

# Study on the Development Status and Optimisation Strategies of Cold Chain Logistics for Fresh Agricultural Products

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**Abstract:** Effective logistics has a direct correlation with the quality of fresh agricultural products. As consumer demands for the distribution of fresh agricultural products have improved, long-distance and time-consuming transportation can readily impact the freshness of agricultural products, resulting in issues with sales of fresh agricultural products, harming businesses' financial interests, and making it difficult to sell related products on a large scale. The level of development of cold chain logistics, a crucial technology to guarantee the quality and prolong the shelf life of fresh food, is closely linked to the rate of agricultural product loss and customer satisfaction. However, the cold chain logistics system for fresh agricultural products still has a lot of shortcomings due to limitations in infrastructure, management, policies, talent, and some regions have not yet met the demand for its high-quality development, which affects the service effect of the cold chain logistics market. Through the research for this thesis, I hope to provide a reference for the promotion of the sustainable development of the cold chain logistics of fresh agricultural products. This paper analyzes the current state of the development of cold chain logistics of fresh agricultural products, identifies the primary reasons for the emergence of the primary reasons, and proposes the corresponding optimization strategy.

**Keywords:** Cold Chain Logistics; Fresh; Agricultural Products; Development Status; Optimisation Strategy

## 1. Introduction

Cold chain logistics industry connects one, two and three industries, is an important industry to consolidate the results of poverty alleviation, effectively connect rural revitalisation and

promote consumption upgrade, and it is also a piece of blue ocean in the field of logistics. The development of cold chain logistics will become a key starting point in the construction of a new double-cycle development pattern, as demonstrated by China's clear commitment to "building a modern logistics system, accelerating the development of cold chain logistics, coordinating the construction of logistics hub facilities, backbone routes, regional distribution centers and terminal distribution nodes, and perfecting the conditions of national logistics hubs and backbone cold chain logistics bases" during the 14th Five-Year Plan period [1]. China's cold chain logistics sector has advanced remarkably as a result of the ongoing advancements in cold chain logistics technology and the ongoing expansion of consumer demand. However, despite its rapid development, it also faces challenges like outdated technology, poor management and service quality, inadequate infrastructure, and faulty rules that impede the growth of fresh agricultural products' cold chain logistics.

## 2. Current State of Fresh Produce Cold Chain Logistics Development

### 2.1 The Market's Size Keeps Growing.

With the scale and intensification of agricultural production, as well as the improvement of consumers' requirements for food safety and quality, the expansion of the fresh agricultural goods cold chain logistics business has gained growing attention and has ushered in an era of rapid growth. At present, the market scale continues to expand and a huge industrial system has been formed. The cold chain market for fresh agricultural products has grown steadily and has surpassed the hundreds of billions of China Yuan, according to systematic statistics. The following factors are mostly responsible for this growth:

2.1.1 Upgrading consumption: As consumers' standards for food safety and quality have improved, there has been an increase in demand for fresh agricultural products, which has raised demand for cold chain logistics.

2.1.2 The rise of e-commerce platforms: Online purchasing of fresh agricultural products has become a widespread consumption pattern as a result of the e-commerce industry's rapid growth and the emergence of new e-commerce. The cold chain logistics industry's growth has been greatly aided by this shift, which has increased demand for its products.

2.1.3 Government policy support: A favorable external environment has been created for the growth of the cold chain logistics sector by the government's growing support for the agricultural logistics sector.

## **2.2 Growing Consumer Demand for Fresh Produce**

Customers' demand for fresh agricultural products is rising as their quality of life increases, and they have more exacting standards for product quality, freshness, and delivery timeliness [2]. The demand for cold chain logistics has also increased, driven by the trend of fresh agricultural product consumption. The following factors primarily reflect consumers' desire for cold chain logistics services for fresh agricultural products:

2.2.1 The pursuit of food quality and safety  
Concerns about food safety and quality are more important to modern consumers. Customers are more likely to select fresh produce that is transported via a cold chain logistics system and is subject to stringent quality control. To guarantee the food's safety and freshness, they pay close attention to details about the production location, storage conditions, and temperature control during distribution.

