Asian Business Research; Vol. 7, No. 2, 2022
ISSN 2424-8479 E-ISSN 2424-8983
Published by July Press

Optimized Design of Warehousing Operation Process Based on RFID Technology

Longjie Que[1] & Shulong Liu[1]

[1] School of Economics & Management, Chongqing Jiaotong University, Chongqing, China

Correspondence: Longjie Que, School of Economics & Management, Chongqing Jiaotong University, Chongqing 40074, China. E-mail: 1349737517@qq.com

Received: February 22, 2022 Accepted: March 17, 2022 Online Published: March 29, 2022

doi:10.20849/abr.v7i2.1065 URL: https://doi.org/10.20849/abr.v7i2.1065

Abstract

Warehousing as one of the main functions of logistics core functions, the optimization of warehousing operation process has been highly valued by the entire industry. Based on RFID technology, taking Jingdong Huizhou Huiyang Logistics Center as an example, combined with the analysis of the current situation of its warehousing operation process, the process design is optimized from the three aspects of warehousing, warehouse management and outbound storage, and the simulation modeling of the inbound and outbound processes is carried out by using Flexsim software. The results show that: 1) The warehousing operations of logistics centers have pain points of long waiting time in storage, low inventory efficiency and high cargo loss rate. 2) Through the comparative analysis of the modeling results before and after optimization, RFID technology can effectively improve the efficiency of the warehousing operation process, and determine the feasibility of the optimized process to improve the efficiency of the warehousing operation process.

Keywords: warehousing process, process optimization, RFID technology, Flexsim simulation software

1. Introduction

In recent years, with the development of e-commerce, the development of China's logistics industry has been further promoted. The sharp increase in the volume of express delivery, the traditional way of warehousing operations has not met the needs of the market. Warehousing connects production, supply, sales and other links, almost all commodities from production to sales must go through the warehousing link, logistics companies in order to obtain more market share, make full use of modern information technology has become the primary means of choice.

RFID (Radio Frequency Identification) technology, also known as radio frequency identification technology, is a kind of automatic identification technology, with real-time monitoring, convenient reading, stable reading information and so on (Phillips, T., Karygiannis, T., & Kuhn, R., 2005). RFID technology can improve the speed of warehousing operations, speed up cargo turnover, and reduce inventory costs on the basis of simplifying the process (Young, B. K., 2015). Therefore, the study of the application of RFID in warehousing has strong practical significance, and it can also provide certain reference significance for China's logistics industry (Carmine, S., 2016).

2. Theory

2.1 RFID Technology

RFID technology through radio frequency mode non-contact two-way data communication, the use of radio frequency mode of recording media (electronic tags) to continue to write, so as to achieve the purpose of identifying the target and data exchange, which is considered to be one of the most promising information technology in the 21st century (Parbakar, V., Kumar, B. V., & Subrahmanya, S. V., 2006). At present, it is widely used in logistics management, manufacturing, public safety and other fields (Weinstein, R., 2005).

Advantages of RFID technology:

(1) Large storage: RFID technology can add target identity information and operating status according to the needs of users and companies, while barcodes can only store simple information and cannot be changed at any time.

(2) Fast recognition speed: Generally, information can be identified within a few seconds to speed up the operation.

(3) Good confidentiality: the customer's information can be better kept confidential, and the adhesion between customers and enterprises can be improved by improving customer satisfaction.

(4) Wide coverage: Precise scanning and reading can be carried out, making the operation more convenient.

2.2 Flexsim Simulation Software

Flexsim is completely based on object-oriented, fully integrated with the C++ language, using drag-and-drop methods to make it graphical and create models, with excellent 3D virtual reality animation, the screen display is extremely intuitive, easy to learn and easy to use software operation interface, with unparalleled flexibility, mobility.

