

Research on the Construction of Intelligent Cold Chain Logistics System for Prepared Dishes Based on AI Technology

Lijuan Xu^{1,2,*}, Heng Zhuang¹, Langqing Li¹, Jifei Hu¹, Xuelian Liao¹

¹*School of Economics and Management, Sichuan Tourism University, Chengdu Sichuan, China*

²*Key Laboratory of Sichuan Cuisine Artificial Intelligence, Chengdu, Sichuan, China*

**Corresponding Author.*

Abstract: China's prepared vegetable industry has achieved certain development, and the prepared vegetable market is huge and the market space is large, but it still faces some challenges and problems. The food quality of prepared dishes needs to be guaranteed by high-quality cold chain logistics. However, the development level of cold chain logistics in China is relatively insufficient, and the corresponding development level of cold chain logistics of prepared dishes is of low quality, which restricts the development of prepared dishes industry to a certain extent. With the development of artificial intelligence, cloud computing, big data, Internet of Things and other technologies, digital and intelligent technologies are increasingly applied in logistics. The application of intelligent logistics technologies such as artificial intelligence technology to build smart cold chain logistics system is conducive to improving the level of cold chain logistics of prepared dishes, ensuring the quality of prepared dishes, promoting the upgrading of prepared dishes industry, and expanding the market of prepared dishes industry.

Keywords: Artificial Intelligence; Premade Dishes; Cold Chain Logistics; Intelligent Cold Chain Logistics System; Logistics Information System

1. Introduction

With the upgrading of consumer consumption level and the diversification of consumer demand, the acceleration of the pace of life and the development of the Internet e-commerce industry, the prepared dish industry has developed rapidly in recent years. Especially in recent years, the rapid growth of the prefabricated vegetable market is expected to exceed 830 billion yuan by 2025, and exceed

one trillion yuan by 2026. In 2022, there are nearly 600 prefabricated vegetable production enterprises in Sichuan Province, with an operating income of nearly 70 billion yuan^[1-2]. Along with the development of prepared dishes, there are also some challenges. For example, consumer distrust, quality problems of prepared food, packaging and storage of prepared food products. In foreign countries, the prepared food industry is more mature, and consumers have a good acceptance, which cannot be separated from high-quality prepared food and healthy ingredients, as well as a high level of prepared food transportation and storage. It can be seen that a higher level of cold chain logistics can effectively ensure food quality, improve consumer satisfaction, and promote the development of the food industry. With the development of big cloud moving intelligence technology, the integration of artificial intelligence technology with the prepared dish industry^[3]. And the construction of the intelligent cold chain logistics system of prepared dish based on artificial intelligence are conducive to improving the level of cold chain logistics, ensuring the quality of prepared dish food, enhancing consumers' trust, and reducing waste, thus promoting the development of the prepared dish industry.

2. Development of Cold Chain Logistics for Prepared Vegetables in Sichuan Province

2.1 Basic Situation

2.1.1 In terms of policies

Sichuan Province has successively issued documents such as the "14th Five-Year Plan" cold chain Logistics Development Plan, "2022 Modern Agricultural drying cold chain Logistics," and the "14th Five-Year Plan" Modern Circulation System Construction Implementation Plan. Opinions on the Key Work of Rural Revitalization in 2023 and

Accelerating the Construction of a strong Agricultural Province issued by the government pointed out that it is necessary to support the construction of agricultural supply chain system, and promote the construction of cold storage and preservation in agricultural production areas and cold chain logistics infrastructure in distribution centers [4]. In 2024, the "Action Plan for the Integrated Development of the One, two and three Industries in Rural Sichuan Province" issued by the Sichuan Provincial Government encourages enterprises to speed up the construction of cold chain logistics facilities such as preservation, refrigeration, freezing, and transportation.

2.1.2 In terms of infrastructure construction

Sichuan Province's cold chain logistics has begun to take shape. It has built the national backbone cold chain logistics base in Chengdu and Suining and the comprehensive cold chain logistics base of the new land and sea channel in the west of Qingbai River, forming a cold chain logistics network centered on Chengdu, Meishan, Mianyang, Zigong, Deyang and other cities, providing important support for local economic development and residents' lives. Vigorously improve the construction of refrigeration facilities, transportation tools and distribution centers to meet the environmental requirements of temperature and humidity during the transportation and storage of prefabricated cold chain products.

2.1.3 In terms of technology application

The development of intelligent technology has promoted the development and level of the cold chain logistics industry, and some third-party cold chain logistics enterprises and prefabricated vegetable production enterprises Tianfu Smart kitchen use artificial intelligence, 5G+ optical fiber, Internet of things and other technologies to build intelligent cold chain logistics monitoring systems. At the same time, the upgrading of food preservation technology such as refrigeration and preservation and the production technology of prepared vegetables has also effectively promoted the development of cold chain logistics of prepared vegetables.

2.2 Challenges and Deficiencies

The development of cold chain logistics has shown a positive growth trend, which makes the cold chain logistics of prepared vegetables have a good development, but it also faces some challenges and problems in the development.

