

Research on the Application of Big Data Technology in the Development of Cold Chain Logistics of Agricultural Products in Guangxi

Jinghuan Zhu¹, Shilong Wang*

270336472@qq.com¹, 65570643@qq.com*

Guangxi Science & Technology Normal University, Laibin, Guangxi, China

Abstract. With the improvement of people's quality of life and the increasing urbanization in China, people are gradually paying attention to and valuing the freshness of agricultural products, especially quality and safety. The emergence of cold chain logistics can precisely solve and ensure the quality and safety of agricultural products, making people feel more at ease when eating. Therefore, this article takes Guangxi as the research object and starts from the background of big data, deeply integrates Big data technology and agricultural cold chain logistics, and uses Big data to manage the whole process of agricultural cold chain logistics, to ensure that every link of agricultural circulation is controllable and traceable, to maximize the quality of agricultural products, reduce the loss of agricultural products, and thus lay a solid foundation for agricultural development and rural revitalization.

Keywords: Cold chain physics, Big data, Real time monitoring.

1 Introduction

In recent years, there has been a notable enhancement in people's quality of life, with a growing emphasis on consuming nutritious and safe food. The introduction of cold chain logistics for agricultural products offers a precise solution to this imperative [1]. The advancement of agricultural cold chain logistics directly correlates with the quality of agricultural goods. Guangxi, renowned as a prominent agricultural province, boasts a diverse array of agricultural products, notably vegetables, fruits, aquatic products, and the distinctive sugarcane industry. With the escalating volume of fresh agricultural produce, the demand for cold chain logistics has correspondingly surged. Given the inherent chemical characteristics and perishability of agricultural products, there is a pressing need for stringent controls, particularly in temperature and humidity regulation and transportation duration. Thus, to uphold the quality and safety standards of agricultural goods, the integration of Big Data technology becomes indispensable for the efficient transmission and management of information throughout the agricultural cold chain logistics process [2]. Against this backdrop, this paper aims to illustrate how Big Data technology can be seamlessly integrated with the cold chain logistics of agricultural products in Guangxi. Such integration holds the potential to substantially enhance the efficiency of agricultural product circulation and serve as a reliable safeguard for the safety of fresh agricultural produce.

2 Overview of Big Data

2.1 Connotation of Big Data

Big data, often referred to as massive data, encompasses an extensive range of information characterized by its vast volume, making it impractical for manual capture, storage, management, and effective processing [3]. This expansive dataset is distinguished by its large scale, rapid processing capabilities, diverse sources, low value density, and inherent authenticity. Presently, the collection, processing, analysis, and application of big data have emerged as a prevailing trend in contemporary society. Viewed through the lens of cold chain logistics for agricultural products, all pertinent information concerning agricultural goods and logistics falls within the realm of big data. This includes data points such as the origin of agricultural products, environmental monitoring during transportation, temperature and humidity levels within transport vehicles, distribution routes, among others.

2.2 The role of Big data in cold chain logistics of agricultural products

As the economy continues to surge forward and people's living standards steadily rise, the demand for agricultural products of superior quality, safety, and freshness has soared. Recognizing the inherent biochemical characteristics and perishability of agricultural goods, stringent requirements for temperature and humidity control throughout the product circulation process have become imperative.

In order to meet the personalized needs of different customers, all major fresh food platforms and agricultural enterprises have introduced barcode, radio frequency technology, global positioning system and other advanced technologies, and the application of Big data has received enough attention and played a pivotal role. First of all, Big data plays an important role in early warning of key links in cold chain logistics of agricultural products. When the temperature and humidity in the circulation process of agricultural products are too high or too low, the data collection layer can automatically identify this abnormal phenomenon and intelligently regulate the storage environment of agricultural products through the application layer. Secondly, Guangxi's agricultural products are sold all over the country. For cities with long transportation distance, Big data should be used to reasonably plan their transportation and distribution routes to ensure that agricultural products can be delivered to customers with quality and quantity in the shortest time [4]. Clearly, big data emerges as a linchpin in the evolution of cold chain logistics for agricultural products, playing a pivotal role in ensuring efficiency and quality throughout the process [5]. The operational framework is depicted in Figure 1.

