Computer Aided Optimization of Picking System in Logistics Distribution Center

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Abstract. With the development of information technology and the improvement of scientific and technological level, the e-commerce industry has begun to enter the stage of large-scale development and operation. Especially with the continuous expansion of the scale of the online shopping market, the order structure of e-commerce enterprises is increasingly showing the development trend of "small batch, multi-batch and diversified", which increases the difficulty of short delivery in the logistics distribution center of e-commerce and becomes one of the bottlenecks restricting the rapid development of e-commerce enterprises. In this paper, C.V analysis method to establish SLP system logistics distribution center and new business model, effectively control the total inventory and end customer satisfaction. In order to solve the problems of insufficient receiving capacity of the main body and low utilization rate of personnel and equipment in the picking operation, a Petri net model of picking operation in the distribution center is established by using Petri net tool. The influencing factors of the model are analyzed and the optimization scheme of picking operation is put forward. The simulation platform is used to convert the Petri net model into a simulation model. By running the simulation model and comparing the simulation results before and after optimization, the feasibility and effectiveness of the optimization scheme are discussed in detail, so as to improve the utilization rate of personnel and equipment and operation efficiency.

Keywords: Computer Aided, Logistics Distribution, Distribution Center, Picking System, System Optimization
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1 INTRODUCTION

Today, with the rapid development of the Internet, consumers have put forward more and more personalized requirements for the products and services of enterprises, which makes the

competition among enterprises more and more diversified. Nowadays, the competition among enterprises is no longer just focusing on the quality of products and the price of products as in the past. Enterprises will spend higher costs to improve their service ability in order to attract more consumers. Now the choice of consumers for the product will not only focus on product price and quality problems, can focus on more after purchasing enterprise products, with consumers to purchase the behavior of the enterprise products, enterprises can bring what services for consumers, such as after-sales maintenance, use of training, logistics distribution, as well as by the quality of services provided by the enterprise. Enterprise services are playing an increasingly important role in the process of consumers deciding whether to buy an enterprise's products. Therefore, for modern enterprises, they not only need to improve product quality and strengthen product marketing efforts, but also need to focus more on reducing product logistics costs and strengthening logistics service capabilities. The improvement of enterprise logistics service ability requires enterprises to take advanced logistics facilities and equipment and higher logistics management level as support.

It can be said that it is the hub connecting suppliers and customers. In the distribution of the nuclear business link, picking goods operation is very important, it is according to the customer order requirements in the system, the order involved in the type and number of items as quickly and accurately as possible from the storage space plunder out of the centralized packaging and delivery. Logistics distribution centers play a huge role in reducing transportation costs, improving market response capacity and reducing consumption loss. The modern distribution center is different from the traditional storage center which only has the storage function. The distribution of the main function is around the distribution and delivery, and it also has the functions of storage, circulation processing and information service. The operation status of the distribution center will directly affect the quality of products and services.

The distribution strategy is studied and the model is solved by heuristic algorithm. Klumpp et al. [1] have greatly improved the working efficiency of the storage system by partitioning the vertical storage locations in the storage system. Dobransky et al. [2] provided a research direction for the selection of automatic access system and the optimization of sequential scheduling through the research on the stacking and hiding machine and vehicle sequential scheduling problems in the automated three-dimensional storage system. Klumpp and Zijm [3] emphasized the need for system before modeling process to conduct a comprehensive understanding, advantages and disadvantages of the existing modeling analysis, by comparing the 12 kinds of business process modeling method, points out the relationship between network can make the process clearer, the method itself has a strict mathematical definition, network model can be verified by means of simulation. Vavrik et al. [4] to grind a Guy large-scale data in the warehouse management system using the Apriority algorithm for mining association rules, improve the whole efficiency of the distribution center, consider small three-dimensional warehouse operation characteristics, the multi-objective warehouse slotting optimization problem is transformed into single objective optimization, the nested partitions algorithm is optimized, the optimization effect is remarkable. Ali et al. [5] provided a research direction for the selection of automatic access system and the optimization of sequential scheduling through the research on the stacking and hiding machine and vehicle sequential scheduling problems in the automated three-dimensional storage system. With the continuous improvement of computer technology, system optimization and modeling and simulation are applied more and more in different fields. Because the study of system modeling and simulation technology needs to be closely connected with the real system in order to play a practical guiding role, the previous research results are often not applicable to the operation and management of enterprises.