3. Empirical Research

3.1 Analysis of the Current Status of Warehousing Operations

Jingdong Mall is the largest e-commerce online shopping platform in China's e-commerce market, due to the vigorous investment of Jingdong in logistics in recent years, the logistics efficiency of Jingdong Mall has been greatly improved, but through the investigation, it was found that there are still many drawbacks in the warehousing operation process of Jingdong Huizhou Huiyang Logistics Center:

(1) Warehousing operation process: the classification of goods is not clear, the warehousing efficiency is low, and the inventory management data is inaccurate. In order to seek convenience in the warehousing process, the logistics center warehouse directly stacks the goods as a whole. Intelligence is low, and the goods need to be manually checked, registered and pasted before being put into storage, and the efficiency of manual operation is low and easy to make mistakes.

(2) In the library management process: the inventory efficiency is not high, the warehouse arrangement is unreasonable, and the cargo information management is not in place. The inventory process uses fragile bar code technology; the management of the warehouse location is still manual management, and the storage location information transmission is not timely, resulting in the inability to rationally use the warehouse location; the logistics center warehouse is limited by management methods and management technology, and it is difficult to achieve strict management of cargo information.

(3) Outbound operation process: the efficiency of outbound storage is too low, and the sorting efficiency is low. The shipment order contains many types of goods, the staff relies on their own memory to pick up the goods according to the order, and the inventory information cannot be updated in real time after the completion of the take-out of the order goods; the random storage of the goods leads to the sorter to sort and pack the goods for a long time.

In summary, the various problems in the warehousing operation process of the logistics center lead to the low efficiency of warehousing, in order to provide better logistics services and meet customer needs, the warehousing operation process must be optimized.

3.2 Optimized Design of Warehousing Operation Process Based on RFID Technology

(1) Optimization design of warehousing operation process

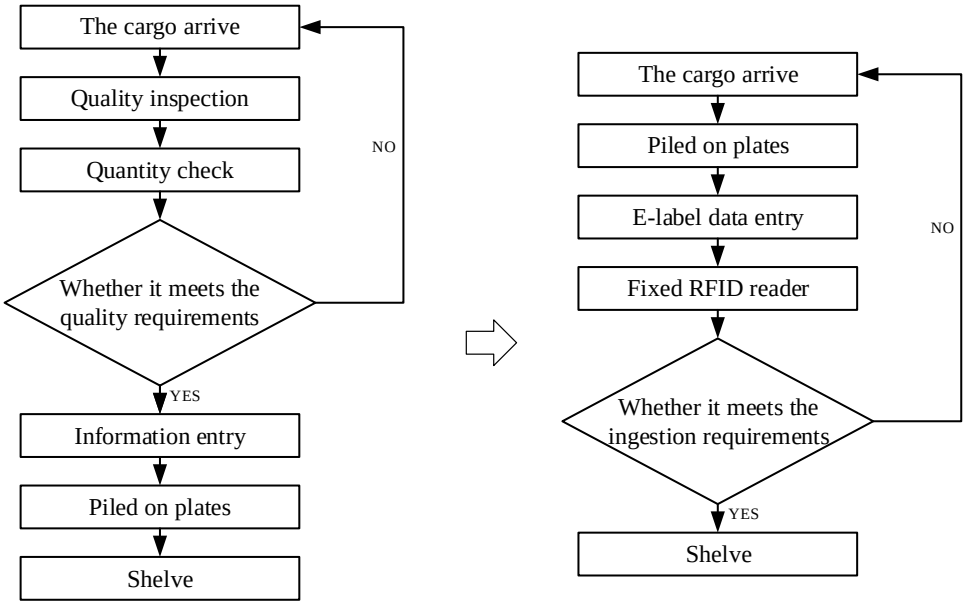

Figure 1. Optimization diagram of the inbound process

Improvement of the warehousing process after the application of RFID technology:

I. The goods are sorted after unloading, which makes the management of goods and the entry and exit of goods more convenient;

II. In the warehousing inspection link, the information of the goods no longer needs to be manually entered by the employee, but is automatically read and uploaded by the RFID reader. Recording data in this way can ensure the accuracy of the data, while also improving the efficiency of warehousing;

III. RFID electronic tags replace barcodes, and the warehousing process saves the time of printing and pasting barcodes. And the operation is convenient, which can reduce the workload of employees and speed up the operation;

IV. After the use of RFID, in view of the reduction of staff workload, the number of employees can be appropriately reduced and labor costs can be reduced.

