Application of RFID Information Technology in Fresh Food Cold Chain Logistics Management

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Abstract. RFID information technology has gradually become a new favorite in cold chain logistics management, and cold chain logistics belongs to temperature control logistics, so the application demand of RFID system with temperature sensor is more intense. At present, the construction of cold chain logistics in China can not meet the development needs, and the food quality and safety problems caused by uncontrollable logistics links are becoming increasingly serious. Combined with the characteristics of RFID technology, and in view of the pain points of China's food cold chain logistics management, this paper will discuss the application of RFID technology in all aspects of food cold chain logistics.

Keywords: RFID Information Technology, Fresh Food, Cold Chain Logistics Management

1. Introduction

In several years, along with the rapid development of China economics and the improvement of people's consumption level, people have higher demand for the quality, quantity and variety of food, especially the freshness of fresh food directly affects its value and sales. Therefore, it is particularly important to ensure the freshness and timeliness of distribution. These changes in demand lead to earth shaking changes in the traditional logistics industry, and the market demand for cold chain logistics arises at the historic moment and is increasing day by day. In general, cold chain logistics is a logistics system in which the frozen food is always in the specified low temperature environment in the production, transportation, storage, sales and consumption, so as to ensure the food quality and reduce the food loss. It has higher and more complex requirements than ordinary temperature logistics, therefore, the relevant input in management and capital is also greater.

To develop the cold chain logistics will advance the commodities circulation such as aquatic products, agricultural products, animal meat and so on, and then reduce the resources loss, enhance the social resources' utilization rate [1]. At present, China's central and local governments are vigorously supporting and advocating the cold chain logistics' development. However, because of the poor technology and later start of China's cold chain logistics, the cold chain industry is lagging behind relatively and a systematic, large-scale system has not yet been formed. Thus, there are still some problems in cold chain logistics, such as serious shortage of cold chain facilities and equipment, unbalanced development and distribution of infrastructure, incomplete industrial support, lack of

coordination between upstream and downstream of supply chain, no national or industry specific standards, and so on [2].

To refrigerate and froze food needs an integrated cold chain logistics to monitor the temperature of the commodity in the whole distribution process to ensure the safety of food. This includes the enclosed spaces when to load and unload, store and transport the goods, etc., and any link cannot be less. At present, advanced RFID technology has become a new favorite of cold chain logistics. Some large-scale fresh food enterprises and cold chain logistics enterprises have taken the lead in introducing RFID technology. The RFID tag with temperature sensor can record the change of temperature environment in the operation of cold chain logistics, and realize the real-time monitoring and fine management of product freshness and quality.

2. RFID Information Technology

RFID is a kind of non-touching automatic recognition technology, which can automatically recognize the target and acquire relevant data by radio frequency signals. The recognition work needs no manual intervention and can work in various severe environments. A basic RFID system consists of three parts: electronic tag, reader and antenna. The reader is usually connected with the computer to read the tag information, which can be transmitted to the computer. The tag can transmit information to radio frequency card readers within 10 feet. The electronic label is pasted on the pallet, packing box or object, so it is no longer necessary to use the handheld barcode reader to scan the materials. This greatly improves the efficiency of operations, and reduces the occurrence of mistakes to a certain degree. The antenna plays the role of transmitting RF signal between tag and reader.
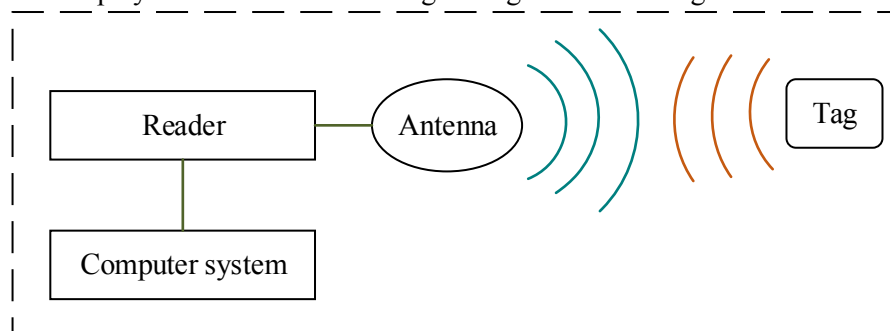
**Fig 1.** RFID system schematic diagram

