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Construction of Logistics Information Management of Small and Medium-sized Enterprises Relying on Recursive Algorithm

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Abstract: - With the rapid development of information technology, the application of information technology in logistics management is more and more, which makes traditional logistics gradually move towards modern logistics, and realizes the optimal allocation of logistics management and resources; at the same time, the logistics industry is also faced with huge data flow. , the low level of informatization and many other challenges, these problems restrict the development of enterprises. In order to solve many problems existing in the construction of logistics management informatization, this paper analyzes logistics management and its informatization application. By understanding the current situation of logistics management in small and medium-sized enterprises, it studies how to construct the informatization application of logistics management in small and medium-sized enterprises, and adds recursive algorithm to the informatization application, and finally constructs a logistics management informatization system. The system is realized through the architecture of B/S model, and the function and performance of the system are tested. The test results show that the system functions well, the maximum load capacity of the system is 600, and the longest response time does not exceed about 20s. The test results are in line with expectations, indicating that the recursive algorithm constructed in this paper is effective in the application of logistics management informatization.

Keywords: Logistics Management, Information Application, Recursive Algorithm, Small and Medium-Sized Enterprises (SMEs)

Introduction

Logistics management is an important part of enterprise supply chain management and an important part of enterprise core competitiveness. Small and medium-sized enterprises implement reasonable and effective logistics management that is in line with the development direction of the enterprise, and introduce various advanced concepts, methods and logistics technologies related to logistics management into enterprise logistics management. This can effectively improve the competitiveness and core competitiveness of enterprises in the market. Information logistics is developed by integrating modern information technology based on traditional logistics mode. This logistics method with information technology can better transmit and feedback logistics information. Under the effective transmission of information, the combination of various circulation links is faster, more convenient and clearer. Using information technology to reasonably allocate resources in logistics management can effectively reduce logistics costs, thereby improving economic benefits, and at the same time promoting the development of market economy. In the context of the information age, the level of informatization of enterprise logistics management is closely related to the development of enterprises. Therefore, in order to better enhance the competitiveness of enterprises and promote enterprises to maintain a good and rapid development in the ever-changing wave of informatization, the informatization construction of logistics management is necessary. Studying the application of modern information technology in logistics

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management of small and medium-sized enterprises has developed the process of logistics management informationization of small and medium-sized enterprises to a certain extent. On the one hand, through the analysis of charts and related models, it has certain reference significance for the theoretical development of logistics management informatization in small and medium-sized enterprises. On the other hand, through the experimental analysis of informatization application construction, it has certain practical significance for the logistics management informatization construction of small and medium-sized enterprises.

With the rapid development of logistics management, more and more people have studied it. Starting from the problems existing in the current business of logistics management, Kain R established a theoretical research framework for these internal and external problems in the form of methodology, and thus proposed a concept-based analysis method for logistics problems [1]. Adeitan D A believed that the full use of information flow in logistics management could effectively improve the competitiveness of logistics by studying the impact of product information flow and logistics information flow on logistics management [2]. Appiah B L analyzed many possible factors that affect logistics management in the construction industry, and evaluated the impact of all relevant information management on logistics management in the entire logistics process [3]. Grabara J studied the impact of legal system on the sustainability of logistics management, and believed that enterprises needed to have a certain sense of social responsibility and consider the sustainable development of the environment and society in logistics management [4]. Although these studies in logistics involve information management, they have little application of informatization. Informatization is widely used in contemporary society. For example, Wong applied it in the construction of smart cities and built the information network of smart cities [5]. Rui D applied information technology to agriculture, and analyzed rural human capital and personal information awareness and learning ability [6]. These relevant studies show that information technology has obvious effects on some industries with more information content. The logistics industry involves a lot of information content, so the application of information technology to logistics management is also one of the more popular topics at present. In these researches on information technology, there are few studies on the simplification of information technology using related algorithms. Therefore, it is meaningful to use related algorithms to optimize the information technology used in logistics management.