(2) Optimize the design of the library management process

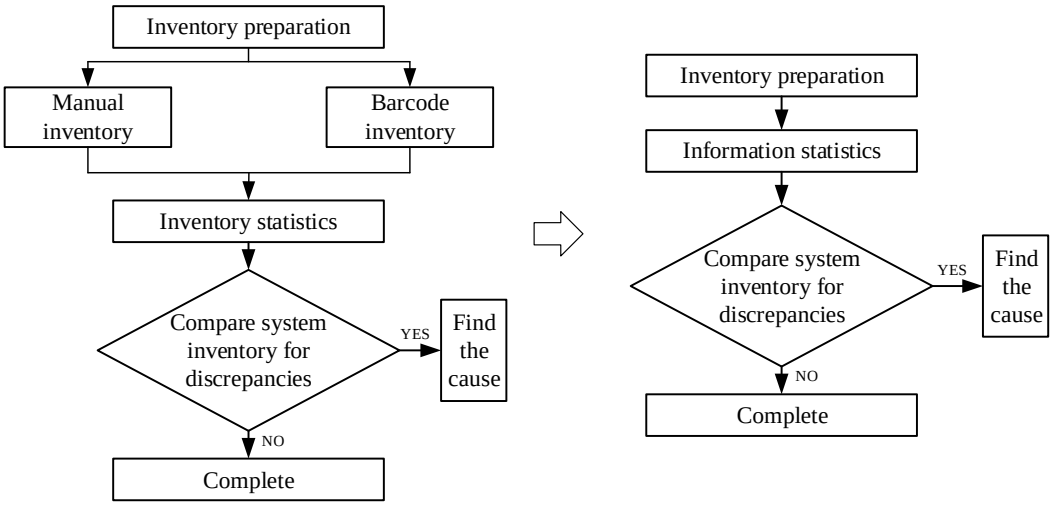

Figure 2. Optimization diagram in the library management process

Improvements in library management after the application of RFID technology:

I. Simplified the inventory process, improved the efficiency of cargo inventory, and ensured the accuracy of data;

II. In the process of inventory, there is no need to move the goods multiple times, which can reduce the physical damage of the goods caused by the removal of the goods;

III. In the warehouse management, the warehouse management of the goods can improve the sorting efficiency of the staff, and then speed up the speed of the goods;

IV. The application of RFID information control management realizes the effective control of warehousing on cargo information, and reduces the possibility of cargo backlog and insufficient goods.