The cold chain logistics of modern fresh food belongs to temperature control logistics, which requires the RFID technology applied in the field of cold chain logistics, not only to apply its primary technology superiority, but also to fulfil the purpose to control the timely temperature in the procedure of logistics implementation. Therefore, it is necessary to transform RFID system and add temperature sensor to RFID tag. According to the research of relevant scholars, after adding temperature sensor to RFID system, not only the function of the original RFID system is retained, but also the new function of temperature monitoring is added, and the working mode of the reformed RFID system is still simple and fast. The operator only needs to write the temperature information gathered by the temperature sensor into the RFID tag chip regularly. The temperature data in the chip will be uploaded to the RFID reader, and then transferred to the computer system of back-end for further treatment, while the RFID tag reads the signal from the antenna. The reformed RFID system can supervise the temperature transformation of the target timely, play the role of early warning management and real-time supervision. It can also read all the point-to-point temperature data of the whole circulation process at one time and generate a static temperature change figure to monitor the temperature change of the whole cold chain logistics system conveniently.

3. Construction of Food Cold Chain Logistics Information System Based On RFID Technology

At present, with the improvement of consumers' awareness of food safety, countries have strong requirements for food safety tracking and traceability. Effective use of RFID identification function

can even be made into a global unified identification and general business standards, which can play a good role in promoting food safety tracking and traceability. Based on RFID technology, a food cold chain logistics traceability information system is established, which combines the cold chain logistics process, enterprise business process and food safety management department, so as to track the relevant information of all kinds of food in the whole life cycle of the system, update and store in real time, and finally facilitate the enterprises, consumers and regulatory departments to trace and query, and then, provide solid logistics guarantee for the quality and safety of food [3].

The production and operation process of a typical supply chain enterprise generally includes supply, production, processing and sales. Cold chain logistics, as an activity to realize the space value and time value of materials in the supply chain, runs through the whole process of enterprise production and operation. It can be summed up as four links, such as refrigerated or frozen processing, refrigerated or frozen storage, refrigerated or frozen distribution and transportation, refrigerated or frozen sales of goods. In the system, the food safety supervision center can be composed of quality inspection and quarantine institutions and industrial and commercial departments of governments at all levels. It can quickly acquire the information of food through the only global trace code attached in the RFID tag, and then quickly find the root of the problem according to the RFID information and control the production and operation of enterprises. The model of food cold chain logistics management information system based on RFID is as follows [4]:
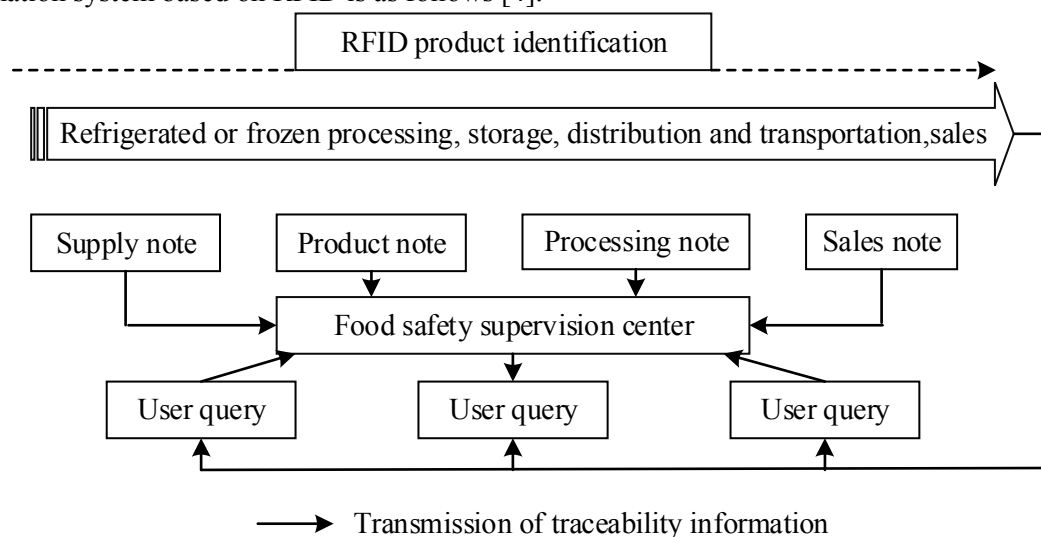
Fig 2. Food cold chain logistics management information system model based on RFID

