The Design of An RFID-based Warehouse Management System for Fresh Agricultural Products of Stores

Wei Li¹,a and Ti-jun Fan²,*

¹,²School of Business, East China University of Science and Technology, Shanghai, China

*Email: 13127653869@163.com

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Abstract. The paper designed an RFID-based warehouse management system for fresh agricultural products of stores. The problem for fresh agricultural products in traditional warehouse business processes is first analyzed. Then according to the results of business processes analysis, system function and database are designed, and the system function includes 4 parts, inbound management, outbound management, electronic goods allocation management and processes management in the warehouse management. The expected results when the system is achieved can enhance the working efficiency of stores, reduce operating costs and improve customer satisfaction.

Introduction

With the development of economy and the enhancement of people’s living standards, people pay more attention to the freshness of fresh agricultural products in daily consumption [1, 2]. The existing stores tend to consider price, inventory, origin and varieties when they sell fresh agricultural products, such as Tmall and SFBest, etc. So considering the determination of freshness of fresh agricultural products is lacked in stores. At the same time, work in the current warehouse management, such as in-out warehouse management and inventory management, relies on artificial operations and bar code technology. Not only is this way of working inefficient, prone to errors, but also the safety management work is not guaranteed.

The emergence of RFID technology provides technical support for solving these problems. With its non-contact, reusable, rapid scanning, read fast and conveniently, large data capacity and long life and so on, RFID gets more and more attention in logistics warehousing industry [3]. Compared with the traditional bar code technology, RFID technology can improve the efficiency of data reading, have further identification distance and higher security and be fake with difficulty. The most important point of its application of RFID technology in retail stores is that the data can be obtained in real time, so that enterprises can master the freshness in real time and provide consumers with the fresher products improve the satisfaction of consumer and reduce business operating costs.

In view of this, the article designed an RFID-based warehouse management system for fresh agricultural products of stores. By using RFID technology, it can realize the dynamic monitoring of fresh agricultural products, the automation in-out warehouse management and real-time inventory management.
Literature Review

RFID, commonly known as electronic label, is an automatic identification technology which doesn’t need contact directly. It depends on launching radio frequency signal to capture data and do not influenced by labor and environment [4]. Compared to the RFID technology, barcode technology has been widely applied in various fields, such as retail, logistics, warehousing and health care, etc. The principle of barcode technology is to obtain data by using barcode reader to read the barcode label. However, although barcode technology is widely used in practice, it also exists problems and shortcomings, for example, because of the complexity of information and data in the actual operation, barcode technology has the problem of insufficient storage capacity in data storage and requires quite short recognition distance. The emergence of the RFID technology makes up the shortcomings of barcode technology [5].

RFID technology, as the vanguard of internet of thing’s key technology, its applications in many fields such as supply chain management cause the attention of enterprises and scholars [6]. Shu-Jen Wang (2008)[7] analysis of simulated impact of the radio frequency identification (RFID) system on the inventory replenishment of the thin film transistor liquid crystal display (TFT-LCD) supply chain in Taiwan, the results shows that the RFID-enabled pull-based supply chain can be effectively achieved with a 6.19% decrease in the total inventory cost, and a 7.60% increase in the inventory turnover rate. Zhou (2009) [8] consider the inventory management of fresh agricultural products, which the demand of the products is under the influence of freshness, and put forward with the increase of product information availability that enterprises can use this information to improve the management performance. Eleonora Bottani (2010)[9] researches the impact of RFID and EPC network on the bullwhip effect in the Italian FMCG supply chain, and the results show that real-time visibility of the supply chain, can dramatically reduce the bullwhip effect, substantially affecting the economical profitability of the whole FMCG supply chain. Selwyn Piramuthu (2013)[10] uses item-level information generated through semi-passive RFID tags with appropriate sensors, and gets the results that the incorporation of item quality increases the resulting overall profit to the retailer. Tijun Fan [11, 12] considers the benefits of RFID technology for reducing inventory inaccuracies which includes inventory misplacement and inventory shrinkage. Wei Zhou(2013)[13] gets the results of cost reduction, service and production quality improvement and pollution and waste reduction through the incorporation of RFID in the reverse supply chain results in cost reduction.

The literatures introduce the concept of RFID technology and the application of RFID technology in supply chain, but the application of RFID technology in supply chain are mainly concentrated in the supply chain model analysis while rare in the actual application of supply chain system. Therefore, the paper applies RFID technology to the stores warehouse management system, and analyzes the application of RFID technology in various business processes of warehouse management system to improve the management efficiency of retail stores.

Business Processes Analysis Based on RFID

Aimed at problems existing in the traditional warehouse management, RFID is used in the warehouse management and an RFID tag is used as the carrier of products data. Through collecting all kinds of product information automatically, not only can it reduce the operation steps in traditional warehouse management, but also it improves
efficiency of products in-out warehouse and data accuracy. Compared with the general products, fresh agricultural products have the characteristic of perishability, RFID technology can be used to obtain real-time freshness of fresh agricultural products, so that the enterprise can grasp products freshness, improve information visibility of in-out warehouse and processes management in the warehouse.

Business processes includes inbound processes, outbound processes and processes management in the warehouse. The detail introduce is as follows.

**Inbound Processes**

![Inbound Processes Diagram](image)

Taking inbound processes in the warehouse as shown in figure 1. First, store staffs prepare for products warehousing, including staffs preparation, documents preparation and equipments preparation. Second, when fresh agricultural products arrive at store, store staffs use RFID readers to collect products varieties, weight and shelf life information, and the system check it, and if it's not right, the staffs fill in the "abnormal receiving registration form" and inform the upstream suppliers; otherwise, the staffs unload products and put them on the shelves. After the completion of products put away, the RFID reader is used to collect products information and the system check it with the information saved in the RFID tags of shelves at the same time. If information is not consistent, store staffs reposition the products until on the right position. At last, they will save the information of products in the database.