2.2.2 High demand for timeliness of delivery  
With the accelerated pace of life, consumers are demanding more and more timeliness in the delivery of fresh produce. Customers expect their orders delivered quickly, particularly in busy cities, and the effectiveness of cold chain logistics has a direct impact on how well customers shop. As a result, one of the key considerations for customers when making decisions is the cold

chain logistics delivery speed.

2.2.3 Increased demand for product diversity  
Customers' varied demands for fresh produce have also led to increased demands for distribution diversity in cold chain logistics. In addition to the traditional distribution by refrigerated trucks, consumers also hope that cold chain logistics can provide services in a variety of temperature control modes, including freezing and constant temperature, to meet the transport needs of different kinds of fresh agricultural products.

2.2.4 Increased demand for personalised services

Consumers' demand for personalisation is evident in the consumption of fresh produce. In order to improve the shopping experience and satisfy particular needs, they anticipate that cold chain logistics service providers would offer individualized services, such as tailored delivery schedules and unique packaging specifications [3]. The cold chain logistics industry's innovation and growth are also fueled by this need for individualized services.

## **2.3 Cold Chain Logistics Infrastructure Construction Level Significantly Improved**

In order to guarantee that fresh food products are consistently kept at a specified low temperature environment during production, storage, transportation, and distribution, cold chain infrastructure consists of a number of facilities and equipment, such as refrigerated trucks, cold storage, refrigerated containers, refrigeration equipment, and temperature monitoring systems, among others. Cold chain logistics infrastructure is being built at an accelerated rate to facilitate the quick movement of fresh agricultural products. A cold chain logistics network that spans both urban and rural areas is being built through the constant use of modern cold storage, refrigerated trucks, railroad refrigerated containers, and other cold chain facilities. China invested roughly 58.55 billion yuan in cold chain infrastructure construction in 2023, an 8.2% increase from the previous year. As of June 2024, China's total cold storage capacity was 237 million cubic meters, up 7.73% year over year, with 9.42 million cubic meters of additional storage capacity scheduled to be added in 2024, according to data from the China Federation of Logistics and Purchasing

(CFLP). In 2023, 432,000 reefer trucks were kept, a 12.9% increase from the previous year. Reefer trucks are predicted to reach 500,000 units by 2024. By combining logistics resources, several major logistics companies are also aggressively mapping out the cold chain logistics market for fresh agricultural products and developing a cold chain logistics system that spans the entire industrial chain.

## 2.4 Technological Innovation and Intelligent Development

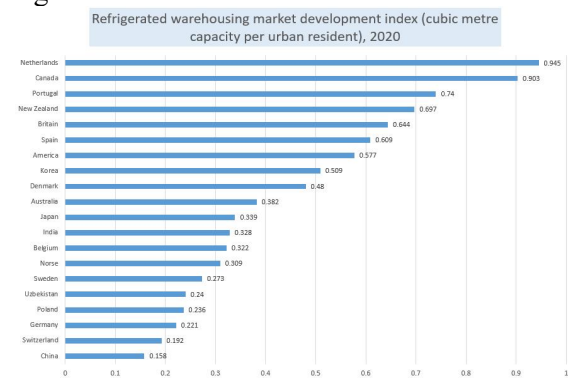
The cold chain logistics sector for fresh agricultural products is aggressively implementing cutting-edge technical tools to support intelligent development in tandem with the ongoing advancements in information technology. The use of big data, artificial intelligence, the Internet of Things (IoT), and other technologies improves the accuracy and efficiency of temperature control, humidity management, and route planning in the cold chain logistics process. In addition to increasing cold chain logistics efficiency, intelligence development lowers operating costs and boosts industry competitiveness [4].

