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Opportunities and Challenges Faced by Aquatic Product Cold Chain Enterprises in Dongshan County in the Context of China's National Backbone Cold Chain Base Construction System

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Abstract: This study focuses on the development trends of aquatic product cold chain enterprises in Dongshan County against the background of China's national backbone cold chain base construction. It systematically analyzes the opportunities and challenges they face, and proposes targeted optimization strategies. The construction of China's national backbone cold chain base brings development opportunities for enterprises through policy support, resource integration, market expansion, and technological upgrading. At the same time, enterprises also face challenges such as infrastructure and technology deficiencies, operational management and cost control issues, competition, and a lack of industry norms. The study proposes strategies such as strengthening infrastructure construction and technological innovation, improving operational management and cost control capabilities, enhancing competitive advantages, and regulating industry development. These strategies provide theoretical support and practical guidance for the stable development of aquatic product cold chain enterprises in Dongshan County and also address deficiencies in related research in specific regions.

Keywords: China's National Backbone Cold Chain Base; Aquatic Product Cold Chain Enterprises; Cold Chain Logistics; Technological Innovation.

1. Introduction

In the context of economic globalization and consumption upgrading, the cold chain logistics industry, as a crucial link in ensuring the quality and safety of fresh food, pharmaceutical products, and other perishable goods, has become increasingly important (Mustafa et al., 2024). With improvements in people's

living standards and changes in consumption concepts, the requirements for the quality and safety of fresh food have been continually enhanced (Galanakis, 2024). Due to the perishable nature and short shelf life of aquatic products, their reliance on cold chain logistics is extremely high (Pedro et al., 2023). A complete cold chain logistics system can maintain a low-temperature environment throughout the entire circulation of aquatic products, maximizing their freshness, nutritional content, and flavor (Wang et al., 2024). Conversely, failure to maintain this environment may result in economic losses and threaten consumer health. The construction of national backbone cold chain bases in China is an important strategic measure for the development of cold chain logistics (Chen et al., 2022; Fan et al., 2024). Since 2020, the National Development and Reform Commission of China has promoted it in multiple batches, and as of 2025, 105 bases have been included in the key construction list, covering 31 provinces, autonomous regions, and the Xinjiang Production and Construction Corps across the country (Xinhua News Agency, 2025). Through the construction of a national-level collaborative network, it promotes cross-regional "mainline large circulation" and regional "distribution small circulation", playing an irreplaceable role in ensuring agricultural product circulation, reducing logistics costs, and promoting regional economic development (Ma, 2023).

Scholars have conducted extensive research on the development of cold chain logistics, the construction of national backbone cold chain bases in China, and the development of cold chain enterprises for aquatic products. Internationally, scholars focus on technological innovation and management optimization in cold chain logistics, the application of advanced technologies such as the Internet of Things and big data, and collaborative supply chain management, cost control, and related areas, making these research areas hotspots (Mustafa et al., 2024; Shi et al., 2024; Wang & Du, 2025). Based on foreign experience and combined with China's national conditions, has formed some theoretical systems and case analyses, but it mostly adopts relatively subjective research methods, such as the analytic hierarchy process, and there are deficiencies in the combination of water product cold chain enterprises in Dongshan County and the construction of national backbone cold chain bases. There is a lack of in-depth research on this specific region.

This study closely focuses on water product cold chain enterprises in Dongshan County, deeply explores their development trends against the background of the construction of national backbone cold chain bases, through a comprehensive analysis of the opportunities and challenges they face, and proposes targeted and operational optimization strategies to provide theoretical support and practical guidance for the stable development of enterprises. The innovation of this research lies in closely integrating the actual situation of Dongshan County, analyzing the connection between the construction of national backbone cold chain bases and local enterprises, and making up for the current deficiencies in

specific regional research; at the same time, it not only analyzes opportunities and challenges but also provides specific optimization strategies, providing systematic and practical suggestions for enterprises to seize opportunities, respond to challenges, and achieve sustainable development.