2 LOGISTICS DISTRIBUTION CENTER LAYOUT

2.1 SLP System Layout

System layout design method is a particularly strong organization, logistics data analysis and closely related to business unit level analysis, obtained by reasonable arrangement of specialized technical method, therefore in the logistics system of plane cloth the classification of the representation of the relationship between business units, take the plant general layout design from qualitative stage gradually developed into the quantitative stage [6]. This approach requires the establishment of a business correlation graph to represent the degree to which each business is closely related to each other. A business correlation diagram is similar to a logistics diagram between cars. The business correlation diagram needs to be gradually adjusted through the trial method until a satisfactory solution is finally obtained. Then it is necessary to dig and build the actual volume situation to reasonably arrange each business unit. In order to better evaluate the layout scheme clearly, the system layout design should carry on the quantitative processing to the relevant scheme.

SLP basic starting point is to use quantitative relationship between the operation department of classified to assess related degree between departments, so the system layout design method is used to get the first job is to layout for the relationship between operation department to make analysis, including qualitative not quantitative relationship between logistics and logistics. There are differences between enterprises' logistics facilities and factories. In factory design, the design of products determines the manufacturing and assembly processes and processes. In logistics, it is reflected in the sequence and lines of logistics operations, while the size of output reflects the production type, and in logistics, it is reflected in the size of material flow. In logistics enterprises, different products have different requirements in terms of logistics functions such as storage, loading and unloading, which ultimately determines the different logistics operation lines.

2.2 C.V Analysis

The coefficient of variation is the absolute value of the level difference, standard deviation and variance, which reflect the degree of dispersion of data. The data size is not only affected by the degree of dispersion of the variable value, but also affected by the average level of the variable value. Generally speaking, the higher the average level of the variable value, the larger the measure value of its dispersion degree, and vice versa [7]. Coefficient of variation is another statistic used to measure the degree of variation among observed values in the data. When comparing the degree of variability of two or more data, the standard deviation can be used directly if the unit of measure is the same as the mean. If units and/or mean are different, the degree of variation cannot be compared by standard deviation, but by the ratio (relative value) of standard deviation to mean. The ratio of the standard deviation to the mean is called the coefficient of variation, denoted as. Coefficient of variation can eliminate the effect of unit and/or mean differences on the degree of variation of two or more data. The calculation formula of coefficient of variation is as follows:

$$\mathrm{C.V}=\frac{SD}{MN}\times 100 \tag{1}$$

In the formula, C.V is the coefficient of variation; SD is the standard deviation; MN is the average.

2.3 New Logistics Business Model

In order to reduce the level of supply chain, a new business model as shown in Figure 1 is proposed according to the characteristics of the enterprise. Under the new model, the public property flow operation has become a first-class logistics center. The production base will send the products to the logistics center in batches, where they will be stored, dismantled and picked, and

then packaged and distributed according to the stores. By eliminating warehouses, the new business model can strengthen the control of the whole logistics link, and effectively control the total inventory and the satisfaction of end customers.