Recursive algorithm is an algorithm that repeatedly decomposes a problem into sub-problems of the same type of problem and solves the problem accordingly. It is widely used in computer science problems. Jayawardhana B studied the effectiveness of recursive algorithms in regulating output in system control [7]. Venkataiah C used the recursive algorithm to optimize the interconnected system, and experiments showed that the CPU running time of the system after using the recursive algorithm was significantly shortened [8]. Dif N applied the recursive algorithm to feature selection, and it was proved by experiments that the classification speed after adding the recursive algorithm was faster and more accurate [9]. Chittora P used recursive algorithms for alleviating various power quality problems in digital signal processing systems [10]. Mf A applied the idea of recursive algorithm to the solution of routing and spectrum allocation (RSA) problems in optical networks, and it was proved to be effective through experiments [11]. Haque M M took advantage of recursive algorithms used in computer science to try to solve lattice problems [12]. From these research contents, the recursive algorithm is indeed effective in the simple optimization of the system. This further illustrates the theoretical feasibility of applying the recursive algorithm to informatization applications.

Starting from the challenges faced by small and medium-sized enterprises in today's social environment, the article put forward the importance of logistics management to enterprise development. And relying on the background of informatization technology, the paper discussed the advantages of adding informatization logistics management, and expounded the importance of logistics management informatization construction and

its significance to the development of small and medium-sized enterprises. Combined with the relevant literature survey, the recursive algorithm was used to study the informatization application of logistics management. And according to the problems existing in the logistics management of small and medium-sized enterprises, the informatization application of logistics management is constructed, and the constructed system is tested and studied. The research results have shown that the application of logistics management informatization with recursive algorithm has certain feasibility.

Small and Medium-Sized Enterprise Logistics Management and Information Application Construction

Role and Problems of Logistics Management in Small and Medium-Sized Enterprises

In a broad sense, SMEs can be considered to refer to enterprises that operate on a smaller scale than large enterprises in the same industry. In this type of enterprise, due to the small size of the enterprise, compared with large enterprises, the flexibility of the enterprise is higher, and the business objectives are more diversified, but the corporate image is relatively weaker. For enterprises, logistics management is also a part of enterprise management. It is mainly for the procurement of various materials, transportation, distribution and storage of enterprises to plan command, coordination organization and control supervision. In SMEs, logistics runs through all aspects of production and operation, as shown in Figure 1.
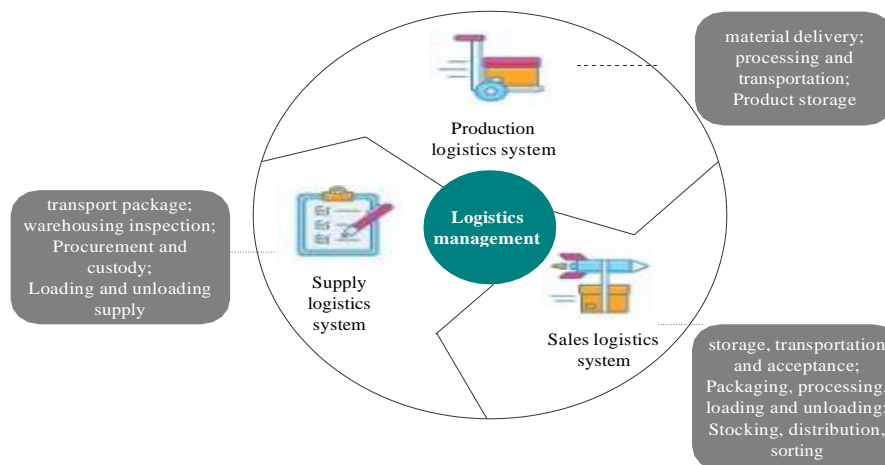