2. Overview of China's National Backbone Cold Chain Base Construction and Current Development Status of Aquatic Product Cold Chain Enterprises in Dongshan County

The China National Backbone Cold Chain Base is a major facility constructed by the Chinese government in accordance with its national layout, targeting high-value-added fresh agricultural products production areas and distribution centers, and relying on the existing cold chain infrastructure cluster (Jiang, 2024; Wang et al., 2025). It is an important node in China's National Backbone Cold Chain Facility Network. The construction goal is to build approximately 100 bases by 2025, basically completing a three-level cold chain node facility network, promoting the scale and intensification of cold chain operations, and facilitating the integrated operation of agricultural production, transportation, and sales (Department of Planning, 2022) . The base layout follows three principles: important logistics nodes, industrial aggregation areas, and consumption aggregation areas. As of 2025, it has covered all 31 provinces (autonomous regions, municipalities) across the country, supporting the construction of the "Four Horizontal and Four Vertical" National Backbone Cold Chain Network and performing multiple functions, including industry leadership and intermediate distribution (Department of Economic and Trade Affairs, 2025). At the policy level, from Central Document No. 1 to relevant plans and implementation schemes, a comprehensive top-level design has been established. Local governments also provide supporting measures in terms of land, funds, and taxes. In the future, the bases will develop towards digitalization, greenification, and intelligence.

Dongshan County, as an important "blue granary" in Fujian Province, has a solid foundation in the aquatic product industry. In 2024, the total aquatic product output reached 491,100 tons, and the output value of aquatic product processing enterprises was 14.1 billion yuan, with export volume ranking among the top in the country at the county level. The county's total cold storage capacity is nearly 250,000 tons, accounting for more than one-fifth of the city's total (Fujian Daily, 2025). There are over 400 cold chain transportation vehicles, accounting for one-third of the city's total. Many aquatic product cold chain enterprises play a significant role in ensuring product quality and safety, and promoting circulation. However, enterprises still face many challenges in their development, including outdated and aging equipment, low technical levels, inefficient refrigeration systems, unstable temperature control, and a lack of advanced monitoring equipment on transportation vehicles. In terms of operational management, the low level of informatization, the shortage of professional talent, the lack of comprehensive talent, and the low level

of industry standardization, as well as inconsistent operational norms across different enterprises, all affect collaborative operations and overall efficiency.

3. Opportunities for Aquatic Product Cold Chain Enterprises in Dongshan County brought by China's National Backbone Cold Chain Base Construction

3.1 Policy Support and Resource Integration Opportunities

Policy Support and Financial Subsidies. The Chinese government and local governments attach great importance to the construction of the China National Backbone Cold Chain Base and have introduced a series of policies and subsidies, including land, taxation, passage, and funding, to provide strong support for the development of aquatic product cold chain enterprises in Dongshan County (Bai et al., 2023; Zhu et al., 2023). In terms of land policies, priority is given to ensuring the land demand for base construction and related enterprises, such as the reserved development space for enterprises in the construction of the Zhangzhou China National Backbone Cold Chain Base, reducing land costs and development difficulties; in terms of taxation, enterprises enjoy preferential policies such as accelerated depreciation of fixed assets and additional deductions for research and development expenses; for cold chain vehicles, they enjoy green passage, reducing waiting time for transportation (Li et al., 2025); in terms of financial subsidies, the government sets up special support funds to provide subsidies for cold chain facility construction and technical transformation (Zhu et al., 2023), and the relevant departments in Dongshan County offer the highest subsidy of up to 3 million yuan for qualified projects, and also help enterprises apply for national and provincial demonstration project support to enhance their brand awareness and market competitiveness.

Resource Integration and Collaborative Development. The construction of the China National Backbone Cold Chain Base has promoted the integration of existing cold chain facility resources of aquatic product cold chain enterprises in Dongshan County, thereby addressing scattered facilities, low utilization rates, and idle resources. Small enterprises can lease idle cold storage facilities to large enterprises to achieve resource sharing and complementarity. In terms of industrial collaboration, enterprises have become more closely integrated with their upstream and downstream partners. They have achieved integrated operations from fishing to storage and transportation, including processing, reducing the number of intermediate links. They have also cooperated with e-commerce platforms to expand sales channels, leveraging big data to optimize inventory management and distribution plans. For instance, Guoyuan Biotechnology Co., Ltd. has collaborated with e-commerce platforms to directly deliver Dongshan specialty aquatic products to consumers, enhancing sales volume and brand awareness. The resulting industrial agglomeration has reduced operating costs and enhanced the industry's overall competitiveness.

