Artificial Intelligence, Medical Engineering and Education
Z.B. Hu et al. (Eds.)

doi:10.3233/ATDE231364

Application of EIQ-ABC Analysis in the Layout Planning of P E-Commerce Preposition Warehouse

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Abstract: New retail fresh instant delivery has changed the traditional sales model of fresh products, and its emergence and development can to a certain extent solve the problems of traditional fresh food retailing industry such as inflexibility, high storage costs, and excessive loss, which has brought a new profit model to the fresh food retail industry. However, the new retail consumption model has generated new problems such as unreasonable layout of preposition warehouse, low distribution efficiency, and consumers' inability to intuitively feel the quality of products, etc., and its development path is still difficult. Based on the above background, this paper takes the operation of P e-commerce preposition warehouse as an example, through the use of EIQ analysis and ABC classification method to statistically analyze the customer order data of the warehouse, summarize the characteristics and laws of customer orders, and classify the customer orders and the products of the distribution center, then use this as the basis for optimizing the layout and storage arrangement of the preposition warehouse, improving the operational efficiency of the warehouse, and ultimately satisfying the customer's order requirements.

Keywords. EIQ analysis method; ABC classification method; Preposition warehouse

1. Introduction

The development of social economy and the development of emerging technologies represented by big data has continuously guided the domestic consumption upgrading, and at the same time accelerated the updating and development of the traditional retail industry. Under the background of the development of internet information technology in the new era and the policy support of the national "digital economy", the business model of new retail fresh food supermarkets has emerged with the help of e-commerce and mobile payment technologies [1]. In this context, the customer's orders show the characteristics of multiple batches, varieties, small batches, short cycle and high frequency demand, which puts forward higher requirements for the distribution center's distribution service level [2]. At the same time, to reduce costs and improve efficiency, distribution centers need to continuously optimize the storage of goods and picking operations to improve the efficiency of warehouse management. Warehousing

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operations as the key to improve the overall distribution service level has become the focus of scholars' research.

Manoche proposed a corresponding optimization scheme for the layout of workshop functional areas through SLP method when studying the workshop layout problem [3].Berg.JP and others compared the three storage methods such as random memory, locational memory and hierarchical memory, summarized their advantages and disadvantages, and explored how to distribute the optimal storage space in the optimal selecting the optimal scheme [4].Riccardo constructed a corresponding mathematical model based on the turnover rate of goods to determine the storage location according to the turnover rate of goods, which achieved the purpose of improving the efficiency of work [5].Yu L established a warehouse space optimization model based on the mixed-order sequencing by simulating the warehouse of an actual enterprise to reduce the racking centering and reduce its handling time [6].Najlae A used electronic technology to determine the optimal storage location of goods in warehouse space by analyzing the distribution of warehouse space [7]. Qian Feng used the method of cargo space distribution to optimize the arrangement of the storage area, established a cargo distribution model based on the aggregation of materials, and solved the model using the ILOGCPLEX software, and adjusted the arrangement of the warehouse based on the results of the calculation [8]. Quan Liu established a multi-objective model by using Fishbone's warehouse layout planning method and obtained the optimal shelf arrangement scheme in Fishbone's warehouse by solving it [9]. Lili Bi obtained the optimization scheme of warehouse cargo space by classifying the original warehouse goods [10]. Zhilan Song and others took the steel logistics park of Company M as the research object and used EIQ-ABC analysis to optimize the unreasonable cargo space allocated in the steel logistics park of Company M [11].

This paper combines P e-commerce's own situation, draws on the theories and methods in the above research content, and adopts the EIQ and ABC classification method to optimize the layout of P e-commerce's preposition warehouse.

2. EIQ-ABC Theory

2.1 EIQ Theory

The EIQ analysis method was first proposed by a Japanese logistics expert, Suzuki Chen. This method is a kind of analysis method focusing on enterprise orders by organizing and analyzing the items, quantities and order times of customer orders, summarizing the distribution characteristics and shipping characteristics of logistics distribution centers, and providing a basis for the reasonable layout and picking methods of distribution centers .The contents of EIQ analysis are mainly EQ (order quantity), EN (number of order items), IQ (number of items), IK (ordering times).The specific analysis steps of EIQ analysis method are: collection and sampling of customer order information, decomposition and organization of order information, making and interpreting analysis charts, planning improvement and application.