Figure 1 Division of logistics management for small and medium-sized enterprises

As shown in Figure 1, the logistics management of SMEs mainly includes three parts: production, supply and sales [13]. The logistics part of production mainly includes a series of behaviors of the enterprise in the production process, including the distribution and transportation of materials, the circulation of the processing process, the circulation inspection and storage after the processing is completed. The supply part has a series of logistics behaviors generated by the company's material procurement, including material transportation and packaging, warehousing inspection and other links. The sales part is the logistics behavior that occurs in the process of the finished product of the enterprise being shipped from the warehouse to being delivered to the wholesaler or consumer. There are transportation, storage and acceptance of commodities, logistics activities generated by packaging, processing and handling in the circulation process, stocking, distribution, and sorting during sales activities, and finally receiving commodities by suppliers or consumers [14]. During these processes, due to the uncertainty in the product and logistics management of material suppliers, business behaviors such as material procurement and storage will have an impact on the logistics management of the enterprise. Meanwhile, sales channels will also limit the logistics management behavior of an enterprise to a

large extent. If the sales channel is single, for the enterprise, the difficulty of logistics management in the sales process will be reduced. If the sales channel is multi-polar, the difficulty of logistics management will be significantly increased [15]. Under normal circumstances, after the goods are sold and reached the hands of consumers, there will be recycling logistics. It is mainly to recycle the used waste and return it to various enterprises in the supply chain. The prosperous development of economy and trade has made the number of small and medium-sized enterprises continue to increase, resulting in increasingly fierce competition among enterprises, resulting in increased costs and thinner profits. Logistics occupies a large proportion in the cost of enterprises, and the role of logistics in this background is self-evident. For small and medium-sized enterprises, if they want to reduce costs and expand profits in the environment, the development of logistics management must be paid attention to [16]. The role of logistics management in SMEs is shown in Figure 2.
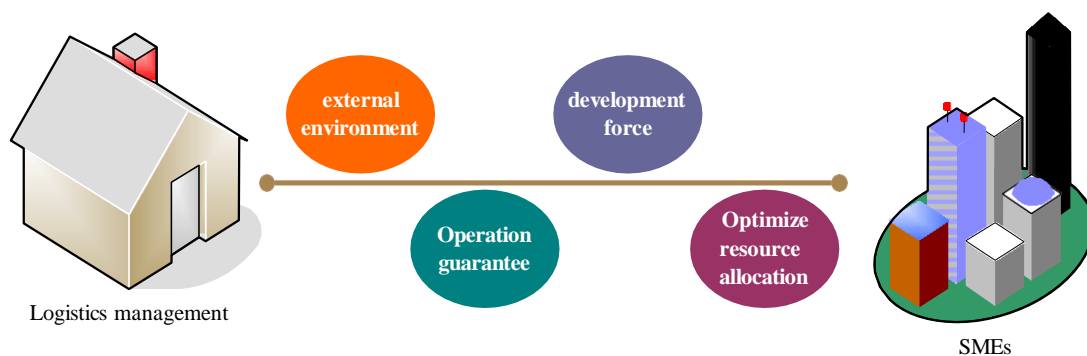

Figure 2 The role of logistics management in SMEs

As shown in Figure 2, logistics can be regarded as the external environment of small and medium-sized enterprises. This is because the normal operation of the enterprise cannot be separated from the timely implementation of the production plan of the enterprise. The material supply of the enterprise needs to be matched with the production plan, and in this process, it needs to rely on the enterprise logistics and its related logistics activities to ensure the external environment for the normal operation of the enterprise [17]. The healthy development of enterprise logistics can save costs and increase profits for enterprises. From this aspect, it has a very good role in promoting the development of enterprises. And in the process of logistics management, the enterprise will involve the reorganization of the business process, which makes the enterprise pay more attention to the resource allocation of the enterprise, and is conducive to the maximization of the enterprise resource utilization [18]. This shows that reasonable logistics management can greatly increase the market competitiveness of enterprises, thereby ensuring the sustainable development of enterprises.