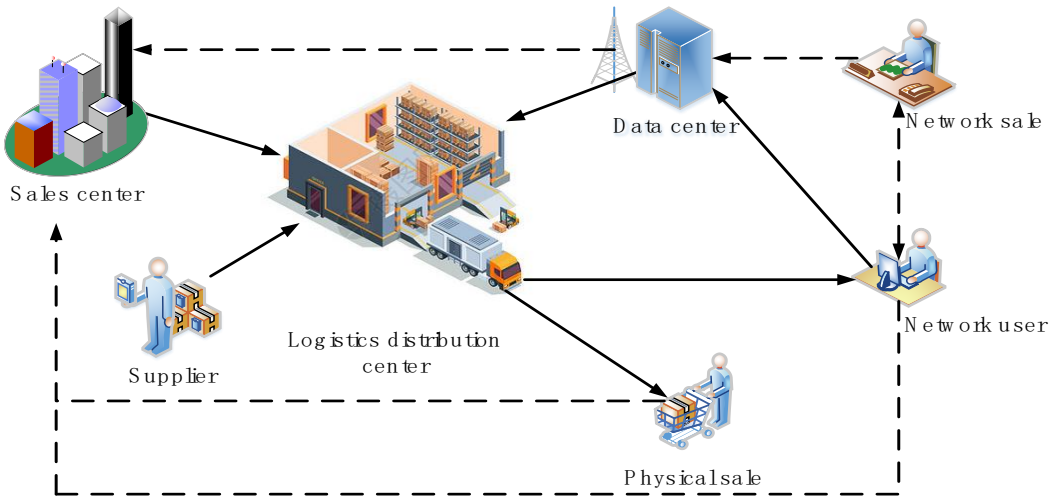

Figure 1: New logistics business network planning.

3 PICKING SYSTEM OF LOGISTICS DISTRIBUTION CENTER

3.1 Distribution Center Picking System

As shown in Figure 2, the system is mainly composed of the upper computer, the controller and the application terminal. The upper computer is composed of a PC, and the upper computer is mainly responsible for the generation and processing of orders. And the upper computer as a network server in the monitoring state, when a controller sends a connection request, the PC will bind the IP address and port number of the control, and then send information to the controller through the network. The controller is the core embedded controller, which is used to receive the data information from the upper computer and control the corresponding electronic label according to the information. When the electronic tag sends data to the controller, the controller sends the information back to the upper computer PC through the network. Each controller has three two-wire bus channels.

Application terminal for electronic tags, labels and digital display tube with high brightness led, when the electronic tag light, said the goods need to choose the electronic tag represents, digital tube is used to display the need to choose the number of the goods, when after picking, picking personnel can through the button out light and digital tube, on behalf of the chosen, The tag feeds the information back to the controller, which sends it back to the PC. The electronic tag of this system also has the function of fault detection. The upper computer and the controller communicate by TCP/IP protocol through the switch. The upper computer is in the listening state as the server, and each controller is as the client.

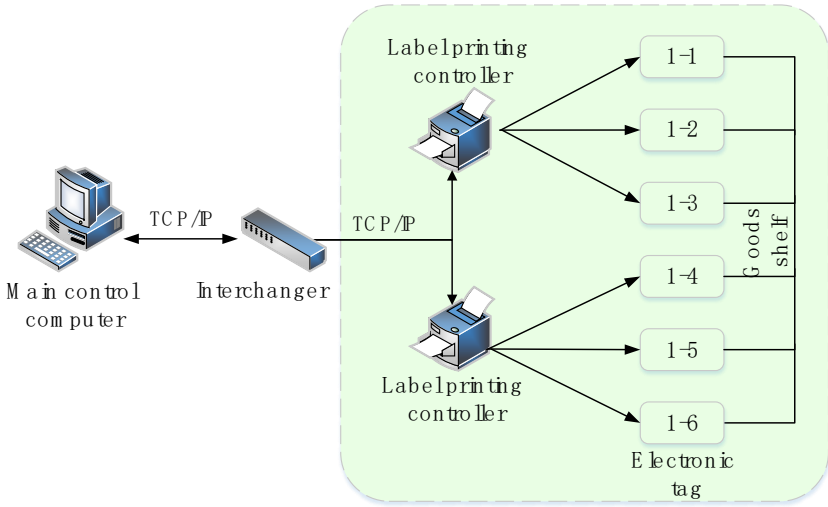

Figure 2: Distribution center picking system.

