Optimization Study of Warehousing Inbound Process of Company L Based on Petri Net

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Abstract: Taking the warehousing operation process of Company L as the research object, the Petri net model of the warehousing operation process of Company L is constructed on the basis of research and analysis of the warehousing operation process of Company L. Firstly, the correctness of the Petri net model is verified through the correlation matrix and invariant analysis method. Firstly, the correctness of the Petri net model is verified by association matrix and invariant analysis, then the conflict and synchronous relationships in the Petri net model are searched by association matrix analysis, and finally the optimization of the warehousing process of Company L is carried out according to the conflict and synchronous relationships in the Petri net model.

Keywords: Warehouse Management; Warehousing Process; Petri Net; Association Matrix Reorganization Algorithm

1. Analysis of relevant concepts

1.1 Petri net model

Petri nets are networks describing the relationship between events and conditions proposed by the German scholar Carl Adam Petri in his doctoral dissertation "Automata Communication" in 1962 [3]. It is a physics-based system model proposed in a computer language. As a mod-
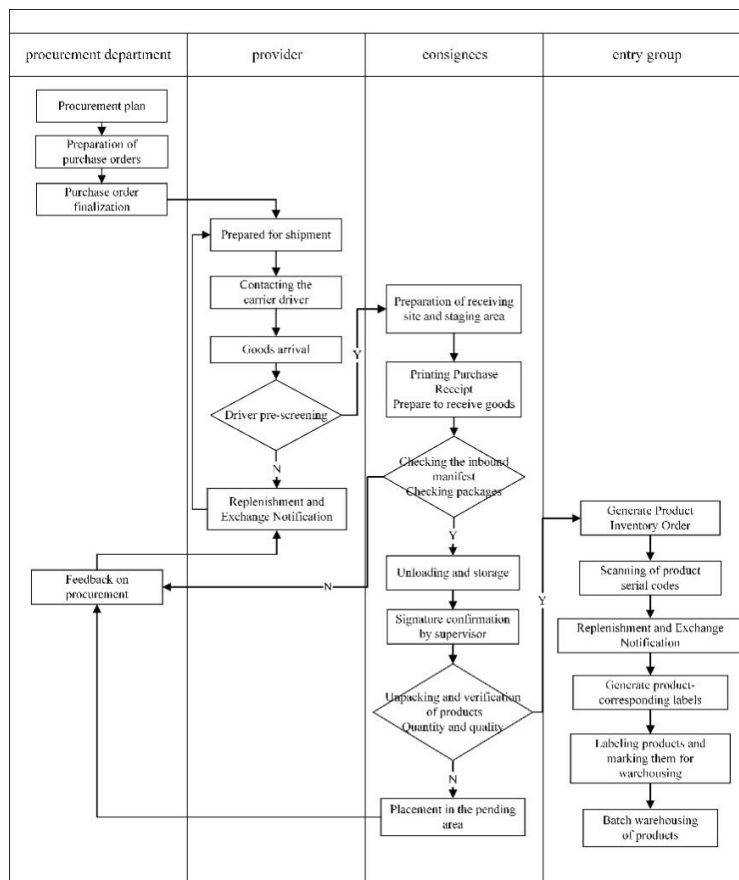

Figure 1

eling tool integrating graphics and mathematics, Petri net can both portray the structure of a system through intuitive graphics and introduce mathematical methods to analyze its properties [4].

1.2 Correlation matrix reorganization algorithm

The association matrix can be used to represent the selection, conflict, synchronization and concurrency relationships of certain activities, in order to further uncover the parallel structure of the problem, the association matrix restructuring algorithm can be used to find the conflict and synchronization relationships between the coupled sets of activities [5]. Firstly, the association matrix reorganization algorithm is used to find out the subnets in the Petri net model, then the concurrency and conflict tables between these subnets are built, and finally the business process is optimized with respect to the conflict and synchronization relationships between the subnets.