3.2 Market Expansion and Brand Enhancement Opportunities

Market Expansion and Logistics Efficiency Improvement. After the completion of the national backbone cold chain base in China, the well-developed cold chain network provides strong support for Dongshan County's aquatic product cold chain enterprises to expand markets both domestically and internationally. In the domestic market, leveraging a wide range of cold-chain transportation networks, enterprises have established partnerships with local distributors and retailers to introduce high-quality aquatic products to inland cities for sale (Liu et al., 2023). In the international market, advanced cold chain technologies and a complete logistics system ensure that aquatic products meet international standards, helping enterprises enter markets in Southeast Asia, Europe, and North America (Wang et al., 2024). Through participation in international exhibitions and trade fairs, enterprises have established cooperative relationships with international buyers. At the same time, improvements to the cold chain network have enhanced the speed of circulation and the quality-guarantee capabilities (Liu et al., 2021). Advanced equipment and information management enable real-time temperature monitoring throughout the process, reducing quality degradation and spoilage, shortening the time from production to market, and improving consumer satisfaction.

Brand Building and Market Competitiveness Enhancement. The "golden brand" of the national backbone cold chain base has promoted the brand building of Dongshan County's aquatic product cold chain enterprises. The strict quality standards and standardized management systems have enabled the products to receive high-quality labels, enhancing consumer trust and recognition. Dongshan County's aquatic product cold chain enterprises have leveraged this brand influence to enhance product quality, optimize packaging design, and strengthen brand promotion, creating regional brands such as "Dongshan Seafood" and "Dongshan Small Tube". Through online and offline promotion, they have increased brand awareness and reputation. Brand building enables differentiated competition among products, helping enterprises stand out in fierce market competition, increasing market share and economic benefits, and driving the upgrading of the entire aquatic product industry, and promoting sustainable development.

3.3 Technological Upgrade and Innovation Opportunities

Technological Innovation and Application Promotion. The construction of the national backbone cold chain base in China has promoted the introduction and application of advanced cold chain technologies by Dongshan County's aquatic product cold chain enterprises. Internet of Things technology enables the real-time collection and transmission of information, such as temperature, humidity, and location, during storage and transportation (Cil et al., 2022). Enterprises can monitor the cold chain status through terminal devices and receive automatic alarms for abnormal situations. Blockchain technology ensures the full traceability of aquatic products, allowing consumers to scan a QR code to access information throughout the supply chain and thereby enhance trust (Zhang et al., 2021).

Automated sorting and storage equipment improves operational efficiency and reduces labor costs and errors. In terms of refrigeration technology, enterprises adopt new, environmentally friendly, and efficient technologies while collaborating with research institutions to conduct technological research and development, thereby promoting continuous progress in cold chain technologies (Petruzziello et al., 2025).

Talent Cultivation and Innovation Capability Enhancement. The construction of the national backbone cold chain base has facilitated the cultivation and introduction of talents by Dongshan County's aquatic product cold chain enterprises. Enterprises have collaborated with universities and vocational schools for order-based training, sending out multi-skilled talents, and regularly organizing employees to participate in training and academic exchange activities to enhance professional skills. By providing competitive salaries and development opportunities, they attract outstanding cold chain talents from home and abroad, bringing advanced technologies and management experience. Through established industry-university-research cooperation, enterprises can promptly grasp the latest technologies and development trends, and convert research results into practical applications. For example, a certain enterprise collaborated with local universities to research cold-chain preservation technology for aquatic products, extending product shelf life and enhancing market competitiveness.