## 3. Issues With Fresh Produce's Cold Chain Logistics

### 3.1 Inconsistency Between Supply and Demand and Unequal Geographic Distribution

Cold chain logistics is highly dependent on infrastructure, including cold storage, refrigerated trucks and refrigerated railway containers. Despite recent increases in national investment in cold chain logistics infrastructure, the infrastructure supply still falls short of the demand growth. Cold chain infrastructure is unevenly distributed between the East, the Middle East and the West, the South and the North, and between urban and rural areas, and there is a lack of supporting cold storage facilities at key logistics nodes, especially in some remote areas, where cold chain logistics infrastructure is weak, which seriously affects the quality of the transport and storage of fresh agricultural products [5]. For example, first-class cities and coastal regions have comparatively flawless cold chain infrastructure, but the central and western regions, which handle the majority of the nation's wholesale trade in fresh agricultural

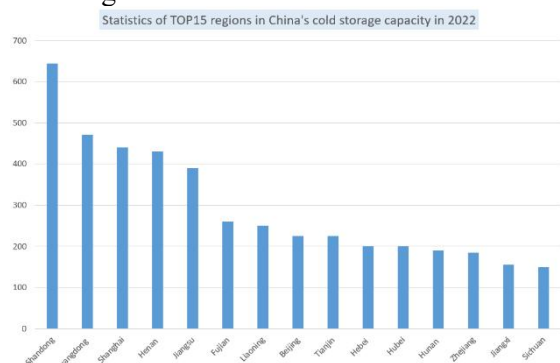
products, struggle with a lack of cold chain resources and lagging development. Firstly, compared to industrialized nations, cities have a modest per capita capacity for cold storage. The market development index developed by Global Cold Chain Alliance (GCCA) shows that in 2020, the per capita storage area in the Netherlands will reach 0.945 cubic metres per person, in Japan it will be 0.339 cubic metres per person, and in China it will be 0.158 cubic metres per person, with the per capita capacity of cold storage only accounting for 1/6 of that of the Netherlands, which reflects that the scale of the cold storage construction in the country still has a large space for growth, and the level of the per capita cold chain resources still needs to be improved, as shown in the figure 1.



**Figure 1. Refrigerated Warehousing Market Development Index (Cubic metre Capacity Per Urban Resident), 2020**

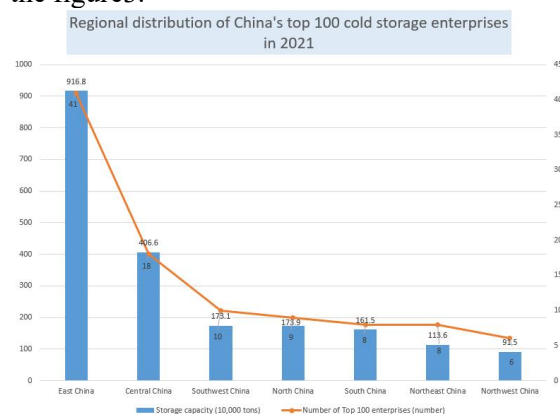
Secondly, the geographical distribution of cold storage capacity is uneven. China Cold Storage Alliance 2022 version of the distribution map shows that in 2022, China's cold storage capacity ranked the top three regions for Shandong, Guangdong and Shanghai, the cold storage capacity of 6,448,000 tonnes, 4,704,000 tonnes and 4.4 million tonnes, respectively, the cold storage capacity of the Shandong region is in the leading position, and Fujian, Jiangsu, Hunan, Sichuan and other sixth to fifteenth-ranked region of the cold storage capacity gap is relatively small. While the central agricultural and animal husbandry production areas and the western characteristics of the agricultural region of the cold storage are relatively few, China's cold storage is primarily concentrated in the East China, North China, and Central China regions, with Shandong, Guangdong, Shanghai, Jiangsu, and other locations having relatively high cold storage capacity and a relatively sound cold

chain transport network and system, as shown in the figure2.



**Figure 2. Statistics of TOP15 Regions with Cold Storage Capacity in China,2022**

The top 100 cold storage companies in 2021 had a combined storage capacity of 20.37 million tons, or roughly 39% of the country's total storage capacity. This represents a 4 percentage point decline from the previous year. The industry's overall concentration is low, the enterprise head is still growing, and the golden period is still developing. Four of the top 100 cold storage businesses in the East China region made the short list, and they are dispersed over 23 provinces and cities. These businesses collectively have 91.68 million tons of storage capacity, making up 45% of the top 100 businesses. The distribution of cold storage typically exhibits the "more east, less west" uneven regional distribution,as shown in the figure3.