2. Modeling Analysis of Warehouse Inbound Process of Company L Based on Petri Net

2.1 Analysis of the current situation of the warehousing and storage process in Company L

Company L is an e-commerce company engaged in the procurement and online sales of photographic products, as a national distributor of Canon, Nikon and other brands, the company's existing warehouse area of 5, 543 square meters. The company's existing warehouse warehousing business process is mainly divided into product procurement, arrival and unloading, product unpacking and inspection, uploading product information, product warehousing and other steps. Specific company L warehouse warehousing flow chart shown in Figure 1:

2.2 Modeling the Warehousing Inbound Process Petri Nets in Company L

According to the company L warehousing process diagram, you can build the company L warehousing process Petri net model, the company L warehousing process Petri net model as shown in Figure 2:
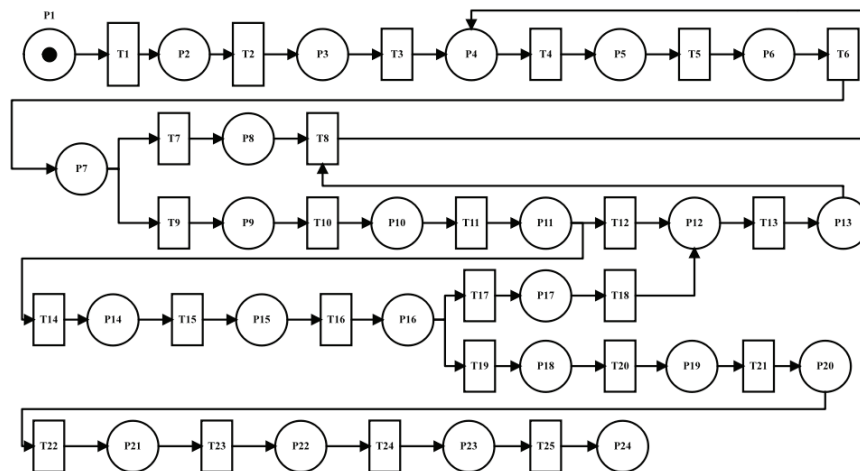

Fig. 2 Petri net model of warehousing inbound process in company L

In the Petri net model of the warehousing inbound operation process of Company L, the actual meanings represented by each depot element as well as each variation element are shown in Table 1:

Table 1. Petri net model of warehousing inbound process in company L Meaning of each depot and variation

Place	Meaning	Transition	Meaning
P1	Procurement plan	T1	Generate purchase plan
P2	Procurement department	T2	Purchase order preparation
P3	Procurement department	T3	Purchase orders finalized
P4	Provider	T4	Prepared to ship
P5	Carrier	T5	Contact Driver
P6	Carrier	T6	Goods arrival
P7	Driver pre-check	T7	Problems with driver checks
P8	Provider	T8	Replenishment and exchange notices
P9	Provider	T9	Driver pre-screening is fine
P10	Consignees	T10	Preparation of receiving site
P11	Consignees	T11	Print Purchase Receipt
P12	Purchase requisitions	T12	Reconciliation of findings
P13	Procurement department	T13	Feedback procurement

Table 1. continued Petri net model of warehousing inbound process in company L Meaning of each depot and variation

Place	Meaning	Transition	Meaning
P14	Provider	T14	No problem with checking
P15	Consignees	T15	Unloading into storage
P16	Consignees	T16	Supervisor's signature confirmed
P17	Unpacking and inspection	T17	Review of findings
P18	Inventory group	T18	Placement in pending area
P19	Inventory group	T19	No problem with review
P20	Inventory group	T20	Generate Product Inventory List
P21	Inventory group	T21	Scan product serial code
P22	Inventory group	T22	Information entry systems
P23	Inventory group	T23	Generate product labels
P24	Inventory group	T24	Labeling to mark
P25	Inventory Completion	T25	Products in batches

According to the Petri net model of Company L's warehousing and warehousing process, the association matrix A of Company L's warehousing and warehousing process Petri net model can be constructed, and the association matrix A can be transposed to obtain the transposition matrix A^T of the association matrix A, and then the invariant $S\_$ of the Petri net model of Company L's warehousing and warehousing business process can be obtained by solving for $A^T X$ as follows:

$X^T = (0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0)$

By calculating the results of the invariants, it can be seen that the items of the eigenvectors are all 0 or 1, which are non-negative, so the invariants corresponding to the association matrix of the Petri net model of the warehousing and warehousing inbound business process of LSR Company exist, and it can be seen that the constructed Petri net model satisfies the reachability, boundedness, and activity.

2.3 Optimization of Warehousing Inbound Process in Company L Based on Association Matrix Reorganization Algorithm

According to the association matrix reorganization algorithm, the obtained association matrix of company L's warehousing and warehousing process can be decomposed, and then get the Petri net model subnetwork, according to the Petri net subnetwork can be obtained from company L's warehousing and warehousing process of the Petri net model of the conflict relationship and the synchronization relationship as shown in Tables 2 and 3.