When each controller connects with the server, the server will create a socket for each controller, which will be bound to the IP address of the corresponding controller. After the connection is established, when a controller needs to communicate with the corresponding socket, the communication can be completed by calling the corresponding socket. The advantages of using network communication are easy long-distance transmission, data is not easy to lose, high communication reliability and strong anti-interference ability. Because each controller and the upper computer is connected through the network interface, each controller is connected to the switch through the network cable, through the switch and PC network communication, network communication is easy to expand the system.

Operation, the PC will be treated as order information, after converted into packets and sent over the network to the specified controller, the controller receives data from the PC and the command, choose the electronic label in the channel to communicate, and then address the frame matching with the electronic label, sends the information to the electronic label after a match, The electronic tag lights up the corresponding indicator light to guide the picking personnel to pick up the goods. After finishing picking up the goods, press the "confirm" button to feed the information back to the PC. When all the goods of this order are picked up, the information feedback will generate a report form. If the indicator light cannot work normally during the operation, it will have a great impact on the picking operation. The ordinary power-on self-inspection can only judge the quality of the indicator light by the naked eye, which makes the workload of picking personnel increase. When working normally, if the indicator light does not work normally, it cannot be judged. With the fault judgment function, the operator can use the PC to detect the failure of the indicator light.

3.2 Picking Operation Process of Logistics Distribution Center

The realization of the efficiency system of picking goods in the modern logistics distribution center can be judged according to the key points of inspection [8]. Only when the ideal efficient logistics distribution center realizes the system of efficiency and high degree of automation, can the work tasks be completed efficiently and timely. The operating process of the system is shown in Figure 3:

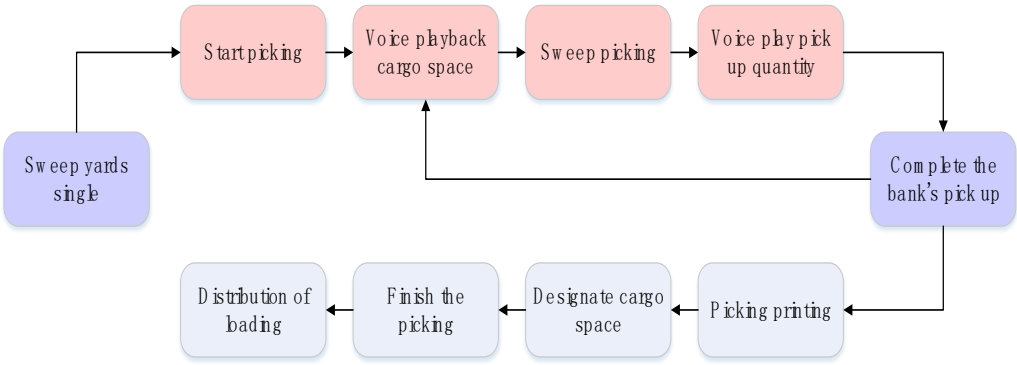

Figure 3: Flow chart of picking operation of distribution center.

3.3 Petri Net System Modeling

The flow of goods and information occurs as the workflow occurs. Workflow is different according to the nature and way of service of the enterprise. Even the same type of enterprise will also be different because of its different emphasis on the work process. The advantage of using Petri net modeling is that the graphical modeling of Petri net is easy to understand [9]. On the one hand, it can reflect the dynamic characteristics between the local and the whole system, and between the local and local parts. On the other hand, it can check whether there is locking phenomenon in the system, find out the potential problems, and ensure the normal operation of the system. Therefore, Petri net is used to establish the system model, which is shown in Figure 4. It is very suitable for the analysis of the current system on the theoretical basis, the identification of bottlenecks in the system and the evaluation of the system's operating status.