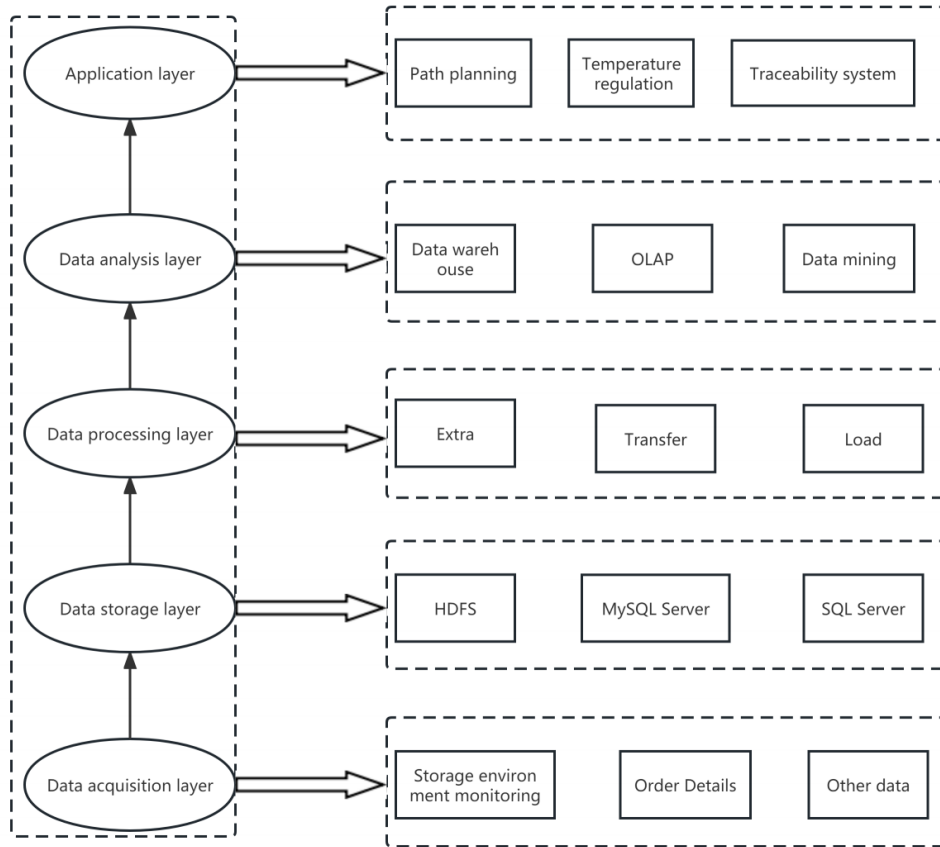


Figure 1. System framework of deep integration of Big data and cold chain logistics of agricultural products

3 The Problems in The Development of Cold Chain Logistics for Agricultural Products in Guangxi

3.1 Agricultural cold chain logistics infrastructure is outdated and outdated

At present, Currently, the cold chain logistics infrastructure for agricultural products in Guangxi lags behind, with outdated facilities and inadequate cold storage construction in production areas. There is a significant lack of pre cooling and refrigeration facilities in the fields of agricultural product production areas, and there is a lack of overall planning for the construction of cold chain infrastructure. According to research data from the Cold Chain Committee of China Internet of Things, as of 2016, the total capacity of cold storage in Guangxi was 894800 tons, which is in the middle to lower position nationwide. The insufficient development of cold storage has to some extent restricted the circulation and development of local fresh agricultural products. Guangxi has adopted cold chain logistics transportation relatively late, resulting in a relatively low utilization rate of cold chain

transportation. Consequently, annual losses during product circulation amount to up to 20% of total agricultural production, significantly surpassing averages observed in developed regions. Moreover, refrigeration technology for agricultural products lags far behind that of developed countries, with a shortage of refrigerated transportation vehicles. Most fresh agricultural products rely on ordinary trucks with ice cooling, or worse, are transported under room temperature or outdoor conditions, dramatically escalating product loss rates. The lagging network infrastructure in the development of cold chain smart logistics for agricultural products fundamentally undermines the level of logistics information available and hampers information sharing throughout the product circulation process. This severe information asymmetry further hinders the connection between agricultural producers and consumers, thereby substantially diminishing the economic benefits derived from agriculture.

3.2 Delayed information sharing

In the advent of the Big Data era, the promptness and precision of information transmission have become focal points across various sectors. The acquisition of market information for agricultural products holds paramount importance in facilitating transactions between buyers and sellers. Presently, China boasts e-commerce platforms like Taobao and JD.com, serving as channels for agricultural product sales online. Additionally, local sales platforms such as Meituan Selection and Duoduo Buying Vegetables further augment market accessibility. Through on-site investigations in Guangxi, most farmers sell their own agricultural products to local buyers, who then sell them. The problems that arise in all subsequent stages are unknown to fruit farmers, including the quality of the agricultural products, the issues consumers have responded to, and the information about their needs. This will to some extent affect the economic returns of fruit farmers, thereby affecting consumer satisfaction with the products, and reducing the economic returns of agricultural product buyers, thereby affecting the sustainable growth of the local agricultural product market.