(3) Optimization design of outbound operation process

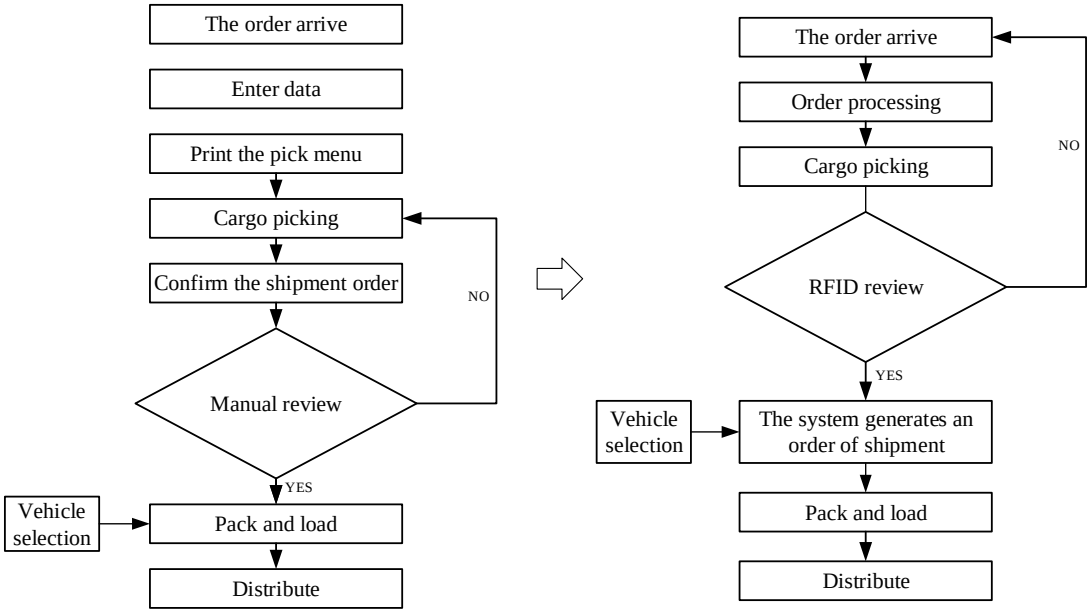

Figure 3. Optimization diagram of the outbound process

Improvement of outbound process after application of RFID technology:

I. After using RFID, the accuracy of the system inventory is guaranteed. Employees can directly process orders based on cargo inventory information;

II. The application of RFID equipment to pick goods, sorting personnel can quickly find the place where the goods are stored, saving the time of employees looking for goods;

III. The review is no longer a manual inventory, but the RFID system is automatically completed, which not only saves the review time, but also improves the accuracy of the review;

IV.After the application of RFID technology, the unified scheduling and management of distribution vehicles is realized, and the utilization rate of vehicles is improved.

3.3 Simulation Modeling of Warehouse Operation Process Optimization

3.3.1 Objectives and Assumptions

Through Flexsim, the simulation model of the initial warehousing operation process and the optimized warehousing operation process is established, and the number of goods passing through the entire process in a certain period of time and the average time required are analyzed through simulation and comparison, and whether the optimized process can improve the operation speed and provide a reliable basis for the optimization of the RFID warehousing operation process.

In practice, there are often various unexpected situations, so make the following assumptions before building a model:

Hypothesis one: all goods involved in the entire model process are the same, the quality of the goods is intact,

and there is no damage to the goods during the whole process;

Hypothesis two: the professional quality of all staff is exactly the same; all the equipment used will not fail throughout the process;

Hypothesis 3: The simulation model of the warehousing process is normal, and does not consider the sudden increase in goods caused by special events, such as "Double Eleven" burst orders;

Hypothesis 4: The time in the system is set to the average state, regardless of the occurrence of individual acceleration and deceleration conditions.

3.3.2 Parameter Settings

Parameter setting of the simulation model of the original warehousing operation process: the arrival time of the goods is set to meet the normal distribution of the mean value of 13.5 and the standard deviation of 4.9. The inbound inspection inspects the quantity and the quality of the outer packaging of the goods, obeying the triangular distribution of the bottom limit of 17, the upper limit of 41, and the mode of 26. The barcode scanning processor parameters follow a triangular distribution with a base limit of 10, an upper limit of 17, and a mode of 13. The maximum capacity of the staging area is 25. There are three delivery routes in the outbound model, and the three order generator parameters are set to obey the exponential distribution of the expected 28, 37, and 50 respectively. The number of outbound disks follows the triangular distribution of the bottom limit of 2, the upper limit of 7, and the mode of 4. The picking time of each plate follows a triangular distribution of the bottom limit of 4, the upper limit of 8, and the majority of 5. The recheck time of each picklist follows a triangular distribution of 8, upper limit of 17, and mode 14.

Parameter settings of the simulation model of the warehousing operation process optimized by applying RFID technology: the inbound inspection obeys the triangulation distribution of the bottom limit of 5, the upper limit of 13, and the mode of 8. The sorting processor obeys a triangular distribution with a base limit of 3, an upper limit of 7, and a mode of 4. The recheck time of each picklist follows a triangular distribution of the bottom limit of 1, the upper limit of 4, and the mode of 2.