For now, there are still some problems in the logistics management of SMEs, as shown in Figure 3.
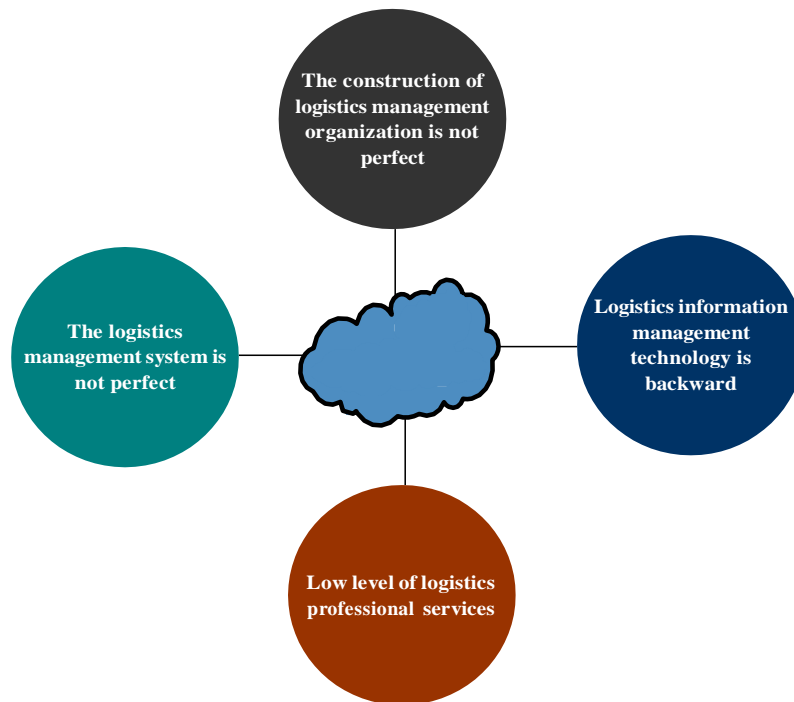
Figure 3 Diagram of the existing problems in logistics management of small and medium-sized enterprises

As shown in Figure 3, the current logistics management organization of SMEs is not perfect, which is related to the production scale of SMEs. Due to the constraints of manpower and financial resources, it is difficult for small and medium-sized enterprises to form a reasonable logistics organization to formulate and complete the corresponding logistics planning. The imperfect logistics management system is mainly reflected in the logistics cost system and the supply chain management system. The low level of logistics professional services is mainly reflected in the quality of logistics. This is mainly because there are many links in a complete product logistics process, including loading and unloading, storage, transportation, etc. The turnaround time and costs incurred in this series of processes may be more for SMEs. In recent years, with the rapid development of Internet technology, informatization has emerged in logistics management, but a complete system has not yet been formed. Enterprises have not fully realized the modernization and automation of logistics management information technology in barcode scanning and commodity sorting. At present, information technology is mainly used in the daily affairs management of enterprises. Most of the logistics management is still in the manual stage. In addition, the use of information technology by managers is not high, so that the degree of logistics information technology of enterprises is not high. It can be seen that the logistics management level of small and medium-sized enterprises still needs to be strengthened, otherwise it will affect the core competitiveness of enterprises and is not conducive to the expansion and development of enterprises.

Information Application Construction

The information technology of logistics management mainly refers to the application of modern information technology in all aspects of the logistics process, and is an important way for logistics to move from traditional logistics to modern logistics. Generally speaking, logistics information technology mainly includes barcode and scanning technology, GPS and GIS technology, radio frequency (RF) technology, and system development language and tools [19].

Barcodes contain numbers, letters, signs, symbols and other information, which are used to represent commodity information such as commodity names, prices, and types. Coupled with scanning technology, various information

of goods can be automatically collected by computer, which is conducive to the query, collection and exchange of logistics information, and timely catches the needs of consumers, thereby improving the level of logistics services. At the same time, it can also effectively improve the working efficiency of the logistics system. GPS and GIS technology can track the logistics location in time to realize the purpose of real-time monitoring and dynamic scheduling. RF technology can be used for non-contact data collection and exchange such as material tracking and delivery vehicles [20]. System development languages and tools, as the name suggests, are network tools built for logistics information systems. In general, logistics information technology has a strengthening effect on the systematization, professionalism, flexibility and integration and coordination of logistics management. It is beneficial to realize the optimization of resource allocation in the process of logistics management. The logistics management information system integrating information technology mainly includes ordering system, sales system and auxiliary ordering system.