Table 2. Petri net conflict relationship table for warehousing and warehousing process in L company

Place	Transition	Subnet 1	Subnet 2	Subnet 5	Subnet 6	Subnet 7	Subnet 8
P7	T7	*					
	T9		*				
P12	T12			*			
	T14				*		
P17	T17					*	
	T19						*

Table 3. Petri net synchronization relationship for warehousing out process in company L

Place	Transition	Subnet 3	Subnet 4
T8	P8	*	
	P14		*

2.3.1 Optimize the conflict relationship between subnet 1 and subnet 2

The conflict relationship between subnet 1 and subnet 2 is caused by P7 in the warehouse. If T9 in Subnet 2 occurs, it means that the driver's inspection of the goods did not find any problem with the goods, so it will not have an impact on the normal operation of the warehousing process of Company L. However, if T7 in Subnet 1 occurs, it means that, after the inspection by the transportation driver, the outer packaging of the transported parcels or the number of the goods parcels is found to be problematic, and it will have an impact on the normal operation of the Company L's The normal operation of the inbound process is affected. Therefore, LSR should improve the screening criteria of suppliers and third-party logistics companies to ensure the quality of goods shipped by suppliers and transported by logistics companies, and to reduce the occurrence of events such as missed shipments or problems in the transportation process.

2.3.2 Optimize the conflict relationship between subnet 5 and subnet 6

The conflict relationship between subnet 5 and subnet 6 is caused by the depot P12. If variation T14 in subnet 6 occurs. It means that the receiving team will check the actual arrival of goods with the goods purchase entry list and find that there is no problem, and it will not affect the operation of the warehousing process of Company L. If the variation T12 in Subnet 5 occurs, it means that after checking the arrival of goods with the goods purchase entry list and finding that there is a problem, it is necessary to communicate with the purchasing department in a timely manner to give feedback, and the purchasing department will contact the supplier to carry out the return and replacement of goods. The purchasing department will then contact the supplier to return or exchange the goods, which will have an impact on the operation of the warehousing process of L Company. Therefore, Company L needs to strengthen the frequency and quality of communication with suppliers to minimize the occurrence of problematic shipments.

2.3.3 Optimize the conflict relationship between subnet 7 and subnet 8

The conflict relationship between subnetwork 7 and subnetwork 8 is caused by warehouse P17. If variation T19 in subnetwork 8 occurs, it means that after the unboxing inspection by the inbound team, there is no problem with the quantity or quality of the various types of purchased products, and there will be no impact on the warehousing inbound process of L Company. If variation T17 in subnet 7 occurs, it means that after checking, it is found that there are problems with the quantity or quality of the products, and it is necessary to give feedback to the purchasing department and then do the return and exchange treatment, which will have an impact on the warehousing and storage process of Company L. Therefore, Company L needs to strengthen the management of suppliers to minimize the occurrence of incidents of quantity or quality problems of arriving products.

2.3.4 Optimize the synchronization between subnet 3 and subnet 4

Sub-network 3 and sub-network 4 in the change T8 there is a synchronization relationship, where T8 for replenishment and replacement notification, sub-network 3 is mainly the driver in the goods of the initial inspection of the goods found to exist in the process of replenishment and replacement notification, sub-network 4 is mainly the warehousing group in the purchase of goods in the purchase of goods in the purchase of goods checking or inventory group in the unpacking checking process of the discovery of goods there is a problem and the purchasing department to give feedback on the process. Since it is too early for the driver to perform the initial check and identify the problem, it is necessary to wait for the inbound and inventory teams to perform the check and identify the problem and then send a replenishment and replacement notice to the supplier together. To reduce the waiting time, it is necessary to optimize the process between the driver's pre-inspec-
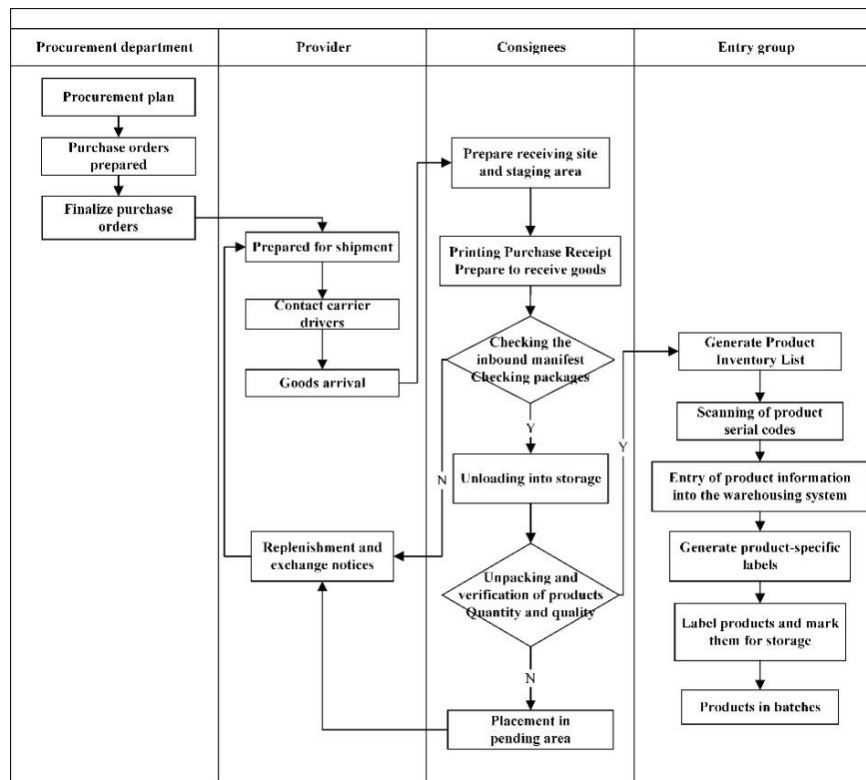