3.3.3 Simulation Results Analysis

The Flexsim simulation model is based on the actual warehouse, and the simulation time should also be based on the working schedule of the real warehouse. Assuming that the working time of the warehouse is 8:30-17:30 (a total of 9 hours, 32400 seconds), the running cycle of the model is set to 32400 simulation time units. To ensure the accuracy of the data, the model will run multiple times and take the average of the data. The storage simulation model is analyzed from the perspectives of the average waiting time of the goods and the number of goods in the whole model within a certain period of time, and the operating status of the warehousing system is analyzed and studied.

(1) Analysis of simulation results of original warehousing operation processes

Simulation result analysis of the original inbound process:

Table 1. Waiting time and the number of inbounds

Project	Minimum	Maximal	Average
Wait for acceptance	583.86s	585.64s	584.75s
Wait for shelves	28.28s	29.82s	29.05s
Numbers	1298p	1302p	1300p

The average waiting time for the goods to wait for acceptance reflects the speed of the goods into the warehouse, from the simulation results of Table 1, it can be found that the average time for the goods to wait for acceptance is 584.75 seconds, that is to say, when the goods reach the warehouse, it is necessary to wait 9.4 minutes to accept the acceptance of the inspectors. The average time for goods to wait for the shelves is 29.05 seconds, about half a minute, and its shelf efficiency has reached a higher level, so in theory, the main inbound inspection link is optimized, but if the warehousing inspection link is optimized, the front-end output speed is improved, which will inevitably cause the accumulation of goods in the shelf link, so in order to ensure the rapid progress of the warehousing link, the speed of the goods on the shelves needs to be improved at the same time as the optimization of the warehousing inspection link, and the number of transport tools on the shelves can be

appropriately increased.

Analysis of simulation results of the original outbound process:

Table 2. Waiting time and the number of outbounds

Project	Minimum	Maximal	Average
Wait for review	873.03s	879.93s	874.41s
Review the loading	12.95s	13.07s	13.03s
Numbers	850p	854p	853p

The average waiting time for cargo review refers to the time when the goods of the order are completed after being selected, waiting for the inspection personnel to review. Table 2 reflects the long waiting time for goods to be reviewed, averaging 14.6 minutes, that is, the goods of an order need to wait 14.6 minutes after they are sorted before they can be reviewed. The reason for the congestion of the review link may be that the work efficiency of the inspector is too low, and the manual inventory operation method is too time-consuming, so the goods out of the warehouse review is the bottleneck link in the outbound process.

In summary, in the waiting review link in the outbound process, as the bottleneck link of the outbound warehouse, it is necessary to change the working mode of the review and improve the work efficiency of the inspector.

(2) Simulation results of warehousing operation processes optimized by applying RFID technology

Simulation result analysis of the optimized inbound process:

Table 3. Waiting time and the number of inbounds

Project	Minimum	Maximal	Average
Wait for acceptance	546.2s	548.0s	546.7s
Numbers	1324p	1326p	1325p

Table 3 statistical results show the application of RFID after the acceptance of goods waiting for acceptance time, compared with the previous goods into the warehouse waiting time, found that the application of RFID after the goods into the warehouse time is relatively reduced, from the previous 584.75 seconds reduced to 546.7 seconds, that is, it takes about 9 minutes to complete the storage, and within a certain period of time, the amount of warehousing has also increased from the previous 1300 to 1325, which shows that after the application of RFID technology, the warehousing speed has been improved to a certain extent.

Simulation result analysis of the optimized outbound process:

Table 4. Waiting time and the number of outbounds

Project	Minimum	Maximal	Average
Wait for review	6.46s	6.61s	6.52s
Numbers	1117p	1128p	1123p

With the application of RFID technology, employees through the RFID reader to review the goods out of the warehouse, the efficiency has been greatly improved, the average waiting time for goods review from the previous 874.41 seconds to 6.52 seconds, before, the completion of the picking of goods need to wait 14.5 minutes to receive review, and now only 7 seconds can be. The work efficiency of the inspectors has been greatly improved, and the bottleneck problem of the outbound link has been solved.