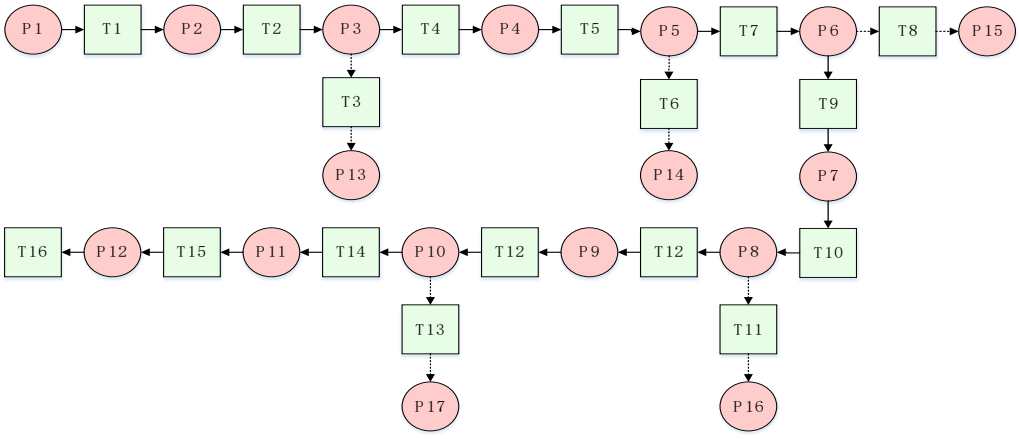

Figure 4: Petri net model of picking process.

3.4 Picking System Optimization Analysis

The optimization of the sorting system plays an important role in improving the operational efficiency of distribution, which can improve the level of customer service to a certain extent, and then improve the operational efficiency of distribution. In the picking system, when the modeling and optimization of the picking system is carried out, the actual flow of goods, the change of goods state and the behavior change of main operators' tools in the outbound process and the picking

process are analyzed, and the outbound process and the picking process are reduced without considering the damage of goods, the difference of goods and the abnormality of storage location.

According to the reduced operation process of picking goods, and the cooperation and waiting relationship between the main operation tools in the specific process of picking goods are described through Petri net, a Petri net model of the reduced operation process of picking goods is established. The static structure, activity and effectiveness of the Petri net model are verified by Tina software. The Petri net model of the reduced sorting process is shown in Figure 5:

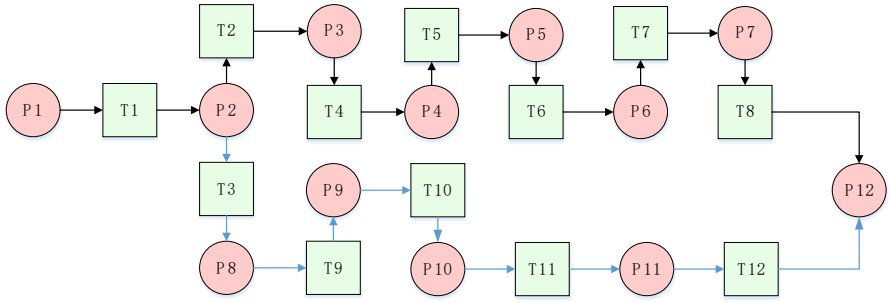

Figure 5: The Petri net model of the reduced picking process.

4 PICKING GOODS OPTIMIZATION SIMULATION ANALYSIS

In the process of picking, the picker operates the picking order generated by the electric horizontal truck according to the system's "first-in, first-out" rule to pick up the goods at the designated warehouse location. Since the storage location of the goods on the shelf is randomly allocated by the receiving members during the receiving operation, this paper holds that the designated warehouse location of the outbound warehouse in the picking order can be regarded as random. When picking orders designated location is located in the bottom shelf, picking member scans goods box code and code without exception and the goods in good location available, picking member completes the goods shelves processes, can be directly transport the goods to check delivery area, and then on to the next harvest, the location of the goods when picking orders above specified goods located in second floor location, forklift truck for picking member need to call high physical shelves, Then it is carried by the picker to the rechecking and shipping area.