Beyond market information, the cold chain logistics process for agricultural products necessitates the integration of various information technologies, including Big Data analysis, barcode technology, and GPS positioning systems. These technologies are extensively utilized in the field of agricultural product cold chain logistics, owing to their high versatility and applicability. However, challenges persist in Guangxi's agricultural product cold chain logistics sector, notably pertaining to delayed information updates. For instance, logistical information often remains stagnant from the distribution center to subsequent stations, thus adversely affecting goods delivery efficiency and customer satisfaction.

3.3 Shortage of professional and technical talents in cold chain logistics

With the development of science and technology, the statistics and analysis of Big data has become the trend of the times, and the allocation of Big data related talents will become one of the important factors affecting the development of cold chain logistics of agricultural products. At present, there is a serious shortage of cold chain logistics talents related to Big data in Guangxi, which is an indisputable fact. And cold chain logistics involving Big data is an emerging technology. At present, most universities and vocational schools in Guangxi have logistics management majors, but talent training programs for logistics management majors mainly focus on teaching logistics knowledge. Most universities have more theoretical knowledge, and their practical and hands-on abilities have not been honed. Guangxi

University, as the only 211 university in Guangxi, has only opened a refrigeration and cryogenic engineering major, and there is no professional cold chain logistics course involving Big data, Internet of Things technology application and other information operations [6]. It is difficult for cold chain logistics enterprises to recruit professional technical management talents, so no matter what line of business, no professional technical talents will be able to develop for a long time. Therefore, the shortage of cold chain logistics professionals related to Big data and Internet of Things technology will lead to the sustainable development of cold chain logistics of agricultural products in Guangxi [7].

4 Big data Helps Optimize and Upgrade The Cold Chain Logistics of Agricultural Products in Guangxi

4.1 Strengthen the construction of cold chain logistics infrastructure for agricultural products

In the realm of Big Data, to expedite the development of agricultural product logistics systems, it's imperative for local governments to allocate appropriate financial subsidies. This would facilitate bolstering the construction of cold chain logistics infrastructure for agricultural products and enhancing the cold storage system. For instance, initiatives could include the establishment of cold chain storage and transportation facilities in agricultural production areas, along with the proactive development of logistics service system outlets. At the same time, in rural areas, to improve network infrastructure, relevant departments should also timely maintain the security of network facilities, regularly carry out maintenance and upkeep work, and ensure the timely maintenance and security of network facilities, conducting regular upkeep to ensure seamless information transmission among branches. This initiative aims to provide enhanced convenience for the circulation of local agricultural products.

Moreover, to mitigate the risk of disruptions in agricultural product circulation, there's a pressing need to fortify Big Data infrastructure, build Big data centers in wholesale markets, key cold chain logistics nodes and other places, ensure that the data of each logistics node and the operation and management of the market can be interconnected, thereby maintaining optimal temperature, humidity, and other environmental conditions throughout the agricultural product circulation process. This concerted effort guarantees the freshness and safety of agricultural products, mitigating risks associated with supply chain interruptions [8].

4.2 Improving the timeliness and accuracy of information transmission in agricultural cold chain logistics

With the widespread application of internet technology, stricter requirements have been put forward for the accuracy and cross regional effectiveness of information in the distribution process of agricultural products. As is well known, the flow of information is also the key to the operation of the agricultural product distribution system, and the accuracy of information transmission is the core link of agricultural product distribution. The platform should achieve the flow of information between various platform participants, including consumers, intermediaries, and distribution enterprises, so that each party involved in transactions can timely obtain key information in the market. Therefore, it is necessary to improve the network information exchange system. Firstly, it is necessary to improve the software and hardware

construction of the agricultural product sales network platform, so as to establish a more direct, faster, safer, and more efficient real-time information communication system, enabling buyers and sellers to connect with each other and achieve transparency in the supply chain. This way, every node of the supply chain from farmers to consumers can accurately obtain each other's needs and reactions, Help farmers and suppliers quickly respond to the market, and also enable consumers to obtain more authentic product information. Secondly, a monitoring and early warning system module for agricultural product logistics can be designed, combined with the use of GPS positioning technology, to plan more efficient delivery routes for delivery vehicles and provide more accurate logistics information for merchants and consumers. For example, when the temperature of the delivery vehicle is too high, an alarm can be issued to timely regulate the temperature inside the vehicle. Meanwhile, the route optimization function of the delivery vehicle can avoid vehicles taking congested routes or detours, thereby reducing production and fuel consumption, as shown in Figure Table 1.

