

Research on the Construction of an Integrated Cold Chain Logistics Model for Agricultural Products in Tai'an City Based on Internet of Things Technology

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Abstract: With the continuous improvement of residents' consumption level and the rapid development of agriculture, the public's demand for fresh meat products, fruits and vegetables and other agricultural products is increasing. At the same time, higher requirements are put forward for the freshness and safety of agricultural products, and cold chain logistics of agricultural products has emerged. However, the establishment of an integrated cold chain logistics system for agricultural products faces problems such as a large span of infrastructure construction regions, high threshold, lack of leading organization in network infrastructure construction, and lack of institutional guarantee in market operation mechanisms, resulting in slow and imperfect system construction speed. Research has found the following problems: the agricultural cold chain logistics industry lacks policy support; The cold chain logistics equipment for agricultural products is not sound, and the cold chain technology is relatively backward; Lack of professional cold chain logistics qualified talents; The informationization standards of cold chain logistics are chaotic, and the laws and regulations are not sound; The development of third-party fresh agricultural product logistics enterprises lags behind; The degree of information sharing in agricultural product logistics is low. Finally, policy recommendations are proposed from two aspects: the cold chain logistics model for agricultural products and the implementation path of integrated cold chain logistics for agricultural products.

Keywords: Internet of Things Technology, Cold Chain Logistics of Agricultural Products, Integrated Mode

1. Introduction

Most of the research on cold chain logistics by Chinese scholars focuses on the current status of cold chain logistics development, as well as comparative studies at home and abroad, existing problems and countermeasures, and development prospects [1, 2]. The problems in the current cold chain logistics system from the aspects of circulation, processing, storage, transportation and sales of agricultural products, as well as the level of informatization. The establishment of the China Logistics Procurement Federation in 2001 and the widespread attention of the government and society to the development of the logistics industry have led to a qualitative leap in the development of cold chain logistics in China. However, due to the fact that China's cold chain logistics has undergone over 200 years of development abroad

in just a few decades, its development has become distorted and extreme. China's production and consumption of fresh agricultural products such as vegetables, fruits, meat, and aquatic products rank first in the world [3]. However, due to the lack of a complete cold chain environment and control in the circulation and transportation of 80% of fresh agricultural products, the circulation and decay rate of fresh agricultural products ranks first in the world, and there is a significant gap in the cold chain circulation rate of agricultural products with developed countries such as the United States and Japan [4]. The low efficiency of cold chain circulation of fresh agricultural products and the lack of integrated cold chain logistics system guarantee have become the main factors restricting the development of China's fresh agricultural product trade market, especially the international agricultural product trade market [5].

As an agricultural city, the construction of an integrated cold chain logistics model for agricultural products in Tai'an based on Internet of Things technology will help promote rural economic development, increase farmers' income, and improve their living standards; It will contribute to the construction of the digital government in Tai'an City; It will contribute to the formulation and improvement of government policies, and has significant practical and guiding significance [6].

2. Analysis of the Current Development Status of Cold Chain Logistics for Agricultural Products in Tai'an City

(1) The Development Status of Modern Logistics Industry in Tai'an City

Tai'an City is located in the core area of the economic circle of the provincial capital city cluster, and is an important component of the national comprehensive transportation hub of Jinan, where the Beijing Shanghai and Jiqing comprehensive transportation channels intersect [7]. In 2017, the total logistics volume of Tai'an City reached 997.56 billion yuan, a year-on-year increase of 10.4%, forming a scale of nearly one trillion yuan in annual total. At present, the city has 1074 registered logistics market entities, 24 logistics parks, 147 logistics enterprises above designated size, with a total investment of 27 billion yuan. The proportion of logistics enterprise investment in fixed investment ranks second in the province, accounting for 11.7% of the city's fixed assets investment [8].