4.1 Picking System Simulation Analysis before Optimization

The simulation model has been run repeatedly, and the model runs normally and the operation results are stable. Under the condition that the hypothesis is established, the model is consistent with the specific actual operation. It can be considered that the model is effective in the study of continuous cargo picking operation coordinated by a single picker and a single high-lift forklift truck. Through the analysis of the simulation output data, it can be seen that in the process of continuous cooperative picking operation, the busy rate of high-lift forklift is 37.80%, most of the time the high lift truck is waiting for the call of the pick. In the simulation model, in order to ensure that the picker is in a waiting state during the moving process and operation process after the high forklift truck receives the call, the actual busyness rate of Labored should be the busyness rate of the simulation output minus the busyness rate of the high forklift truck, namely 62.20%. The 37.80% business rate of high lift truck and 62.20% business rate of electric horizontal truck are both at a low level. The existing cargo picking operation mode has a great waste in the utilization of personnel and equipment, which is likely to cause a delay in the shipment of goods under the condition of large outbound orders and large outbound volume.

4.2 Simulation Analysis of the Optimized Picking System

Based on the analysis of Petri net model of picking operation, an optimization scheme was proposed to improve the operation mode of picking process and eliminate the phenomenon of the pickers waiting for the high forklift truck. The specific implementation of the improvement of the sorting process is as follows: (1) The sorting list generated by the system is only received by the picker, the operator of the high level forklift truck and the picker receive it simultaneously, and the operator of the high level forklift truck only receives the information of the warehouse location of the goods located on the shelves above the second floor and waiting to be removed by the system; (2) The picker and the high forklift truck pick up goods at the same time, and there is no waiting relationship between the two sides; (3) Change the calling mode of the high forklift operator and the goods picker. The high forklift operator will place the goods on the shelf passage after the physical goods are removed from the shelf, and call the goods picker to carry the goods; (4) The picker directly removes the goods on the bottom shelf of the order without being called; (5) Considering that the receiving operation and picking operation in the warehouse area will be carried out at the same time, after the high forklift takes the goods off the shelf, the goods to be exported will be marked to distinguish the goods to be put on the shelf and the goods to be exported; (6) In order to avoid because of the high a forklift will be placed in the reservoir area after the goods under the physical channel within the channel congestion, affect the reservoir area within the picking operation and receiving operation and other operations, picking member after receiving high a forklift call, after finish the assignment priority is called the location of the goods, the goods by picking off the shelves after a preliminary check system operation, And transported to the shipping port and the shipping review area; (7) After the field investigation and analysis of a warehouse, it is preliminary determined that the quantity of goods placed in the passage for system removal and handling after the physical disassembly of the high level forklift truck should not exceed 25PLT without affecting the operation in the warehouse.

Each unit of simulation time is taken to represent the actual 1 minute, and the actual simulation time is 30 days. According to the 8-hour working time per day, the total simulation time is 14,400 minutes. The simulation data is shown in Figure 6:

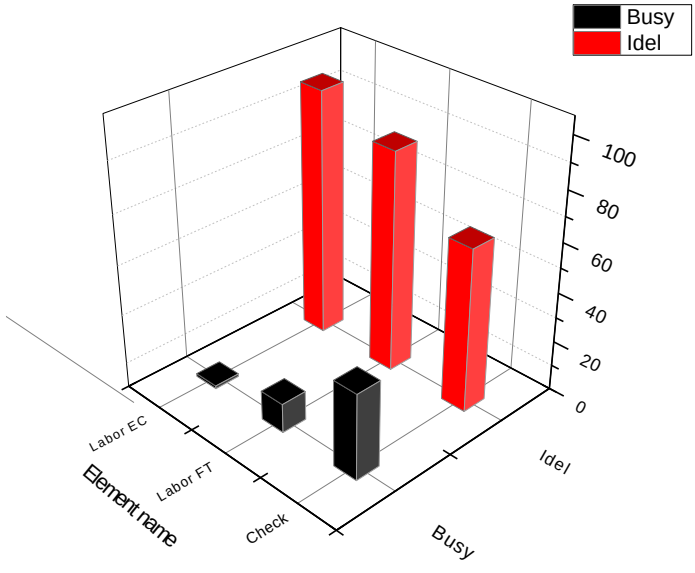

Figure 6: Simulation statistical diagram of each element of the simulation model.

