industrial cluster, is accelerating the construction of a free trade port shipping service system. This initiative promotes the coordinated development of international shipping, port logistics, and bonded warehousing, establishing an initial spatial pattern where port economies drive industrial chain aggregation.

2.2 Current Status and Challenges of Industrial Chains

Despite significant progress in industrial development within the Hainan Free Trade Port, the overall industrial chain system remains in its infancy, plagued by issues such as short chains, weak supporting infrastructure, and insufficient coordination. First, the problems of short industrial chains and inadequate upstream-downstream coordination are particularly prominent. Most industries in Hainan remain concentrated in primary processing and service segments, with insufficient vertical extension of industrial chains. The lack of supporting facilities for core manufacturing and deep processing segments results in low industrial value-added. Second, the driving force of core enterprises is weak. Hainan lacks leading enterprises in high-tech and equipment manufacturing sectors, resulting in insufficient leadership within industrial chains and the failure to form industrial cluster effects. Third, the innovation chain remains disconnected from the industrial chain. While Hainan actively promotes the development of a science and technology innovation system, the efficiency of transforming scientific achievements into practical applications remains low. Collaboration between research institutions and enterprises lacks depth, and innovation resources fail to effectively support industrial upgrading. Fourth, the talent chain and policy chain provide insufficient support. There is a relative shortage of high-level innovative talent, and the local talent cultivation system is mismatched with industrial needs. Although a preliminary policy support system has been established, the implementation and effectiveness of policies still require strengthening. Fifth, external openness and international cooperation remain inadequate. Despite progress in institutional opening-up, Hainan's integration with high-end international industrial chains remains limited. The breadth and depth of cross-border industrial cooperation, international investment, and the flow of high-end factors require further enhancement. Overall, Hainan Free Trade Port's industrial chain still suffers from structural weaknesses and functional deficiencies, urgently requiring systematic improvement through extending, supplementing, strengthening, and integrating the chain.

2.3 Evaluation of the Current State of Integrated Industrial Chain Development

From the perspective of industrial integration, while Hainan Free Trade Port has achieved certain results in developing its industrial chains, the overall level of integration remains at an early stage. The interconnectivity among Hainan's industries exhibits the characteristic of "strong linkage in services and weak linkage in manufacturing." Modern service industries such as tourism, transportation, finance, and information services exhibit high forward linkages, driving downstream sectors. However, most manufacturing and high-tech industries have low backward linkages, relying heavily on external supply and lacking sufficient industrial embedding. Regarding industrial agglomeration, Hainan has gradually formed an industrial spatial layout centered on Haikou, with Sanya as a secondary hub and Yangpu and Danzhou as key nodes. The "one core, two belts, multiple points" industrial pattern has been preliminarily established. Some areas, such as the Yangpu Economic Development Zone, have achieved cluster effects in petrochemical new materials and port logistics. However, the supporting systems and innovation collaboration mechanisms within these clusters remain underdeveloped, and the benefits of industrial

agglomeration have yet to be fully realized. According to relevant research estimates, Hainan's overall industrial integration level remains relatively low. Integration is primarily concentrated in service sectors such as "tourism + internet," "culture + exhibitions," and "medical care + wellness," while cross-sector integration between manufacturing and services is insufficient. The depth of integration between the digital economy, green economy, and traditional industries also falls short. Overall, the integrated development of industrial chains in Hainan Free Trade Port still faces challenges such as low inter-industry connectivity, insufficient innovation collaboration, and an incomplete institutional support system. It is necessary to build a high-level industrial chain integration system through policy innovation, technological empowerment, and regional coordination, thereby providing sustained momentum for the construction of the free trade port.