With the continuous growth of the economy in Tai'an City and the continuous development of China's logistics industry, many well-known logistics enterprises at home and abroad have joined the Tai'an market, driving the development of Tai'an's logistics industry. In 2018, there were more than 14000 specialized logistics enterprises in Tai'an, an increase of more than 30 times from the more than 400 in 2010. It is these enterprises that have formed a comprehensive logistics industry cluster. This includes Sino foreign joint ventures, local enterprises, and enterprises that focus on refined delivery services, leading to the continuous improvement of service methods and professional operation levels of various logistics enterprises [9].

During the 12th Five Year Plan period, focusing on building a large logistics system, Tai'an City made efforts to integrate existing resources, accelerate institutional and mechanism innovation, and build a total of 24 logistics parks with a total investment of nearly 30 billion yuan. The construction of logistics infrastructure is steadily progressing [10].

(2) Production, sales, and circulation status of agricultural products in Tai'an

Tai'an City is a major agricultural city with a wide variety of agricultural products and high yields. In 2017, the added value of agriculture, forestry, animal husbandry, and fishery in Tai'an Province reached 20.346 billion yuan, an increase of 3.8% compared to the previous year. From the specific

situation, the added value of the planting industry reached 4.772 billion yuan, an increase of 5.8% compared to the previous year; The vegetable production was 573700 tons, a decrease of 0.1%; The fruit production was 411400 tons, an increase of 3.7%; The total meat production was 197600 tons, an increase of 4.5%. The overall industrial value of agriculture is showing a development trend [11].

In 2016, Tai'an City was designated as a demonstration city for the development of cold chain logistics in Shandong Province. Subsequently, in accordance with the spirit of the Notice of the Provincial Department of Commerce and the Provincial Department of Finance on Doing a Good Job in Cold Chain Logistics Demonstration [12], and in combination with reality, the Implementation Plan for the Construction of a Cold Chain Logistics Development Demonstration City in Tai'an City was formulated. At the end of 2017, Tai'an cold chain logistics public information platform was opened in Suheng Logistics Park, Mount Taishan District. The level of cold chain logistics technology is constantly improving, people's dietary structure is constantly improving, and the demand for fresh agricultural products is constantly increasing, bringing opportunities for the development of cold chain logistics for agricultural products [13].

Shandong Province, where Tai'an City is located, is a major city for agricultural product circulation. In order to promote the continuous development of the agricultural product trading market, the government has established Shandong Agricultural Product Trading Network and Agricultural Product Trading Platform. The construction of e-commerce platforms has expanded the scope of agricultural product transactions, broadened channels for farmers to obtain agricultural product transaction information, improved market transaction efficiency, and played an important role in promoting the growth of the number of agricultural product transactions [14].

In recent years, Tai'an City has focused on enhancing logistics infrastructure construction, investing a large amount of financial and human resources in the construction of transportation modes such as railways, highways, waterways, and aviation.

3. Existing Cold Chain Logistics Integration Models for Agricultural Products at Home and Abroad

(1) Integrated model of cold chain logistics for domestic agricultural products

With the continuous development of cold chain logistics, Chinese scholars have conducted a lot of research on the integration of cold chain logistics and proposed many integration models. However, at present, the operational models of cold chain logistics for agricultural products in China can generally be divided into the following three categories:

One is the cold chain logistics model led by the operation of large-scale agricultural product wholesale markets. The

advantage of this model is that it can gather dispersed agricultural products, integrate agricultural product resources to a certain extent, and avoid decentralized management of agricultural products. It can improve the utilization rate of logistics resources and effectively solve the contradiction between small production and large market. But there are inadequate supporting facilities and single service functions; There are many broken links, making it impossible to achieve the full cold chain of agricultural products; the problem of untimely feedback and weak transmission of information [15].

The second is the cold chain logistics model led by large agricultural product processing enterprises. This mode has fewer logistics links and can accelerate the speed of material circulation; High market sensitivity and timely information feedback can enhance the added value of fresh agricultural products to a certain extent. However, due to the limited scale and weak coordination and negotiation abilities of most agricultural product operators at present, they are at a disadvantage in profit distribution and negotiation with partners. Once information asymmetry occurs, the interests of logistics demanders are easily infringed upon.