3.3.4 Comparative Analysis of Warehousing Operation Process Based on RFID Technology and Original Warehousing Operation Process

(1) Waiting time

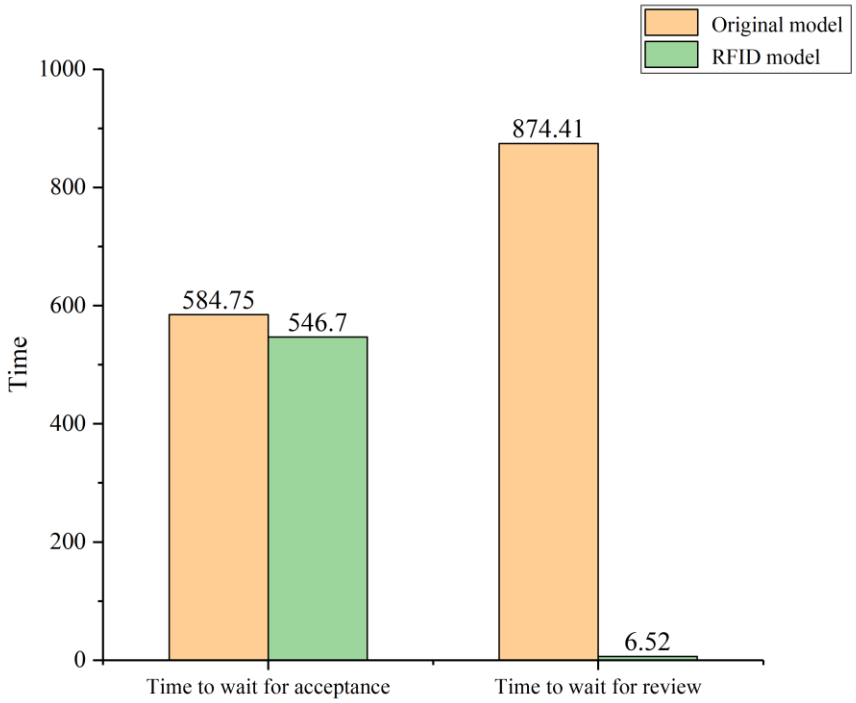

Figure 4. Average waiting time

As can be seen from Figure 4, after the application of RFID technology, the waiting time for acceptance and waiting for review time have been reduced to varying degrees. The waiting time of goods into the warehouse was reduced from 584.75 seconds to 546.7 seconds, indicating that after the application of RFID technology, the speed of goods into the warehouse has been slightly improved; the time for goods to leave the warehouse for review has changed the most, from 874.41 seconds to 6.52 seconds, and the waiting time has been shortened by 100 times, which has improved the speed of leaving the warehouse. After the application of RFID technology, the work efficiency of all aspects of warehouse management has been improved, which not only reduces the waiting time between links, but also saves the space of the buffer zone.