4. Application of RFID Information Technology in Fresh Food Cold Chain Logistics
Cold chain logistics of fresh food generally includes to product, store, transport, and sales under refrigerated or frozen conditions, and so on. RFID technology can be used in any link, and also can be used selectively in a certain link.

4.1. Application of RFID Information Technology in Production and Processing
In the process of refrigeration or freezing production and processing, RFID technology can record the source information of raw materials and ingredients, and automatically identify, sort and track the raw materials, ingredients, semi-finished products and finished products, so as to reduce the cost of manual identification and error rate, and then to improve the production efficiency and economic benefits. Especially, on the automatic assembly line with JIT production and processing mode, after using RFID technology, each link of product production process is placed under strict monitoring and management, which can achieve balanced and stable production line, and strengthen the control and tracking of quality. Cold chain logistics of fresh food in some enterprises has established a data platform of cold chain monitoring center, which can automatically add the information of the product processor, main

processing methods, processing time, shelf life, product grade and storage environment to the RFID tag automatically after the completion of product production and processing. Customers can query the product information after consumption. RFID tags with temperature sensors can open paperless supervision, closely and carefully supervise the whole cold chain process of products, and promote the seamless docking of temperature detection in all links of fresh food cold chain logistics [5].

4.2. Application of RFID Information Technology in Cold Chain Logistics Warehousing and Distribution

First of all, to apply RFID information technology in the entry process. The entry operation includes inspection and warehousing. Before inspection, it is necessary to attach RFID electronic tag which records the information of the goods on the outer packing box of the goods, and then load the goods onto the pallet with the same RFID tag. The RFID tag on the pallet records the relevant information such as the number of the pallet, the shelf and location after warehousing, and also the basic information of the goods on the pallet. Then the goods are loaded onto the pallet with the same RFID tag which records the relevant information such as the number of the pallet, the shelf placed after warehousing, and the location, and the basic information of the goods on the pallet. Finally, when the forklift passes through the door of the warehouse and carries the goods into the warehouse, the RFID tag will send the recorded information to the reader above the door, and the reader will read it and send it to the back-end system. Finally, when the forklift passes through the door of the warehouse and carries the goods into the warehouse, the RFID tag will send the recorded information to the reader above the door, and the reader will read it and send it to the back-end system. The staff can directly inspect the goods from the display screen. After the inspection is qualified, the forklift will transport the pallet to the shelf location and finally, the warehousing operation is completed [6].

Secondly, for the goods in stock, the RFID reader fixed on the shelf can automatically complete the inventory operation, update the inventory information in time, monitor the inventory in real time, and realize the automatic replenishment function. The temperature sensor in the label can provide real-time temperature information when the goods are stored. In case of abnormal temperature rise or temperature drop, the system can alert the staff through the background monitoring to remind the staff to take timely cooling or heating measures, so as to reduce or avoid loss, and then ensure the quality of food.