**Figure 3. Regional Distribution of China's Top 100 Cold Storage Enterprises,2021**

### 3.2 It Is Necessary to Increase Standardization.

Standardisation of cold chain logistics is key to ensuring product quality and safety. Even while the government has implemented a number of legislative initiatives in recent years to encourage the standardization of cold chain

logistics, there are still numerous obstacles to overcome. Firstly, there is a lack of standardisation in the upstream. Fresh agricultural products and other products have their own natural attributes, which make it difficult to achieve standardisation and large-scale production, and for different kinds of fresh agricultural products, the temperature, humidity and other requirements during storage and transportation are different, but the relevant standards fail to adequately cover these differences, which leads to difficulties in unification of the modifications made by cold-chain logistics enterprises in terms of warehousing, distribution, vehicles and equipment. Secondly, there are differences in the packaging specifications. China's current standards for packaging materials are not specific enough, and if the chain breaks or the temperature is not adequately controlled during cold chain transportation, the fresh goods will deteriorate and decay, which will have a major negative impact on the products' quality and the market's reputation. At the same time, the use of inappropriate packaging materials may lead to packaging is not strong, easy to break, can not effectively protect the fresh goods. In addition, irrational packaging design may also lead to poor packaging results, which cannot maximise the freshness of fresh goods to extend the preservation time. Thirdly, the information sharing and traceability mechanism is imperfect. Many cold chain logistics enterprises lack an effective information management system to monitor and record real-time transport trajectories, temperatures and other key information of the goods. This not only increases the difficulty of logistics management, but also makes it difficult to trace the responsibility when problems occur. Furthermore, data cannot be efficiently shared due to enterprise information system incompatibilities, which hinders the development of standardization and results in ineffective synergy across the cold chain logistics chain [6].

### 3.3 Shortage of Specialised Personnel

Talent is highly sought after in the cold chain logistics sector, particularly in the areas of technology, management, and operation. However, there is currently a shortage of specialised talents in the industry. On the one hand, colleges and technical schools offer

fewer specializations in cold chain logistics, and the quantity of talent developed is insufficient to satisfy market demand. On the other hand, the caliber of current practitioners varies, and they are not well-versed in cold chain logistics standards or capable of putting them into practice. In order to reduce costs, some enterprises tend to neglect the training and education of their employees, resulting in the inability of their employees to operate in accordance with the standard specifications during the operation process, which restricts the innovation and development of the industry.

#### **4. Optimization Techniques for Fresh Agricultural Product Cold Chain Logistics**

##### **4.1 Increasing Infrastructure Investment and Optimising Resource Allocation**

Cold chain logistics companies that create and operate fresh agricultural products should prioritize building hardware facilities and specialized equipment. The government must increase capital and manpower investment in cold chain logistics infrastructure, aggressively encourage the construction and modernization of critical cold chain facilities and equipment, and offer businesses special financial subsidies, such as funding the purchase of refrigerated vehicles and equipment, the construction of modern cold storage facilities, and the encouragement of the construction of cold storage facilities, cold chain equipment, and other hardware, particularly in the less developed areas of the central and western parts of the nation.[7]. To maximize the distribution of cold chain logistics resources and improve system efficiency, social capital investment should also be actively directed. Bolstering the professional equipment for fresh agricultural goods and the hardware development of cold chain logistics infrastructure, in the early stages of cold chain logistics, financial assistance is required. The adage "if you want to do a good job, you must first make good use of your tools" applies here, as modern hardware facilities and equipment are essential to increasing business productivity.

##### **4.2 Establishment of A Sound Standard System and Regulatory System**

In addition to establishing a standards and

regulatory framework, the government has improved macro-control, reinforced the development and revision of standards, and created an ideal cold chain logistics system for agricultural products. In addition to depending on market regulation, government promotion is essential in the development of cold chain logistics for agricultural products [8]. In order for businesses to operate based on evidence, the government should take on the role of policy advice and monitoring, allowing cold chain logistics companies to choose the right development path. To guarantee the safety and traceability of cold chain food, the government should understand proportion, enhance the cold chain logistics supervision and support system, and fortify the management of cold chain logistics. This will allow the implementation of pertinent laws, regulations, and standards. With the help of full temperature control equipment, intelligent temperature sensing and other means to achieve intelligent supervision of cold chain logistics. Actively exploring innovative regulatory methods, fully utilizing the beneficial role of the credit system, public opinion supervision, and industry organizations, and further standardizing the cold chain logistics operating process through these diverse means are all necessary to ensure the industry's healthy and orderly development. At the same time, mandatory regulations should be in place to oversee and manage the pertinent operations of cold chain logistics companies, encourage agricultural cold chain logistics companies to fulfill their primary safety responsibility, stop irregularities, and create a favorable environment for their growth.