Table 1. Agricultural product logistics warning and monitoring system

System	System functional modules	Primary coverage	Effect
Agricultural product logistics warning and monitoring system	Order intelligent allocation	Sort orders by region	Improve delivery efficiency
		Assign the same area to the same delivery person	
	Warning threshold intelligent recommendation	Distribute according to the preservation requirements of different agricultural products	Ensure the freshness of agricultural products
		Vehicle temperature and humidity alarm threshold and order delivery time threshold	
	Real time monitoring of delivery vehicles	Real time monitoring of temperature, humidity, and location information of delivery vehicles	Ensure information interconnection and interoperability
	Order delivery time monitoring	Real time monitoring of order delivery time information	Improve the accuracy of logistics information
	Agricultural product management	Timely check agricultural product information	Improve the transparency of information
Customer feedback management	Manage customer information	Improve customer satisfaction	

4.3 Comprehensive and multi-level cultivation and introduction of cold chain logistics talents

The application of Big data and Internet of Things technology in the field of cold chain logistics of agricultural products requires a large number of resources as support, and the most

important one is logistics professionals. Colleges and universities are not only places for talent gathering, but also "cradles" for cultivating various top talents. If you want to develop cold chain logistics, logistics vocational education is indispensable. All colleges and universities need to have a professional team of excellent teachers who have studied cold chain logistics management and Big data technology, to lay the foundation for colleges and universities to cultivate professional talents. Ordinary higher education institutions and secondary vocational colleges with corresponding conditions can offer courses and majors related to cold chain logistics and Internet of Things technology, with a focus on cultivating composite, professional, and strategic cold chain logistics talents based on Internet of Things technology. Strengthen the cooperation and docking between various universities and cold chain logistics, IoT related enterprises, research institutions, and industry associations, and train cold chain logistics talents through on-the-job internships, practical training bases, and other methods. The government supports the development of cold chain logistics in policies, and in order to attract and encourage talent introduction and retention, provides certain preferential measures to cultivate sustainable agricultural cold chain logistics reserve talents based on the Internet of Things.

5 Conclusion

In the new era, the speed of technological development is very fast, and people also attach great importance to the safety of food. Therefore, cold chain logistics of agricultural products has become an important field of big data application and an important link to ensure the quality and safety of agricultural products [9]. Applying big data technology to cold chain logistics of agricultural products in Guangxi has become an inevitable trend in the development of the times. This can not only improve the efficiency of agricultural product flow, but also ensure the quality and safety of agricultural products, and provide guarantees for the development of rural economy and people's happy lives in China.

Acknowledgments. The first author is Jinghuan ZHU, and the corresponding author is Shilong WANG. The first author is from Guangxi Normal University of Science and Technology, and has obtained the autonomy of Guangxi Normal University of Science and Technology's Youth Social Science Project in 2022, with project number GXKS2022QN056.

References

- [1] Ma Xiaoya Analysis of Development Strategies for Cold Chain Logistics of Fresh Agricultural Products in Guangxi under the Background of "Internet Plus" [J] Business Economics Research, China, 2017 (6): 212-214
- [2] Brito J. Fuzzy Optimization for Distribution of Frozen Food with Imprecise Times[J]. Fuzzy Optimization & Decision Making, 2012, 11(3): pp.337-349.
- [3] Wang Jingyi Research on the development path of smart logistics industry in the context of "Big data" [J]. Journal of Shandong Agricultural engineering University, China, 2020,37 (06): 31-33
- [4] Zhang Qian, Tian Yihui, Xiao Wen, et al Application of Big data in cold chain logistics of agricultural products [J] Journal of Agricultural Big data, China, 2022,4 (1): 55-61

- [5] Kuo Y. Using Simulated Annealing to Minimize Fuel Consumption for the Time-dependent Vehicle Routing Problem[J]. *Computers & Industrial Engineering*, 2010, 59(1): 157-165.
- [6] Xu Xiaohan. Construction of cold chain intelligent logistics information platform for agricultural products based on Big data technology [J]. *Heilongjiang Grain, China*, 2021 (10): 123-124
- [7] M. Yao, "Optimization of Cold Chain Logistic Distribution Networks in the United States,"[c].2019 IEEE 6th International Conference on Industrial Engineering and Applications (ICIEA), Tokyo, Japan, 2019, pp.284-288.
- [8] Cao Guoxiong, Deng Zhihui, He Lihong. Analysis of the Development Status and Direction of Cold Chain Logistics for Agricultural Products Based on RFID Technology [J]. *Grain Technology and Economy*, 2018,43 (07): 66-71
- [9] James S J, James C. The food cold-chain and climate change[J]. *Food Research International*, 2010, 43(7): 0-1956.