The ordering system is mainly to carry out the ordering operation and the exchange of ordering information. It can effectively shorten the time from receiving an order to issuing an order, reduce the error rate of commodity orders, and save labor costs. And this method helps enterprises to better analyze commodity order information, accurately determine the best-selling and unsalable product categories, and has a certain enlightening effect on the adjustment of production plans and sales plans of enterprises. The sales system mainly reads and organizes the sales information of the products, and can be directly transmitted to the relevant departments through the computer system for market analysis. It is beneficial to improve the operating efficiency of the enterprise [21]. The auxiliary ordering system automatically generates replenishment orders by judging the existing or current product data, and the computer system tracks the commodity inventory and adjusts the quantity and sales. In theory, logistics management informatization helps enterprises to improve logistics efficiency, logistics service level, and reduce the consumption of human, financial and material resources.

Informatization Application Construction of Fusion Recursive Algorithm

Recursive algorithm can express some more complex problems concisely and is an important method in the process of program development. In the process of program development, adding recursive algorithms can make the structure of the program clearer. Its principle is to directly or indirectly call itself, decompose complex problems into sub-problems with simple scale, and repeat self-calling to achieve the purpose of solving the problem [22-23]. For the construction of logistics management informatization, in the functional section of the system, such as the classification and identification of commodities, the use of recursive algorithms in the background processing will make the calculation steps simpler. It is supposed that the given processing rule is:

$$G = f(m) \tag{1}$$

m represents an object. If an object needs to be summed in the system, according to the principle of recursive algorithm, the iterative rule is:

$$f(m) = m + f(m-1) \tag{2}$$

When the operation to be performed in the system is in the form of factorial, the iterative rule is:

$$f(m) = m \cdot f(m-1) \tag{3}$$

During recursive parameter passing, the parameter value is gradually reduced until the boundary condition is reached.

Construction of Logistics Management System

Logistics Management Information System Model

In small and medium-sized enterprises, the logistics management information system can be roughly divided into material procurement and inventory management, material use and sales management, system services and so on.

In the inventory management of materials, different management strategies are implemented according to the importance of the materials. It is assumed that the factors affecting product inventory are:

$$Y = \left(Y_1, Y_2, Y_3, \ldots Y_m \right) \tag{4}$$

The influencing factors are classified into levels, and the factor evaluation is performed to obtain the factor relationship matrix:

$$D = \left(D_1, D_2, D_3, \ldots D_m \right)$$
$$V = \left(v_m \right) m \times m \tag{5}$$

The weight vector Q of the evaluation factor is determined, and the factor grade score vector F is determined, and the evaluation model is firstly obtained:

$$H = Q \times V \tag{6}$$

The final evaluation score is:

$$Z = HF^T \tag{7}$$

The main contents of the logistics management information system are shown in Figure 4.
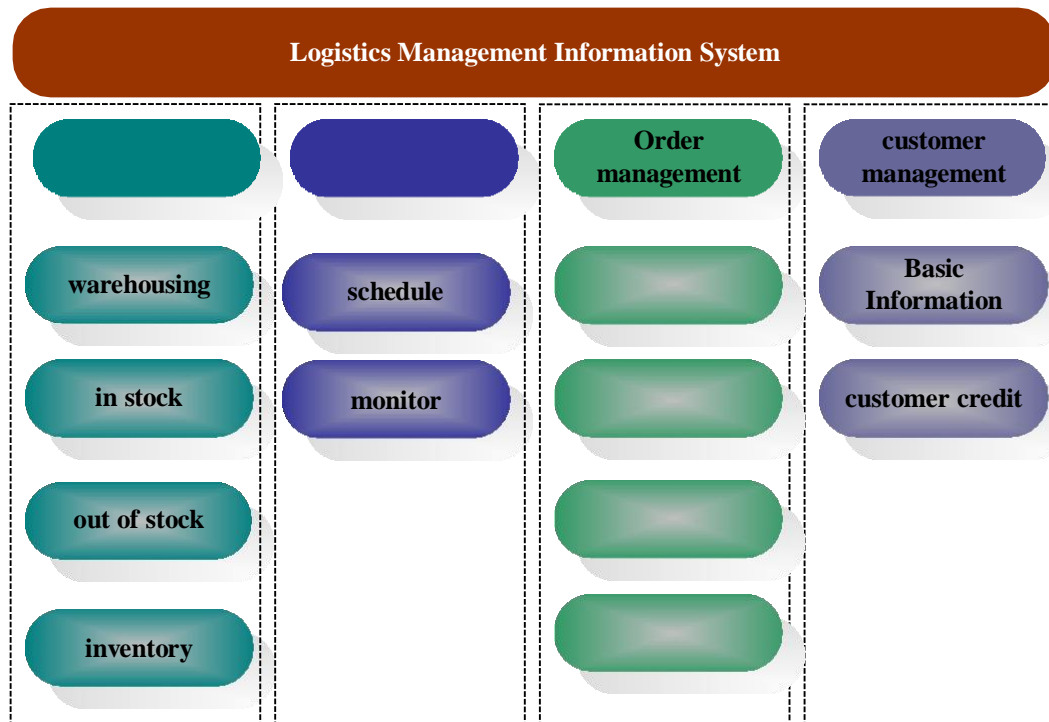
Figure 4 Logistics management information system

As shown in Figure 4, the entire logistics management information system mainly includes warehousing, distribution, order and customer management modules. In warehousing management, including material procurement inventory management. Distribution is mainly reflected in the scheduling and monitoring of commodities. Order management includes order query processing and real-time monitoring of sales. The customer management module is mainly to sort out the customer information to analyze the customer and improve the quality of service.

Specific Design of the System Function Structure

(1) Warehouse management

Warehousing management includes material planning, procurement, warehousing, warehousing, and inventory management in the warehouse. In the warehousing link, the administrator obtains the goods information of the materials according to the warehousing notice, and then carries out the warehousing operation. During this process, the administrator needs to verify the goods and proofread the information. After the items are successfully put into the warehouse, the warehouse management will manage the items that have been put in the warehouse, and the administrator will put the goods on the shelves according to the cargo location list. Next, according to the importance of the materials, different management methods are adopted for different types of materials. When the goods need to be shipped out, the relevant information will be transmitted to the outbound management module to generate an outbound notice. Then, the administrator will check whether the information on the notice is consistent with the information of the outgoing items, and observe whether the items are in good condition, and then decide whether to go out of the warehouse, and then update the item information after the outgoing is successful.

(2) Delivery management

Distribution management includes scheduling and monitoring functions. It is mainly to sort out the status of the goods, inquire about the transportation status of the goods, and monitor the transportation process in real time to ensure the normal distribution of the goods. Scheduling includes transportation route planning, distribution management, etc. The transportation route plan is mainly based on the location information of the item buyer, the purchase scale, the company's own capabilities and other factors to plan, and comprehensively evaluate these factors to obtain the optimal route selection.

(3) Order management

Order management is mainly to supervise the sales of goods. In this management module, operations such as order processing, analysis, and verification are included, and the status of orders can be observed, and abnormal order processing services can be provided. The sales records of the goods are counted and connected with the warehouse management to replenish the supply in time. This module also handles when a customer asks for a return for the goods he purchased that fails to meet his expectations.

(4) Customer management

Customer management is mainly to conduct statistical sorting of customer information, including customer purchases and other information. It helps enterprises to mine customers and help them provide customers with better services. In this module, customers can be classified, high-quality customers can be screened, and good relationships between high-quality customers can be maintained.