4. Challenges Faced by Water Product Cold Chain Enterprises in Dongshan County in the Construction of China's National Backbone Cold Chain Base

4.1 Challenges of Infrastructure and Technology Shortcomings

Insufficient Cold Chain Facilities and Inappropriate Layout. Although water product cold chain enterprises in Dongshan County have a certain scale in terms of cold storage capacity and the number of transportation vehicles, they still face insufficient facilities and inappropriate layouts. With the development of the water product industry, existing cold storage capacity is unable to meet growing storage needs (Zhang et al., 2023). The problem of insufficient capacity during the fishing season is particularly prominent, and some water products cannot be stored in time (Yang et al., 2022); some transportation vehicles are severely aged, with deteriorating refrigeration equipment and high energy consumption (Wu et al., 2022); in terms of layout, the construction of cold storage facilities in the production area lags behind, making it difficult to pre-cool the water products after fishing, and the connection between the sales area cold storage and the market is not tight, resulting in long distribution distances and poor communication between different cold storage facilities, causing long waiting times and temperature fluctuations during cargo transfer, which affect the continuity and stability of the cold chain and increase losses (Huang et al., 2025; Li et al., 2025).

Lagging Technology and Low Degree of Informationization. Compared with advanced regions, the water product cold chain enterprises in Dongshan County have a large

technological gap. Many enterprises use traditional refrigeration technologies and equipment, with low refrigeration efficiency, high energy consumption, and inaccurate temperature control (Fu et al., 2024); the storage process lacks automated equipment, relying on manual operations, resulting in low efficiency, damage to goods, and inventory chaos; in the transportation process, the application of automated sorting and packaging equipment is limited, affecting transportation efficiency and the safety of goods (Wang et al., 2025). In terms of informationization, most enterprises have not established a complete information management system, unable to conduct real-time monitoring of the entire cold chain process, making it difficult to obtain vehicle location and temperature information during transportation, inaccurate inventory data in the storage process, prone to stock accumulation or shortages, difficulties in information sharing among enterprises, and inability to achieve supply chain collaboration, reducing the efficiency and responsiveness of the entire cold chain system (Han, 2021; Shen et al., 2022).

4.2 Challenges in Operations Management and Cost Control

Low Operational Management Level and Poor Synergy. The operational management of the water product cold chain enterprises in Dongshan County has many problems. The logistics route planning lacks scientific methods, the transportation routes are unreasonable, the mileage increases, wasting resources and prolonging transportation time (Qian et al., 2022); inventory management lacks effective strategies, with widespread stock accumulation, occupying funds and storage space, while there is a risk of shortage (Sheng et al., 2023); the synergy with upstream and downstream enterprises is poor, with poor communication of information between fishing, processing enterprises, and the production plans and logistics plans are difficult to be coordinated (Wang et al., 2024), and there is no effective information sharing with the sales terminals, unable to respond to market demand changes in a timely manner, and the enterprises lack unified dispatch management, resulting in disconnection of logistics, poor information transmission, and reduced overall efficiency of the supply chain (Gao et al., 2021).

High Cost Control Pressure and Weak Profitability. Water product cold chain enterprises in Dongshan County face significant pressure to control costs. Transportation costs continue to rise due to higher fuel prices, increased equipment maintenance costs, and higher labor costs (Shi et al., 2024). The cost pressure is further exacerbated by unreasonable route planning and vehicle scheduling. Storage costs are high due to the high construction and operating costs of cold storage facilities, and aging facilities consume more energy, further increasing expenses (Feng et al., 2023). The continuous increase in labor costs further aggravates the cost burden. In fierce market competition, enterprises find it difficult to pass on costs through price increases; they can only compress profit margins, resulting in weak profitability and a lack of funds for technological innovation, equipment renewal, and market expansion (Wang & Zhao, 2021). This vicious cycle restricts sustainable development.

4.3 Challenges in Market Competition and Industry Regulation

Intense Market Competition and Severe Homogenization. With the advancement of the construction of China's national backbone cold chain base, more capital and enterprises have entered the cold chain logistics sector, and the water product cold chain enterprises in Dongshan County face fierce competition from domestic and foreign counterparts (Xu & Long, 2021). There is a serious phenomenon of homogenized competition in the market, with most enterprises' products and services lacking differentiation. The service content and quality across the cold chain storage, transportation, and distribution processes are almost identical, making it difficult to meet consumers' diverse demands (Mustafa et al., 2024). Enterprises mainly compete for market share through price wars, which not only reduces profit margins but also affects the healthy development of the industry. The lack of differentiation advantages leads to low customer loyalty, leaving enterprises in a passive position in market competition.