2.2.1 In terms of standard formulation

Cold chain logistics involves many subdivisions, food, medicine, etc., and in the food field, the appropriate temperature zone for different types of fruits, vegetables, fish and so on is also different. Similarly, in the subsector of prefabricated cold chain logistics, it also involves different ingredients and prefabricated food products in different storage temperature zones. For prefabricated cold chain logistics, the formulation of its standards has not been unified. This makes the cold chain logistics operating standards, operating processes, and operating requirements of different prepared vegetable enterprises and different prepared vegetable cold chain logistics service providers different. To a certain extent, it is difficult to ensure the provision of high-quality prepared food cold chain logistics services, so it is impossible to guarantee the quality of prepared food and the speed of product circulation in the cold chain logistics link.

2.2.2 In terms of infrastructure construction

Compared with ordinary logistics, cold chain logistics requires large investment in cold chain logistics infrastructure construction, such as freezing storage, cold storage, air conditioning storage, refrigerated trucks, and refrigerated trucks, and the return cycle of investment is short, making its infrastructure construction lag behind. Although the state, province and municipal government have invested a large amount of funds to support the construction of cold chain logistics, due to the late start and poor economic conditions compared with the eastern provinces, Sichuan, as one of the central and western core city circle, as one of the main provinces in China's cold chain warehousing demand, there is still a gap in the construction of cold chain logistics infrastructure. At the same time, it also faces the problem of unbalanced development of cold chain logistics and unbalanced construction of cold chain logistics infrastructure between provincial capital Chengdu and surrounding cities and counties.

2.2.3 In terms of technical application

Cold chain logistics of prepared vegetables involves cold storage technology such as food preservation and refrigeration, as well as transportation, storage and distribution of prepared vegetables and finished products of prepared vegetables. In order to ensure food quality and control and check the prepared vegetables and products at any time, the

deployment of cold chain logistics monitoring system, cold chain logistics traceability system, cold chain logistics temperature and humidity control system and other systems also requires corresponding sensors, RFID tags, video image recognition acquisition system, communication transmission system and so on. In general, it is necessary to have a high level of hardware and software integration, large investment, long cycle, and large integration environment, and technical difficulty. At the same time, in terms of technology, the technology update iteration is relatively fast. Due to the large investment amount and the impact of cost control, the technology update application cannot be carried out in a good and timely manner.

3. Function Analysis of Intelligent Cold Chain Logistics System for Prefabricated Vegetables Based on AI Technology

Based on the application of artificial intelligence technology, The smart cold chain logistics system of prefabricated vegetables mainly uses technologies and facilities such as Internet of Things technology, sensors, radio frequency identification technology, bar code technology, Internet, mobile terminals, handheld devices, 4G network, 5G network, big data technology, video surveillance system, image acquisition system, artificial intelligence technology and other technologies and equipment in the production process of prefabricated vegetables. Monitor the temperature, humidity and carbon dioxide environment in raw material picking, pre-processing, transportation, production of prefabricated vegetables, storage, transportation and distribution of finished products of prefabricated vegetables, trace the source of ingredients, warn and deal with abnormal conditions, logistics risks and food quality risks, and visually display orders, warehousing, transportation and distribution ^[5-7].

3.1 Smart Cold Chain Logistics Storage System for Prefabricated Vegetables

In the cold chain logistics of prepared vegetables, the storage link is one of the key links, which is a strong guarantee of the quality of prepared vegetables. In the process of cold chain logistics storage, it is mainly necessary to ensure the freshness of prepared vegetables and the quality of finished products. The freshness of the prepared vegetables and the quality of the finished products of the prepared vegetables

need to be kept fresh and refrigerated or frozen in a low temperature storage environment, which is not suitable for human daily operations. Therefore, in the cold chain logistics storage system of prefabricated vegetables based on artificial intelligence technology, on the premise that the Internet of Things technology, sensor technology and other technologies collect and perceive information such as temperature, humidity and carbon dioxide concentration [8], Emerging technologies such as big data, cloud computing and artificial intelligence are used to analyze historical order data of prefabricated vegetable raw materials, order data of prefabricated vegetable products, warehouse data of prefabricated vegetable products, warehouse storage data of different categories of prefabricated vegetable products, order processing timeliness of warehouse operations, picking efficiency, etc., so as to analyze and warn of anomalies and risks. Combined with intelligent robots, automated control systems, intelligent storage management information systems, etc., to complete the low-temperature storage environment of stacking, warehousing and other operations. At the same time, when the system prompts abnormalities and risks, the staff is reminded to operate or automatically control and adjust the temperature and humidity.