The third is the agricultural product cold chain logistics model led by chain supermarkets. This mode can reduce logistics links, lower costs, help improve the efficiency of fresh agricultural product logistics, and help achieve continuous low-temperature status of agricultural products throughout the entire logistics chain. However, it is difficult to achieve economies of scale in the short term, there are production risks, and the interests of farmers cannot be guaranteed.

(2) Integrated Development of Cold Chain Logistics for Agricultural Products Abroad

In the United States, the main body of the market is agricultural product producers and consumers. Products are distributed from agricultural product producers through wholesalers or direct sales to supermarket chains, small and medium-sized stores, catering enterprises, etc., directly reaching consumers. The circulation links are few, the efficiency is high, and the degree of integration is high. In addition, the cold chain infrastructure is well-established and the level of informatization is high; The cold chain logistics industry has a detailed division of labor and a high degree of organization.

Japan is currently the country with the most extensive application of automated three-dimensional warehouses in the world. And Japan has established a cold chain logistics supply chain management system for agricultural products through information technologies such as RFID and sensors, which dynamically monitors and tracks goods and refrigerated transportation vehicles, improving logistics efficiency. Statistics show that the number of refrigerated and fresh-keeping vehicles in Japan is around 120000, with a refrigerated transportation rate of over 90% and a product decay rate of less than 5% during transportation.

In order to meet consumer demand, the Netherlands actively develops agricultural product supply chains. One method is to establish a transfer station near the market, where

agricultural products are first concentrated and then distributed. At present, a new electronic and exchange based information and ordering system has been established at the Dutch Flower and Horticulture Center, and services are provided to customers worldwide through the development of e-commerce transaction models.

4. The Constraints of the Integrated Development of Cold Chain Logistics for Agricultural Products

In China, relevant laws and regulations are not sound enough, and the government does not have many preferential policies and financial support for the development of the cold chain logistics industry. The government lacks institutional basis in regulating the logistics of agricultural products, and the flawed logistics market provides many unscrupulous businesses with opportunities to take advantage of it.

Due to the high price of cold chain logistics equipment and the lack of professional talents in cold chain logistics, the popularity of cold chain logistics in Tai'an City is poor, and the infrastructure and equipment are relatively lacking, resulting in low operational efficiency. As a result, the vast majority of current agricultural product logistics distribution is natural logistics distribution. Especially in the main agricultural product production areas, the coverage of cold storage is low, and there is a serious disconnect in the initial field pre cooling stage of the cold chain supply chain. In addition, there is a serious shortage of refrigerated transportation vehicles in the city, which cannot meet the logistics transportation needs of the peak season for agricultural product picking. Traditional transportation methods also greatly increase the loss of agricultural products, reducing the overall logistics efficiency.

Compared to normal temperature logistics, cold chain logistics is much more complex and has higher requirements in management, technology, and operation. The good operation and management of agricultural product cold chain logistics require practitioners to master knowledge of food freezing and refrigeration, as well as logistics and supply chain operation skills. They also need to be familiar with e-commerce related knowledge and network marketing operation skills. However, there is currently a shortage of high-quality composite logistics talents who meet the above requirements.

Although China has officially released the "Classification and Basic Requirements for Cold Chain Logistics", the national standards related to "cold chain" include "Evaluation of Service Conditions for Cold Chain Logistics Enterprises", "Specification for Cold Chain Logistics Services for Aquatic Products", "Requirements for Traceability Management of Food Cold Chain Logistics", etc., the legal norms for e-commerce self built cold chain logistics are still outside the agenda. Moreover, many relevant laws and regulations on cold chain logistics are scattered among multiple laws and regulations. At the same time, the supervision of fresh

agricultural product cold chain logistics is also very chaotic, with multiple regulatory departments managing it, resulting in insufficient supervision and responsibility shifting.