Incomplete Industry Regulations and Regulatory Gaps. The current regulations for the cold chain logistics industry are not yet complete, with many loopholes. The quality of cold chain services lacks clear, unified norms (Shi et al., 2024). Some enterprises, to reduce costs, do not strictly adhere to operational standards, leading to unqualified temperature control and long transportation times that compromise the safety and quality of aquatic products (Chen et al., 2022). Although there are relevant regulations and standards for food safety supervision, their implementation is hindered by insufficient regulatory oversight and outdated means, leading to the entry of unqualified products into the market, threatening consumer health and damaging the brand image of Dongshan aquatic products. Incomplete industry regulations and regulatory gaps also lead to market disorder, with illegal enterprises engaging in illegal operations and malicious competition, disrupting the market's normal order and hindering the healthy development of cold chain enterprises for aquatic products in Dongshan County.

5. Strategies for Optimizing the Development of Dongshan County's Aquatic Product Cold Chain Enterprises

5.1 Strengthen Infrastructure Construction and Technological Innovation

Increase Investment in Cold Chain Facilities and Optimize Layout. Dongshan County's aquatic product cold chain enterprises should increase investment in cold storage facilities, transportation vehicles, and related infrastructure, and formulate long-term construction plans to expand cold storage capacity to meet demand driven by production growth. The construction of cold storage should fully consider the distribution of production areas and market demand, prioritize layout in the main production areas and major consumption markets, reduce transportation distances, and upgrade and renovate existing cold storage facilities, update aging refrigeration equipment, and adopt efficient, energy-saving refrigeration technologies. In terms of transportation vehicles, old

vehicles should be eliminated, new specialized vehicles equipped with advanced temperature monitoring devices and refrigeration systems should be purchased, the dispatch management should be optimized, the utilization rate of vehicles should be improved, and the collaborative layout of cold chain facilities between the origin and destination should be established, establishing pre-cooling centers and distribution centers to achieve rapid and efficient transportation of aquatic products, reducing intermediate losses.

Introduce Advanced Technologies and Enhance Informationization Level. Dongshan County's aquatic product cold chain enterprises should actively introduce advanced technologies such as the Internet of Things, blockchain, and automated equipment, install sensors in cold storage, transportation vehicles, and product packaging, and monitor the entire cold chain process in real time through management platforms, and promptly alarm in case of abnormal situations; use blockchain technology to achieve full traceability of products, allowing consumers to obtain detailed information; introduce automated storage equipment in cold storage and use automated sorting and packaging equipment in the transportation process to improve efficiency, reduce labor costs and product losses. At the same time, strengthen the construction of information management systems, integrate information resources from all links, achieve information sharing and collaboration, and monitor inventory, transportation, and orders in real time to optimize operational decisions and improve service quality.

5.2 Improve Operational Management Level and Control Costs

Optimize Operation Management Processes and Strengthen Collaborative Cooperation. Dongshan County's aquatic product cold chain enterprises should comprehensively optimize operational management processes, use logistics planning software, and formulate scientific transportation routes based on transportation demand, traffic conditions, etc., avoid repetitive transportation, and reasonably arrange departure times and batches. In terms of inventory management, introduce advanced methods such as ABC classification and the economic order quantity model; manage inventory by product type and sales frequency; establish inventory warning mechanisms; conduct regular inventory checks; and reduce losses. At the same time, strengthen collaborative cooperation with upstream and downstream enterprises, communicate and coordinate with fishing enterprises to obtain production information in advance, communicate and coordinate with processing enterprises to ensure production needs, and establish information sharing platforms with sales terminals to monitor market changes in real time, achieving seamless connection of all links in the supply chain, improving overall operational efficiency and competitiveness.

Strengthen Cost Control and Enhance Profitability. Aquatic product cold chain enterprises in Dongshan County should conduct an in-depth analysis of cost composition and adopt measures to reduce costs. In terms of transportation costs, optimize routes, increase vehicle loading rates, carry out joint distribution and share resources

with other enterprises, strengthen vehicle maintenance and upkeep to reduce maintenance costs and fuel consumption; in terms of storage costs, optimize the layout of cold storage facilities to improve space utilization, adopt energy-saving equipment and technologies to reduce energy consumption, strengthen equipment maintenance to reduce malfunctions, and reduce overstocking through optimized inventory management; in terms of labor costs, introduce automated equipment and information technology to reduce manual operations, strengthen employee training to enhance business skills and efficiency, establish a reasonable salary system to control cost growth, and improve profitability through comprehensive cost control to provide a guarantee for sustainable development.