3. Analysis of Factors Influencing Industrial Chain Integration in Hainan Free Trade Port

3.1 Policy Environment Factors

The policy environment serves as the primary driver for promoting the integrated development of industrial chains. The greatest advantage of the Hainan Free Trade Port lies in institutional innovation and policy openness. Since the release of the "Guiding Opinions of the Central Committee of China and the State Council on Supporting Hainan in Deepening Reform and Opening Up" in 2018, Hainan has taken the lead in exploring liberalization and facilitation policies in areas such as trade, investment, finance, taxation, data flow, and personnel exchanges, providing institutional support for industrial chain integration. On one hand, preferential tax policies have effectively reduced corporate costs, creating conditions for the formation of industrial clusters. On the other hand, the implementation of a negative list for investment access and streamlined approval procedures have enhanced the convenience for foreign enterprises to enter the Hainan market, thereby elevating the internationalization level of industrial chains. However, the coordination and implementation of policies still require improvement. Some policies face fragmentation issues at the local implementation level, with time lags and gaps in supporting measures between institutional innovations and industrial implementation. It is essential to enhance the systematic coherence and connectivity of the institutional framework, establish policy coordination mechanisms, and achieve a "policy chain" that supports the "industrial chain."

3.2 Market Environment Factors

The market environment directly determines the depth and breadth of industrial chain integration. As one of China's most open special economic zones, Hainan possesses enormous market potential. However, its overall market scale remains relatively small, upstream and downstream market demand is unstable, and regional consumption levels have yet to be fully unleashed. These factors collectively constrain the endogenous integration momentum of industrial chains. First, from the perspective of domestic demand, Hainan's limited population base and insufficient local market capacity to absorb mid-to-high-end manufacturing and high-tech industries make it difficult for some industrial chains to achieve regional closed-loop development. Second, regarding external demand, although Hainan occupies a key node along the Belt and Road, stable long-term cooperative mechanisms with neighboring countries and regions have yet to be established, leaving its international market reach underdeveloped. Hainan's market system remains in a developmental stage, with persistent issues such as information asymmetry, inadequate financing channels, and incomplete industrial support markets. To advance industrial chain integration, it is essential to enhance market-driven momentum by improving market mechanisms, expanding openness and cooperation, and strengthening market competitiveness. This will foster an open, transparent, and

efficient market environment.

3.3 Science and Technology Innovation Factors

Technological innovation serves as the core driving force for industrial chain integration. Hainan Free Trade Port has achieved initial success in establishing its technological innovation system. The development of innovation platforms such as Sanya Yazhou Bay Science and Technology City, Haikou National Hi-Tech Industrial Development Zone, and Lecheng Pilot Zone has provided a solid foundation for industrial chain integration. Technological innovation can stimulate upstream and downstream industrial collaboration through technology diffusion, achievement transformation, and industrial application. However, Hainan's overall scientific and technological innovation capacity remains relatively weak, with low conversion rates for research outcomes and inadequate alignment between the innovation chain and industrial chain. Most research institutions and universities fail to effectively match their findings with corporate needs, resulting in inefficient allocation of innovation resources. It is imperative to strengthen collaborative innovation mechanisms among industry, academia, and research institutions, establish platforms for transforming innovation outcomes, extend technological advancements to all segments of the industrial chain, and achieve deep integration between the innovation chain and industrial chain.

3.4 Talent and Education Factors

Talent is the key element in industrial chain integration. The extension and upgrading of industrial chains cannot be achieved without the support of high-caliber talent. In recent years, Hainan has intensified its talent policies, launching the "One Million Talents to Hainan" initiative and establishing a free-flowing talent recruitment mechanism to attract high-level professionals, technical specialists, and innovative entrepreneurial teams. However, challenges persist in recruiting and retaining top-tier talent. Constrained by weak industrial foundations, insufficient research platforms, and disparities between salary levels and living costs, Hainan's appeal to multidisciplinary innovators remains limited. Furthermore, vocational education remains poorly aligned with industrial demands, and the technical-skilled talent cultivation system requires refinement. Industrial chain integration necessitates robust support from the talent chain. Efforts should focus on establishing an integrated talent cultivation mechanism encompassing government, industry, academia, research, and application. By establishing joint training bases, industry-education integration demonstration zones, and technological innovation platforms between universities and enterprises, the talent supply structure can be optimized to form a "talent chain" system that synergizes with industrial chain development.