Through several simulations, it is verified that the output result of simulation is stable. After 30 days of operation, the output of the improved model reaches 9,867 PLT, and the busy rate of high-lift forklift and electric horizontal truck is 88.21% and 98.82%.

Through the Petri modeling analysis of the picking operation, the specific process of the picking operation was redesigned. The Petri net model before and after the improvement was transformed into a simulation model by the Witness simulation software. After the improvement, the simulation results showed that the utilization rate of the high-lift forklift was increased to 86.21%. After the waiting time of the picker was eliminated. The utilization rate of electric horizontal vans is increased to 97.23%. Before the optimization of the picking operation, the simulation model runs for 30 days with a total of 5,562 PLT of goods out of the warehouse. After the optimization of the picking operation, the simulation model has a total of 9,867 PLT of goods out of the warehouse. The optimization effect of the picking operation is shown in Figure 7: ·

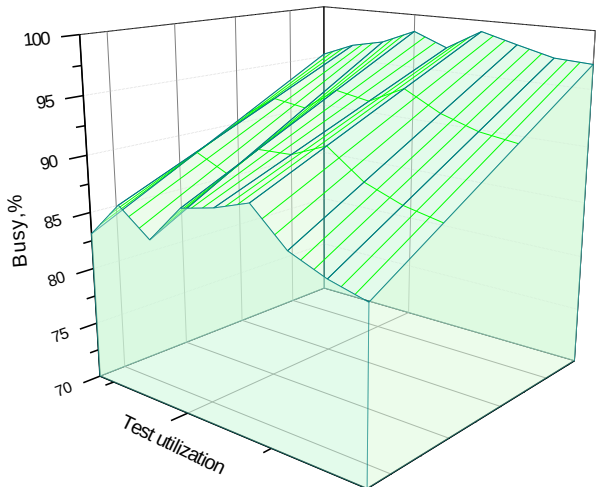

Figure 7: Optimized renderings of picking operations.

It can be seen from the optimization results that the optimization effect is significant. In the case of no increase in picking personnel and equipment, under the condition of continuous picking operation with high-lift forklifts and electric horizontal trucks, the outgoing volume of the optimized picking operation is increased by 77.40% compared with that before optimization. Since outbound orders of the distribution center are driven by sales, the optimization results are of great significance for a warehouse to improve outbound speed, order fulfillment rate and demand response ability in the peak season of sales, and then improve the operational efficiency of the supply chain.

5 CONCLUSION

In this paper, through solving the problems of insufficient receiving capacity of the main body and low utilization rate of personnel and equipment in the picking operation, the Petri net tool is used to establish the Petri net model of picking operation in the distribution center, and the influencing factors of the model are analyzed to put forward the optimization scheme of picking operation. The Petri net model was transformed into a simulation model by using the simulation platform, and the original cargo picking operation process was evaluated by running the simulation model and the output results of the simulation operation. The optimized scheme was implemented by specific simulation, and the personnel and equipment configuration that maximized the cargo receiving capacity was designed. Under the condition of minimizing the increase in cost, the capacity of

receiving goods in the peak season is improved on the original basis. By improving the process of picking goods, the utilization rate of personnel and equipment is improved without increasing additional personnel and equipment, and the efficiency of picking goods is increased by a factor of 77.40%. The existing sorting operation process was improved, and the simulation software was used for simulation analysis, and the personnel and equipment utilization rate and work volume before and after the improvement were compared to demonstrate the feasibility and effectiveness of the optimization scheme of sorting operation.

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