5.3 Strengthen Market Competitive Advantage and Regulate Industry Development

Implement Diversified Competitive Strategy and Build Brand Advantage. Aquatic product cold chain enterprises in Dongshan County should implement a diversified, competitive strategy, deeply study market demand, leverage the unique advantages of Dongshan's aquatic products, and develop characteristic products such as organic products, deep-sea treasures, ready-to-eat products, and leisure snacks to meet the needs of different consumer groups. In terms of services, provide customized cold chain logistics solutions, strengthen after-sales services, and improve customer satisfaction and loyalty. In terms of brand building, formulate development strategies, clearly define brand positioning and core values, through improving product quality, optimizing packaging design, using the Internet and social media for promotion and publicity, etc., to enhance brand awareness and reputation, and leverage the differentiation advantage and brand influence to win more market share and customer resources in the market competition.

Promote Industry Regulation and Strengthen Supervision. The government and industry associations should lead the formulation and improvement of industry regulations, clarify the operation norms and technical requirements for cold storage, transportation, and distribution, establish unified service quality standards, improve the food safety supervision system, strengthen quality inspection and supervision throughout the process, formulate industry entry and exit mechanisms, raise the threshold, and eliminate unqualified enterprises. At the same time, strengthen market supervision, establish a specialized supervision institution, equip with professionals, and use advanced technological means to monitor enterprise operations in real time, severely crack down on illegal operations, malicious competition, etc.; guide enterprises to strengthen industry self-discipline, abide by norms and ethics, jointly maintain industry image and reputation, and create a favorable market environment for the development of aquatic product cold chain enterprises in Dongshan County.

6. Research Conclusion and Outlook

This study analyzed the opportunities and challenges faced by aquatic product cold chain enterprises in Dongshan County against the backdrop

of China's national backbone cold chain base construction, and proposed targeted optimization strategies and suggestions. In terms of opportunities, policy support provides land, tax, and financial support for enterprises, and resource integration promotes cooperation among enterprises and industrial synergy; the complete cold chain network helps enterprises expand domestic and international markets, and the "golden brand" of the base promotes brand building; the introduction of advanced technologies and talent cultivation have enhanced the technical level and innovation ability of enterprises. In terms of challenges, there are problems such as insufficient infrastructure and unreasonable layout; technical shortcomings such as backward levels and low informatization; low operational management level; poor coordination; high cost control pressure; weak profitability; fierce market competition and serious homogeneity; incomplete industry regulations; and lack of supervision. Corresponding optimization strategies include: strengthening infrastructure construction and technological innovation, increasing investment in facilities, optimizing layout, and introducing advanced technologies; improving operational management and cost control, optimizing processes, strengthening coordination, and strictly controlling various costs; strengthening market competitive advantage and regulating industry development, implementing differentiated strategies, building brands, promoting industry regulation and strengthening supervision, these strategies are expected to solve the problems of enterprise development and promote the sustainable development of enterprises and the overall competitiveness of the industry.

With the continued expansion of China's national backbone cold chain bases, the development prospects for aquatic product cold chain enterprises in Dongshan County are broad. With improvements in the cold chain logistics network and enhanced technical capabilities, Dongshan's aquatic products will have easier access to domestic and international markets, further increasing their market share and brand influence. Future research can take multiple directions. Firstly, explore the integrated resource collaboration and coordination model between China's national backbone cold chain bases and surrounding regions, establish regional alliances or cooperation mechanisms, and achieve integrated development. Secondly, study cross-regional cooperation models and benefit distribution mechanisms among aquatic product cold chain enterprises in Dongshan County and other regions, and strengthen cooperation in technology, talent, and markets. Thirdly, deeply study the application of emerging technologies, such as artificial intelligence and big data, in cold chain logistics, and explore intelligent warehousing, transportation, and distribution models. Fourthly, improve the regulatory framework and standard system for the cold chain logistics industry, providing a better policy environment and normative guidance for enterprise development.

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