3.5 Infrastructure and Logistics System Factors

Well-developed infrastructure and an efficient logistics system form the material foundation for industrial chain integration. In recent years, Hainan has accelerated construction in ports, airports, expressways, information networks, and energy supply, significantly enhancing its transportation and communication infrastructure. In port development, a multi-tiered port system centered on Yangpu Port, Haikou Port, and Sanya Port has taken shape, with international shipping services continuously improving. In aviation, Haikou Meilan International Airport, Sanya Phoenix International Airport, and Qionghai Boao Airport have formed a "multi-point linkage" network. Regarding information infrastructure, Hainan has established an international submarine cable landing station and achieved full 5G network coverage, providing support for the integration of the digital economy and industrial chains. However, compared to other domestic free trade zones,

Hainan's logistics costs remain relatively high, and supply chain efficiency still needs improvement. Cross-island transportation is constrained by geographical conditions, and warehousing, cold chain, and supply chain management systems are not yet fully developed. Efforts should focus on developing modern logistics, building intelligent supply chain platforms, and promoting digital logistics management to enhance industrial chain operational efficiency, reduce business operating costs, and strengthen the overall competitiveness of the industrial chain.

4. Realization Pathways for Integrated Industrial Chain Development in Hainan Free Trade Port

4.1 Overall Approach and Development Goals

The overarching approach to integrated industrial chain development in the Hainan Free Trade Port centers on institutional innovation as the guiding principle, technological innovation as the core driver, open cooperation as the propelling force, and high-quality development as the ultimate goal. This strategy aims to establish a modern industrial system featuring deep integration among industrial chains, innovation chains, supply chains, and value chains. By optimizing industrial structures, strengthening chain connectivity, and refining supporting systems, it will facilitate the free flow and efficient allocation of various factors, fostering a multi-tiered, open, and eco-friendly industrial integration framework. Its development objectives lie in achieving "three transformations and two enhancements": shifting from single-industry development to multi-industry synergy, transitioning from factor-driven to innovation-driven growth, and evolving from closed chains to open ecosystems. Concurrently, it aims to elevate the overall competitiveness of industrial chains and the openness level of the regional economy. By building an efficient and collaborative industrial ecosystem, the Hainan Free Trade Port will secure higher-value segments in the global industrial chain restructuring, becoming a vital window for China's high-level opening-up and a strategic fulcrum for high-quality development.

4.2 Key Pathways

The key pathways for integrated industrial chain development in Hainan Free Trade Port can be summarized into four aspects: extending, supplementing, strengthening, and integrating industrial chains. Extending industrial chains should focus on improving upstream and downstream supporting systems, expanding vertical space within industrial chains, and extending value chains. Particularly in tropical specialty agriculture, tourism, and modern services, this involves developing new business models such as deep processing, cold-chain logistics, and "tourism + health" or "tourism + cultural creativity" to extend industrial chains into high-value-added segments. Filling gaps should concentrate on addressing technological and resource deficiencies in critical segments. For sectors like pharmaceutical manufacturing, smart manufacturing, and new energy, where core links are missing, attracting investment and talent, facilitating technology transfer, and introducing advanced technologies will eliminate bottlenecks hindering Hainan's industrial advancement. Strengthening chains requires prioritizing the cultivation of leading enterprises and industrial alliances. This encourages companies to take the lead in technological innovation, brand building, and international expansion, forming an industrial ecosystem centered on leading enterprises with coordinated development from small and medium-sized businesses. Integrating chains emphasizes synergistic linkage among industrial, innovation, financial, talent, and policy chains. This involves promoting industrial upgrading through technological innovation, facilitating resource flow via financial empowerment, enhancing innovation vitality through talent attraction and cultivation, and strengthening institutional safeguards with policy coordination. Ultimately, this achieves organic

integration and collaborative development of the industrial system.