Thirdly, in the outbound link, the picker should pick the goods according to the distribution order. After picking, the latest information of the corresponding location will be transferred to the background database through the handheld reader, so as to update the cargo information of the location in time. The warehouse out reviewer checks and binds the delivery list, commodity details and delivery vehicles with RFID handheld device.

Finally, in the process of distribution picking, RFID readers distributed in the warehouse can obtain the location information of goods and the location of picking equipment (such as forklift) to track and monitor the distribution picking process.

4.3. Application of RFID Information Technology in Cold Chain Logistics Transportation

Transportation is an important link in the process of cold chain logistics. At present, the overall strength of domestic cold chain logistics transportation enterprises is relatively weak. In particular, the strict control of temperature and time of refrigerated food on the way has been the difficulty of cold chain development. In the product transportation process, the combination of GPS, WSN and RFID can settle the problems of temperature monitor and line optimization of transport. Using RFID tags and on-board reader, the temperature change of the goods in the transport vehicle can be monitored at any time, and the route and time of the transport vehicle can be tracked. Put the reader in the cab, install GIS and GPRS system, and put the temperature label directly into the cold compartment. Through the fixed reader installed in the car, the temperature change in the car is transmitted to the temperature control center in real time, which is used to recognize the logistics conditions of the goods. The control center is in charge of the information interchange with the intelligent vehicle terminal, the

flow of business information with other relevant functional departments through the information platform, and the monitoring and management of the whole transportation process [7], to achieve transparent transportation, advance the distribution efficiency, and ensure the quality of the transportation.

4.4. Application of RFID Information Technology in Sales

RFID technology is one of the core competitiveness of the logistics industry sales management. Through this technology, the seller can obtain accurate delivery information and make timely purchase preparation [8]. After the arrival of the goods, the receiving personnel will compare the actual arrival situation with the purchase plan through the information transmitted by the reader in the background, analyze the temperature change of the goods through the RFID information system, quickly inspect the goods, and determine whether to receive the goods. The work efficiency is improved and the error of manual operation is reduced. After the tallyman put the goods on the shelf, the real-time monitoring of the food is carried out through the relevant supporting facilities, such as the expiration date and temperature of the food. Once the validity period of the food is exceeded, the label will send an alarm to remind the staff to deal with it in time and reduce the damage rate of the goods. Through the public information platform, consumers can understand the information of various links in the process of food raw materials, processing and circulation, including the origin environment, the use of pesticides, fertilizers and other inputs, so as to realize the whole process monitoring from the production to the dining table, and satisfy the consumers' right to know and choose. If there are food safety problems, it can be traced back to the responsible person, protecting the interests of consumers.

5. Conclusions

China is a big country of food production and consumption, food safety has always been a problem worthy of special attention. The voice of vigorously developing food cold chain is getting higher and higher. China has also issued relevant laws and policies, and the establishment of food cold chain logistics system is becoming increasingly important. It involves many links from planting, breeding to food processing and production, cold chain transportation, storage, distribution, sales and so on. RFID technology can quickly and accurately identify and input the information of food flow, and provide traceability information support for food safety inspection. The application of RFID information technology in fresh food cold chain logistics management activities can comprehensively and systematically record the data information of the whole process from production to consumption [9]. Enterprises and relevant departments can understand and monitor the status of food in all aspects in real time, and timely discover and eliminate potential safety hazards, which is conducive to improving food safety.

RFID technology is considered to be the core force of China's logistics industry to catch up with the international level, and its role in the field of food cold chain traceability cannot be ignored. But in the process of application, there are still some problems, mainly in three aspects. First is about the technical security of RFID, that is, how to ensure and improve the security of the information stored in RFID tags. Second is about standards, such as the lack of trade standards and ripe application model, and how to ensure the transmission of label information in each link of traceability system. Third is about how to reduce the cost of RFID tags, promote its application in the logistics industry and so on. It is also an useful way to advance food safety that RFID technology can be widely used in food cold chain logistics management [10].

Acknowledgements

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