Fig. 3 Optimized flowchart of warehousing inbound at Company L

tion and the inbound team's verification and the inventory team's unpacking inspection. Therefore, the need to improve the driver pre-check to the inventory group to check the purchase of goods into the inventory list and inventory group unpacking check between the process of running rate, the warehouse supervisor to sign the process may waste more time, so you can cancel the warehouse supervisor to sign to confirm the steps directly in the warehouse management system to feedback and sign to confirm, to improve the overall operational efficiency of the warehousing business process.

Through the above analysis and optimization of the conflict and synchronization relationship in the Petri net model of Company L's warehousing business process, the optimized business process flow diagram of Company L's warehousing can be obtained, as shown in Fig 3.

2.4 L Company Warehouse Inbound Process Optimization Guarantee Measures

2.4.1 Strengthening the quality of management of product suppliers

By analyzing the Petri net model of Company L's warehousing and storage process, it can be found that the quality and accuracy of the products supplied by the suppliers are the main reasons for the conflicting relationship in the Petri net model of Company L's warehousing and storage process. Therefore, in the follow-up work, Company L should effectively improve the screening threshold and management quality of suppliers. First, It needs to establish a supplier evaluation mechanism to comprehensively evaluate the supplier's ability, reputation, and quality management system. Secondly, establish supplier management standards and processes, clarify suppliers' responsibilities and obligations, and standardize suppliers' behaviors and operations. In addition, establish supplier communication channels and collaboration mechanisms to realize information sharing and cooperation between suppliers and enterprises. Through the establishment of a perfect supplier management system, the stability of suppliers and the reliability of the quality of products provided are ensured.

2.4.2 Establishment of a comprehensive employee training system

Research shows that the degree of standardization and proficiency of the relevant process staff is also an important factor affecting the overall efficiency of the L company warehousing process. Therefore, in order to improve the overall operational efficiency of the warehousing process of L company, we need to strengthen the management and training of relevant staff. First of all, in order to standardize the relevant personnel's operating methods, we need to improve the enterprise's training system, to provide employees with perfect training. Secondly, in the workshop work site strict implementation of 5S management, so that employees can consciously create a good working environment, comply with the relevant work system. In addition, it is also necessary to establish a corresponding supervision and assessment system for each process, regular assessment and evaluation of the staff's work, so as to motivate the staff to complete the work in the specified time responsible for the content of the work.

3. Conclusion

This paper firstly analyzes the status quo of warehousing process of L company, and finds that the overall operation efficiency of the process is not very high. Therefore, it establishes the Petri net model of the warehousing and warehousing process of L company, then uses the association matrix reorganization algorithm to divide the sub-network in the Petri net model, and establishes the sub-network conflict and synchronization relationship table, and finally proposes corresponding optimization measures for the conflict and synchronization relationship between sub-networks, and at the same time, adjusts the serial process that exists in the process. The results of the study show that the operational efficiency of the warehousing process of L company has been improved, which is of some reference significance for other enterprises to carry out the optimization of the warehousing process.

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