System Architecture and Test Environment

In the development of the information industry, there are many kinds of architectures for informatization applications, and the most widely used are the architecture of the C/S model and the architecture of the B/S model. Combined with the needs of small and medium-sized enterprises logistics management information application, this paper chooses the architecture of the B/S model, and its structural model is shown in Figure 5.
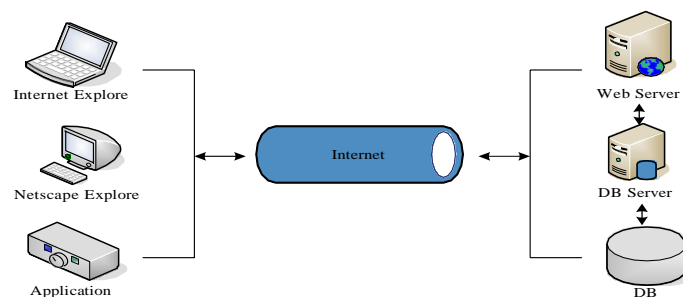

Figure 5 Architecture of B/S Model

As shown in Figure 5, the architecture of the B/S model is mainly calculated through the Web. It uses the existing software and hardware equipment of the enterprise, and uses the Internet technology and distributed object technology to establish an internal Internet network within the enterprise to form a virtual enterprise computing environment. The model architecture has good dynamic reconfigurability, integration and openness. The logistics management information system designed based on this architecture can promote the effective cooperation of all aspects of the enterprise's internal logistics and improve the efficiency of logistics management.

The test of the system is carried out in the main software and hardware environment, mainly to test the performance of the system. The system is verified whether it meets the requirements of the enterprise or the difference between the operating results of the system and the expected results is determined and improved. The test environment of the system in this paper is shown in Table 1.

Table 1 System test environment

Service-Terminal	application server	hardware environment	Intel、i5 、512GB
		operating system	windows server 2016
	database server	hardware environment	Intel E5300
		database	MSSQL Server2005
client	PC client	hardware environment	Intel E5300
		operating system	Windows

Test Results Analysis

System Function Test: System functionality is tested to see if the system is operational. This article will use the three parts of system login, storage management and order management as typical test cases for query testing. The test results are shown in Table 2, Table 3 and Table 4, respectively. Table 2 is the system login test result, Table 3 is the warehousing management test result, and Table 4 is the order management test result.

Table 2 System login test results

test steps	output	Test Results
1.Enter the correct username and password and click Login	Enter the home page and display the current user name correctly	consistent with expectations, pass
2. Don't enter username and password but click login	Prompt user name and password are empty, please re-enter	consistent with expectations, pass
3.Just enter the correct username and click login	Prompt login password is empty, please re-enter	consistent with expectations, pass
4. Just enter the correct password and click login	Prompt username is empty, please re-enter	consistent with expectations, pass
5. Enter correct username but wrong password and click login	Incorrect password, please log in again	consistent with expectations, pass
6. Enter wrong username but correct password and click login	Prompt to re-enter username and password	consistent with expectations, pass
7.Incorrect username or password entered three times in a row	Unable to log in and display the auto-logout login screen	consistent with expectations, pass
8. Enter outliers	The entered characters contain abnormal characters, please re-enter	consistent with expectations, pass
9. Enter the critical value	Prompt the input character exceeds the specified length, please re-enter	consistent with expectations, pass

10. An error occurred during the input process, click Cancel	Restore defaults and initialize all inputs	consistent with expectations, pass

Table 3 warehousing management test results

test steps	output	Test Results
1. Click Warehouse Management	Jump to sub-interface	consistent with expectations, pass
2. Enter the warehousing management module with the role of warehouse management,	Jump to the Inventory Management page	consistent with expectations, pass
3.Enter the commodity warehousing information and submit it, which will be approved by the warehouse supervisor	Prompt that the commodity warehousing information has been successfully entered	consistent with expectations, pass
4. Enter the warehousing management module as a warehouse manager to query inventory information	Display updated inventory information	consistent with expectations, pass