Compared with the traditional inbound processes, the processes based on RFID technology have advantages in two aspects. On the one hand, through reading batch products information, products information collection reduces artificial participation, lets information been updated more timely and improves the accuracy of information.
and product warehousing efficiency. On the other hand, it can prevent product misplacement by adding the product location information check.

**Outbound Processes**

[Diagram of Outbound Processes]

Taking outbound processes in the warehouse as shown in figure 2. According to the outbound notification, store staffs generate product outbound orders. Second, according to the product outbound orders, store staffs pick fresh agricultural products in the location area. After picking, the RFID reader in the outbound door reads the products information and the system checks it with the orders, include varieties, specifications and quantity, etc. If the information is not consistent with the product outbound orders, they need to find out the reasons and solve it to ensure that product information is consistent with the outbound orders. If information checking is finished, store staffs arrange vehicles and then update the inventory.

Outbound processes based on RFID technology have advantages over traditional outbound processes in the outbound information acquisition. By using RFID technology to read batch products information, it can reduces the error rate and improve the outbound efficiency of products.

**Processes in the Warehouse**

Processes in the warehouse include inventory check and early warn of freshness. Taking processes in the warehouse as shown in figure 3. Warehouse staffs make check plans, and according to the check plans, warehouse staffs use a handheld RFID reader to collect products quantity information. Comparing the actual quantity with book number, if not consistent, the staffs view the in-out record of products to find out the reason and change the product inventory. When the present freshness is lower than the lower limit of products freshness which the best use date is used to instead the limit
here, the system will inform staff to handle the product when the save time of products in the warehouse is more than the best use date.

Figure 3. Processes of fresh agricultural products in the warehouse.

Compared with traditional processes in the warehouse, processes management based on RFID in the warehouse have advantages in two aspects. On the one hand, checking products by adopting RFID technology improve the working efficiency and when there appears some problem, in-out record of products can be called to look up for the reasons. on the other hand, by adding warn the freshness of products the retailer can make timely decisions for products freshness change, so as to reduce the shrinkage rate of products and improve customer satisfaction.

System, Database Design and System Realization

System Design

The RFID based warehouse management system for fresh agricultural products of retailers is the expansion of traditional warehouse management system, and mainly includes 4 parts, inbound management, outbound management, electronic goods allocation management and processes management in the warehouse management. Inbound management, implement automated warehousing operation; allow warehousing documents to be inserted, queried, modified and deleted, automatically assign product storage position, etc. outbound management. Implement automated outbound operation, allow outbound documents to be inserted, queried, modified and deleted, automatically assign product outbound position, etc. position management. Query and display goods storage conditions, and visually adjust position operation, etc. processes management in the warehouse. It includes check management and early warn of freshness. Check management allow check results to be inserted, queried and deleted.

Take system structure as shown in figure 4.
The diagram includes three modules, business module, data transmission and data collection. Data collection module uses fixed and hand-held RFID reading and writing devices to collect real-time information of fresh agricultural products, including static information which refers to the wholesale price, varieties, specifications and producing area and dynamic information which refers to in-out time, inventory, location and freshness, etc. In data transmission module, the system filters and calculates data which is obtained from data acquisition layer. After that, the system interacts with the database and updates the data in real time. Business module includes inbound management, outbound management and processes management in the warehouse, and exchange data with event processing components in the data transmission layer.

**Database Design**

The main business of system involves seven tables, abnormal receiving form, inbound information table, inventory information table, location information table, shelves information table, checklist table and outbound information table.

Inbound management includes three tables, namely abnormal receiving form, inbound information table and inventory information table. The abnormal registration form is used to save the problem which exists in checking the inbound products which include varieties, quantity, expiry date and best use date, etc. The inbound information table which includes varieties, quantity, expiry date and best use date is based on the advance storing notification sent by suppliers, and used to save inbound information. The inventory information table is generated in storing products and used to save products information in detail.

Processes management in the warehouse includes two tables, namely inventory information table and checklist table. The inventory information table is the same as the table in inbound management. The checklist table which includes products code and practical quantity is used to save check results.
Position management includes two tables, namely location information table and shelves information table. The location table is used to save shelves information in each location. The shelves information table is used to save products information in each shelf.

Outbound management includes one table, namely outbound information table. The outbound table is based on outbound notification and is used to save outbound information of fresh agricultural products.

**System Realization**

The realization of the system will use B/S structure to set up, which can let retail administrators open the system by the browser, such as IE, Firefox and Google, etc. Its database will use mysql, a rational database. The server is apache which can be run in various operation systems, and server language is php, a common open source scripting language. The browser language will use javascript language, which can add dynamic function to the webpage.

**Conclusions**

RFID technology used in warehouse management system of fresh agricultural products can optimize operational processes, provide basic services and decisions support. The main value of the system is in three aspects. First, improve efficiency by reducing in-out warehouse operations, achieve the automation of storage management and improve data accuracy. Second, reduce operation costs by eliminating misplaced rate in the warehouse and lowering shrinkage rate. Third, improve customer satisfaction by making proper decisions based on collecting products information in real-time.

An RFID-based warehouse management system for fresh agricultural products of stores is designed, but the realization of the system is not referred in the paper. Therefore, further developments are expected on the realization of the system.

**References**