The perishable nature of fresh products places high demands on logistics delivery, making it difficult for enterprises to achieve comprehensive and door-to-door delivery, and they can only rely on third-party logistics companies. Third party logistics is a concrete manifestation of the gradual refinement of social division of labor, and its development level has a significant impact on the establishment of the entire cold chain logistics system. At present, an important factor restricting the integrated development of cold chain logistics in Tai'an City is the slow development of third-party logistics.

At present, there are few agricultural e-commerce websites and e-commerce logistics websites in China, and their coverage is low, especially in Tai'an City. Real time sharing of agricultural product logistics and e-commerce information cannot be achieved throughout the entire chain of picking, transportation, storage, packaging, circulation, processing, and sales of agricultural products. The information technology construction of market-oriented cutting-edge information, agricultural product traceability system, public service system, etc. is still relatively lagging behind, often resulting in the phenomenon of "goods cannot be found and vehicles cannot be found and delivered".

5. Construction of an Integrated Cold Chain Logistics Model for Agricultural Products in Tai'an City

(1) Analysis of Cold Chain Logistics Model for Agricultural Products in Tai'an City

The agricultural trade docking model for local low-end products, which means that agricultural products are directly transported from farmers in the production area to the agricultural market for trading without transportation.

The wholesale market model of regional circulation products, which refers to products with high demand such as local or regional specialties, is not strictly controlled by the market compared to agency products. This type of product generally has high market demand but low profits.

The agricultural enterprise docking model for exporting products. Through agricultural enterprise docking, enterprises carry out research and development and promotion of advanced planting and preservation technologies in production areas, cultivate high-quality varieties, implement standardized production, and ensure the quality and yield of products during production. In addition, enterprises will directly cooperate with farmers to develop export and production plans, providing them with fixed sales channels for their products, reducing their planting risks, stabilizing their income, increasing their planting enthusiasm, and promoting large-scale production and agglomeration of agricultural products.

The agricultural supermarket docking model for popular consumer products. Merchants can conduct on-site

inspections at the origin of agricultural products and make personal purchases, greatly reducing unnecessary links in cold chain logistics and minimizing the occurrence of "chain breakage" and repeated freezing in cold chain logistics. This ensures product quality and hygiene safety, reduces logistics costs, and meets consumer needs.

(2) The Implementation Path of Integrated Cold Chain Logistics for Agricultural Products in Tai'an City

At the government level: (1) Increase investment and plan a complete cold chain logistics system. (2) The model of government investment and enterprise operation can be adopted, and both parties can jointly build an integrated query platform for cold chain logistics and transportation of agricultural products to improve the degree of integration. (3) Develop relevant laws, regulations, and industry standards.

Industry level: (1) Improve information monitoring technology for product cold chain. (2) Unified technical standards for cold chain logistics integration of agricultural products. (3) Establish a sound coordination and cooperation mechanism between relevant departments and organizations.

Production level: Increase cooperation among producers and reduce transaction costs for individual farmers entering the market. At the same time, ensuring the stability and sustainability of fresh agricultural product supply, reducing individual transaction risks and costs.

At the enterprise level: (1) Strengthen software and hardware construction, achieve information integration, and actively promote the application of modern technology in cold chain logistics. (2) Vigorously cultivate leading logistics enterprises and promote the continuous optimization of the supply chain. (3) Actively promote the joint distribution model and promote the development of integrated cold chain logistics for agricultural products.

6. Conclusion

This article first analyzes the current development status of agricultural cold chain logistics in Tai'an City and finds the following problems: the lack of policy support for the agricultural cold chain logistics industry; The cold chain logistics equipment for agricultural products is not sound, and the cold chain technology is relatively backward; Lack of professional cold chain logistics qualified talents; The informationization standards of cold chain logistics are chaotic, and the laws and regulations are not sound; The development of third-party fresh agricultural product logistics enterprises lags behind; The degree of information sharing in agricultural product logistics is low. Finally, policy recommendations are proposed from two aspects: the cold chain logistics model for agricultural products and the implementation path of integrated cold chain logistics for agricultural products.

Conflicts of Interest

The authors declare no conflicts of interest.

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