##### **4.3 Promoting Technological Innovation and Application**

Fully support science and innovation-oriented enterprises based on the cold chain infrastructure field, and guide the efforts of governments at all levels in terms of policies, funds, land and talents. Firstly, promote the pilot of digital cold storage and build a multi-level digital cold storage network. Simultaneously, the cold chain logistics information platform's architecture has been progressively enhanced, removing obstacles to industry data and enabling information sharing and circulation. Secondly, it will improve the

level of industry intelligence, encourage the integration of technological innovation, strengthen the use of cold chain smart technology, and encourage the extensive use of cutting-edge technologies like blockchain, 5G, and the Internet of Things in the field of cold chain logistics [9]. Thirdly, in order to meet the "double carbon" aim, we will assist cold chain logistics companies in their green transformation. Fourthly, we will improve the current state of uneven urban and rural cold chain development, encourage two-way integration and coordinated development of urban and rural cold chain networks, and optimize urban and rural cold chain channels. Fifthly, create the ecosystem for the cold chain industry, establish the new "cold chain logistics +" model, and use industrial collaborative innovation to broaden the cold chain logistics sector's varied development route.

#### **4.4 Specialised Personnel Training**

Talents are indispensable to the operation of enterprises, and the quality and quantity of talents determine the level of development of agricultural cold chain logistics enterprises. The national policy encourages qualified general undergraduate colleges and vocational colleges to establish cold chain logistics majors or courses in order to address the shortage of cold chain logistics talent. These courses will focus on developing professionals in cold chain product supply chain management, cold chain logistics system planning, cold chain logistics technology and enterprise operation, and other related fields. Enhance the integration of academia, industry, government, research, and application. The government, industry, academia, research and application of multi-level cold chain logistics personnel training system should be improved, and international exchange and cooperation should be carried out at multiple levels and in a wide range of fields, so as to cultivate high-level cold chain logistics personnel with a global vision and experience in international supply chain operation. At the same time, it should strengthen the cooperation between universities, cold chain logistics-related enterprises and industry associations, and enhance the cultivation of practical ability and innovation ability of cold chain logistics talents through various ways such as practical

training bases and order classes. Enterprises should make great efforts to introduce high-quality technical talents, organise comprehensive training and operation experiments to improve the theoretical knowledge and professional skills of existing management and operation personnel, so as to improve the supply chain management level and service level of fresh agricultural products in enterprises [10].

#### **5. Conclusion**

As an important link in guaranteeing food safety, cold chain logistics for fresh agricultural products is facing tests in many aspects. First of all, from the analysis of the current situation, the geographical distribution of cold chain logistics infrastructure is unbalanced, the degree of standardisation needs to be improved, and there is a shortage of professional talents, which requires that the government should increase the investment in cold chain logistics infrastructure, optimise the allocation of resources for cold chain logistics, set up a perfect standard system and supervisory system, and play the functions of policy guidance and supervision, so as to point out the correct direction of development to cold chain logistics enterprises. Cold chain logistics enterprises have continuously invested in technological research and development and equipment upgrading to continuously improve service quality and enhance competitiveness. Establishing a cold chain logistics talent echelon and improving the training of cold chain logistics specialists are necessary. Businesses enhance employee training and raise the technical proficiency and professional caliber of cold chain logistics workers handling fresh agricultural products. In addition, the seasonal and time-sensitive characteristics of fresh agricultural products also require logistics enterprises to build a flexible logistics network to cope with the rapid changes in market demand. The market for cold chain logistics has a lot of potential because of the ongoing rise in consumer demand for fresh agricultural products. In order to jointly support the continued growth of the fresh agricultural products cold chain logistics industry, logistics companies should take advantage of the chance to offer customers safer and more effective logistics services through technological innovation and

service optimization. At the same time, they should increase their scale and improve their market competitiveness through collaboration, mergers, acquisitions, etc.

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