3.2 Prepared Vegetables Intelligent Cold Chain Logistics Transportation System

Transportation is another key link in the cold chain logistics of prepared vegetables. High-quality and efficient cold chain logistics transportation can effectively reduce the consumption of food materials, reduce various costs, and ensure the quality of prepared vegetables, improve customer satisfaction and improve market recognition. In the process of cold chain logistics transportation, mainly for the prepared vegetable products with special temperature requirements, the prepared vegetable food is always maintained in an optimal storage temperature through the use of refrigerated trucks or refrigerated trucks, low temperature boxes and other forms to ensure the cold chain of prepared vegetable products, so as to ensure the quality and quality of prepared vegetable products. In order to ensure the continuous cold chain of such prefabricated vegetable products, it is necessary to collect the status of prefabricated vegetable products in real time in the artificial intelligence-based cold

chain logistics transportation system. Therefore, the temperature and humidity collector is used in the interior of the carriage and the low temperature box to collect the temperature, humidity, carbon dioxide concentration and other environments in real time, and the collected data is remotely transmitted to the background management system through the communication module. By the background management information system for data processing and judgment, when the temperature, humidity and other environmental abnormalities, the system alarm and through 4G, 5G and other communication networks quickly issued reminders, the staff and other relevant personnel timely processing of the abnormal situation, in order to prevent the deterioration of prepared food damage, reduce more losses, improve the flow speed and quality of prepared food products. At the same time, through statistics and analysis of the amplitude statistics of the transport vehicle, the number of car doors and cryogenic box opening, the position of the cryogenic box ice bag and the change of the temperature environment in the box, and through the application of big data technology, it is analyzed with historical abnormal data, historical temperature and humidity data and other data, so as to identify the link that has a relatively large impact on its temperature change. To focus on, so as to optimize the transportation, improve the level of cold chain logistics transport of prepared vegetables, to ensure the quality of prepared vegetables.

3.3 Prefabricated Vegetables Intelligent Cold Chain Logistics Distribution System

Distribution is the last link of the prepared food supply chain, facing consumers, is a very important link in the prepared food industry supply chain and the prepared food cold chain logistics. In the cold chain logistics distribution system based on artificial intelligence, GPS and GIS positioning technologies are mainly combined to organize the distribution path between the refrigerated truck and the receiving points on the last kilometer, and automatically select the best distribution path and distribution sequence for path planning, thereby reducing the distribution time and distribution cost. In the distribution system, prepared vegetables can be automatically guided by refrigerated trucks and refrigerated trucks for unmanned distribution, and automatically make delivery time

reservations with the consignee to determine the customer's delivery time, through the Internet of Things, video surveillance system, wireless video transmission, radio frequency identification technology, positioning technology, 5G technology, etc. In the background, the real-time distribution of prepared food in several carts is monitored. When there is an abnormal situation, the abnormal situation can be reminded and alarmed in time, prompting manual intervention and handling of the anomaly, improving customer satisfaction, improving distribution efficiency and quality, and reducing the loss of prepared food. To ensure the food quality and safety of prepared food in the cold chain logistics distribution process.

3.4 Smart Cold Chain Logistics Visualization System for Prepared Dishes

The smart cold chain logistics visualization system for prefabricated vegetables is mainly a visual display of the whole process of the entire supply chain of prefabricated vegetables from raw materials to raw material storage, transportation, in-storage and semi-finished products, as well as finished product production, finished product transportation, finished product warehousing, finished product distribution and so on. As long as the application of radio frequency identification system, bar code technology, sensor technology, visual monitoring system, voice reminder system, video recognition technology, image recognition technology, mobile terminal and other technologies is used to build a visual system and automation platform, and carry out visual order management, visual warehousing management, visual transportation management and visual distribution management of prepared dishes [9]. Real-time tracking and display of the order status of raw material purchase orders for prepared vegetables, the production of prepared vegetables and the sale of finished products for prepared vegetables. Visually display the changes in the quality of prefabricated vegetables and finished products, the changes in ambient temperature and humidity, the execution of tasks in and out of the warehouse, the situation in the warehouse, the transportation and distribution status of prefabricated vegetables and finished products, and the changes in vehicle status, etc., collect relevant data in real time, monitor and control each link

and each operation process, and make statistical analysis of the data. To remind abnormal data, so as to carry out real-time monitoring and management, convenient quality management and control ^[10].

4. Conclusions

Based on the analysis of the current situation of the development of prefabricated cold chain logistics in Sichuan Province from the aspects of policy, infrastructure construction and technology application, this paper analyzes the current challenges from the aspects of standard formulation, infrastructure construction and technology application. In order to improve the level of cold chain logistics of prepared vegetables and ensure the quality of prepared vegetables, an intelligent cold chain logistics system based on AI technology was built based on intelligent logistics technologies such as artificial intelligence, big data and the Internet of Things, and the overall function of the system was analyzed. At the same time, it constructs four sub-systems of prefabricated cold chain logistics storage system, prefabricated cold chain logistics transportation system, prefabricated cold chain logistics distribution system and prefabricated cold chain logistics visualization system, and expounds the functions of the sub-systems respectively.

Acknowledgments

This paper is supported by Key Laboratory of Sichuan Cuisine Artificial Intelligence of Key Laboratory of Sichuan Provincial Federation of Social Sciences: Research on Construction of artificial Intelligence-based Cold chain logistics System for prepared dishes (No. CR23Y17); University-level research Project of Sichuan Tourism University: Research on Development Strategy and Promotion Mechanism of Sichuan Catering Cold Chain Logistics from the perspective of High-quality Development.

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