(2) The amount of inbound and outbound warehouses

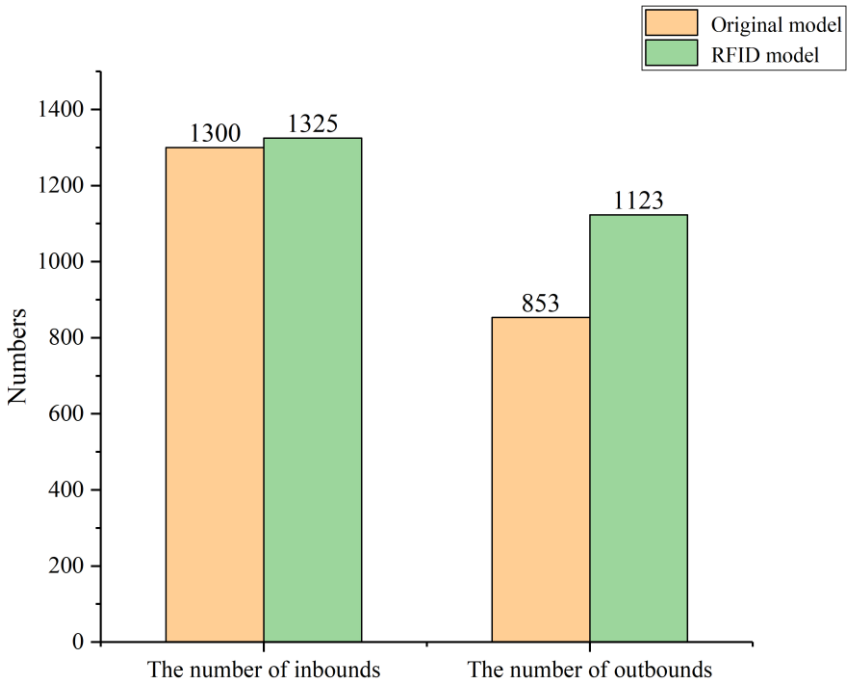

Figure 5. The number of inbounds and outbounds

As can be seen from Figure 5, after the application of RFID technology, the amount of warehousing increased from 1300 disks to 1325 disks in the same time, and the outbound volume increased from 853 disks to 1123 disks. This shows that the RFID system can effectively improve the in-and-out process in the warehousing process, thereby better improving the efficiency of the entire warehousing process.

By comparing and analyzing the simulation results of the two models, it can be found that the application of RFID technology is feasible for improving the efficiency of the warehousing process. After the application of RFID technology, the speed of warehousing operations has been improved, the work intensity of employees has been reduced, and the turnover of goods has been further accelerated.

In summary, the optimization scheme proposed in this article is feasible. Combining RFID technology with warehousing operation process, using RFID technology to complete the collection and collation of data, improving the traditional warehousing operation process, can realize the visualization of the whole process of warehousing operation process, improve warehouse management efficiency, accelerate the speed of cargo turnover, and improve the market response ability of enterprises.

4. Conclusion

In this paper, through the empirical study of the warehousing operation process of Huiyang Logistics Center in Huizhou, Jingdong, the optimization design of the operation process and the combination of RFID technology are optimized, and the Flexsim simulation modeling is used for analysis, and the feasibility of the scheme is determined. The optimized operation process can improve the speed of operation, speed up the turnover of goods, reduce the inventory occupation of funds, and improve the logistics service level of enterprises. The main conclusions of this article are as follows:

First, the warehousing operation process of the logistics center generally has pain points of long waiting time in storage, low inventory efficiency, and high cargo loss rate.

Second, it proves that RFID technology can effectively improve the efficiency of warehousing processes. The application of RFID technology can improve the intelligent level of warehousing, reduce the work intensity of employees, and improve the operational efficiency of warehousing, library management and outbound links to varying degrees.

Third, with the help of Flexsim simulation software, this paper theoretically verifies the feasibility of the solution in the absence of practical application.

The solution proposed in this paper can effectively solve the problems in the warehousing operation process of

Jingdong Huizhou Huiyang Logistics Center, and can also bring reference value to other enterprises to optimize the warehousing operation process.

References

Carmine, S. (2016). Information quality attributes associated with RFID-derived benefits in the food warehouse. *Information of Journal Retail & Distribution Management, 1*(24), 69-87.

Parbakar, V., Kumar, B. V., & Subrahmanya, S. V. (2006). Management of RFID-centric business networks using Web Services. In *Telecommunications, International Conference on Internet and Web Applications and Services/Advanced international Conference.* Guadeloupe. 2006. IEEE Computer Science, pp. 133-133.

Phillips, T., Karygiannis, T., & Kuhn, R. (2005). Security standards for the RFID market. *Security & Privacy Magazine, IEEE, 3*(6), 85-89.

Weinstein, R. (2005). RFID: a technical overview and its application to the enterprise. *IT Professional, 7*(3), 27-33.

Young, B. K. (2015). A Framework for Rapid Development of RFID Application, Department of Computer Engineering. *Posen National University, Pusan*(609-735), 24-25.

Copyrights