4.3 Mechanism Innovation Pathway

Mechanism innovation serves as the institutional safeguard for achieving integrated industrial chain development in the Hainan Free Trade Port. First, institutional innovation and policy coordination should be deepened to establish a free, open, and efficient institutional framework. A unified and coordinated mechanism should be created to synergize industrial policies, science and technology policies, talent policies, and financial policies, thereby generating a cohesive policy force. Second, industrial clusters should serve as the vehicle for building an innovation ecosystem. By gathering enterprises, research institutions, and intermediary organizations, an industrial innovation network for resource sharing and collaborative technology development can be formed, driving the upgrade of industrial clusters from "spatial agglomeration" to "functional integration." Third, improve industry-academia-research collaboration and technology transfer mechanisms. The establishment of joint laboratories, industrial research institutes and pilot testing platforms should rely on universities and research institutions in Hainan to promote the local transformation and industrial application of scientific and technological achievements and bridge the "last mile" between scientific research and the market. Fourth, regional coordination and international cooperation mechanisms should be established. The industrial linkage and market connectivity with the Guangdong-Hong Kong-Macao China Greater Bay Area, the Beibu Gulf Economic Zone, and ASEAN countries need to be strengthened. The successful experiences of free trade ports like Singapore and Dubai can enhance Hainan's openness and competitiveness within the global value chain system.

4.4 Digitalization and Green Transformation Integration Pathway

Digitalization and green transformation are key directions for driving high-quality integration of industrial chains in Hainan Free Trade Port. Digital empowerment should serve as the primary engine for industrial convergence. By accelerating the development of digital infrastructure, we will promote the deep application of emerging technologies—including big data, cloud computing, artificial intelligence, and blockchain—across manufacturing, logistics, finance, and services. This will enable information exchange, intelligent coordination, and resource sharing across the entire industrial chain, building a modern industrial system characterized by "digital-driven, intelligent coordination, and integrated innovation." Green and low-carbon development should permeate the entire industrial chain integration process. By promoting clean energy, circular economy, and green manufacturing systems, we can accelerate the adoption of energy-saving and environmental protection technologies, thereby facilitating the transformation and upgrading of traditional industries. Hainan should establish green finance and carbon emissions trading mechanisms to guide enterprises in achieving energy conservation and consumption reduction through technological and management innovation, thereby building a green, low-carbon, resource-efficient, and environmentally friendly industrial development model. Through dual-engine drivers of digitalization and greening, the Hainan Free Trade Port will forge a new pattern of intelligent and sustainable industrial integration, providing enduring momentum for high-quality regional economic development.

5. Conclusions

The integrated development of industrial chains in Hainan Free Trade Port represents a crucial pathway to achieving high-quality regional economic growth and enhancing global competitiveness.

This paper analyzes industrial structure, current development status, and influencing factors, proposing a multidimensional development strategy encompassing chain extension, chain supplementation, chain strengthening, and chain integration. It emphasizes the pivotal role of mechanism innovation, digital empowerment, and green low-carbon development in industrial upgrading. Research indicates that establishing a synergistic system integrating industrial chains, innovation chains, supply chains, and value chains can optimize industrial structures, enhance innovation capabilities, and elevate openness levels, thereby providing robust support for the high-quality development of the Hainan Free Trade Port. Furthermore, this study offers theoretical foundations and practical insights for other Chinese free trade ports and open economies in terms of industrial chain integration, policy design, and strategic planning, laying a solid foundation for building high-level free trade ports and modern industrial systems.

Acknowledgements

This work was supported by Hainan Provincial Natural Science Foundation of China, Research on the Development Potential of Hainan Free Trade Port Industry Chain Based on Dynamic Network Planning Mode, Grant No. 722RC728.

References

- [1] Lin Y.Y. and Gao C.Y.(2025). *Innovation and Market Pathways for Green Financial Products in Hainan Free Trade Port under the Dual Carbon Goals*. *Business & Economy*,10,180-183.
- [2] He D.F., Chen T., Liu H. and Yang F.J.(2025). *Policy Practices and Countermeasure Analysis for the Deep Integration of Technological Innovation and Industrial Innovation*. *Bulletin of Chinese Academy of Sciences*,5,781-794.
- [3] Chi Y.X.(2024).*Research on Pathways and Strategies for Industrial Convergence Development in the Context of the Digital Economy*. *Digital Economy*,11,71-73.
- [4] Meng G.Y.(2021). *International Experience Offers Insights for the Planning and Construction of the Hainan Free Trade Port*. *Resources Science*,2,217-228.
- [5] Chen B.(2020). *Hainan Free Trade Port's Geographical Advantages and Industrial Development Direction*. *People's Tribune*,27,30-33.