Table 4 Order management test results

test steps	output	Test Results
1. Click on the order management module	Jump to order management page	consistent with expectations, pass
2. Click on order inquiry	Display order basic information	consistent with expectations, pass
3. Click on an order to query	Show the correct status of the order	consistent with expectations, pass
4. Enter the information analysis and processing module and enter the order data and click submit	Display pending approval, which can be reviewed and modified	consistent with expectations, pass
5. Enter the out-of-stock processing module and register out-of-stock information	Complete information entry and prompt whether to jump to the purchasing module	consistent with expectations, pass

According to the test results in Table 2, Table 3 and Table 4, it can be seen that each business process module of the system can operate normally and in sequence, each function is well implemented, and the test results are in line with expectations. It indicates that the system works normally and can meet the business function requirements.

System Performance Test: According to the designed logistics management information system, the system is tested, and the maximum carrying capacity of the system is tested. The test results obtained are shown in Figure 6.
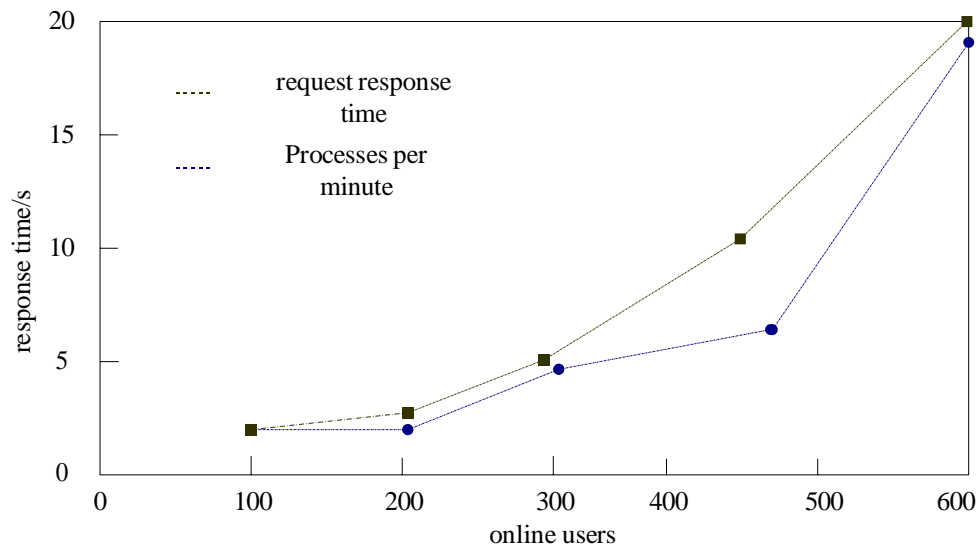
Figure 6 System performance test

As shown in Figure 6, when the performance of the system is tested according to 100 online users, the system's query request response time at this time is less than 5 seconds, and the system's maximum response time and tolerance time are about 20 seconds. And without exceeding this response time, the maximum capacity of the system is 600. The system performs well and meets the expected results.

Conclusion

Starting from the current situation of logistics management of small and medium-sized enterprises, through the analysis of the problems existing in logistics management of small and medium-sized enterprises, this paper drew the importance of information application in logistics management of small and medium-sized enterprises. Combined with recursive algorithm, the informatization application of logistics management was constructed. The design of system functional structure and architecture was included. From the warehouse management of the enterprise to the customer management of the enterprise, the system replaced the traditional logistics management method of paper documents and manual reports through information technology. The informatization construction of logistics management was realized, which was conducive to the more orderly and efficient development of business behavior of enterprises. At the same time, it could also establish a good management and informatization foundation for the expansion and development of the enterprise's production capacity, maintain the vitality of the enterprise, and better provide an internal management environment for the enterprise to improve its economic benefits. Through the test analysis of the construction system, it was concluded that the function and performance of the system were good. It can be shown that the construction of logistics management informatization application of small and medium-sized enterprises integrating recursive algorithm has certain feasibility.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

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