2.2 ABC Theory

ABC Classification (Activity Based Classification) is also known as Plato's analysis. Enterprises classify goods into three categories, A, B and C, according to the relevant

characteristics of the goods, and adopt different management methods for different categories of goods. Among them, goods of category A are best-selling products with high frequency of storage and shipment; goods of category B are better-selling, with high frequency of storage and middle shipment; goods of category C are slow-moving products with low frequency of storage and small shipment. Differentiated management of different kinds of products can compress the total amount of inventory, reduce financial pressure, optimize the inventory structure and improve management efficiency [12].

2.3 EIQ-ABC Analysis

An EIQ analysis table is established for the goods in each warehouse. By randomly selecting 10 sales orders, the data is analyzed by EIQ, and the EIQ statistical table is established. According to the statistical data, the EQ (order quantity), EN (number of order items), IQ (number of items), IK (ordering times) are analyzed, so as to derive the ABC classification level of the goods, which is used to make suggestions for the warehouse location planning.

3. P E-Commerce Preposition Warehouse Layout and Problem Analysis

3.1 P E-Commerce Preposition Warehouse Layout Status Quo

Take the preposition warehouse of a store of P e-commerce as an example. At present, the layout of the P e-commerce front warehouse needs to be optimized, the distribution of goods in the storage area is chaotic, and the goods are shelved randomly. Goods with large picking volume and high picking frequency are shelved at the far end of the warehouse, resulting in long picking distances and congested aisles during peak periods, affecting operational efficiency. The existing warehouse layout is not planned according to the ABC classification of goods, resulting in storage space is not fully utilized.

By collecting order picking anomaly data from a front warehouse of a store of P e-commerce in July 2023, it can be seen that the existing warehousing layout has a great impact on the picking efficiency. (Table 1)

The total number of orders picking anomalies in this warehouse in July was 886, of which the percentage of order picking overtime reached 82.51%, which is due to the unreasonable warehouse layout, resulting in order peaks that are prone to picking routes congested, picking distances far away and other problems. Ultimately, the phenomenon of overtime picking occurs, thus affecting the distribution time of fresh goods.

Table 1. Statistics of Order Picking Anomalies in a Store of P Ecommerce, July 2023

anomaly	pick more	pick less(in stock)	pick less (out of stock)	faulty pick	damaged	order picking timeout	lack of supplies	total
quantity	6	36	2	6	63	731	42	886
percentage	0.68%	4.06%	0.23%	0.68%	7.11%	82.51%	4.74%	100%

Meanwhile, by collecting and organizing all customer complaint cases within July

2023, it can be seen that delivery overtime and substandard delivery services account for a large proportion of customer complaint issues, as shown in Table 2. It can be seen that order delivery overtime seriously affects the consumer's consumption experience, and may also cause the quality of fresh products to decline.

Table 2. Statistics of Customer Complaints in a Store of P Ecommerce, July 2023

grounds for complaint	quality	delivery timeout	lack of supplies	pick less	delivery service	irregular packaging	total
quantity	22	37	5	3	12	4	83
percentage	26.51%	44.58%	6.02%	3.61%	14.46%	4.82%	100%

3.2 Problems in the Layout of P E-Commerce Preposition Warehouse

1) Arbitrary placement of goods

P e-commerce preposition warehouse currently follow the logic of traditional retail supermarkets for merchandise layout, i.e., shelf distribution based on product category names, and are not categorized according to the ABC classification. This practice leads to farther picking paths for pop-up goods, which can easily cause problems such as longer picking times and congestion in the aisles during peak hours.

(2) Commodity warehouse space is not updated in time

Due to the complexity of consumer demand for fresh products, the number of daily arrivals of fresh commodities varies greatly. Therefore, it will cause the problem that the commodity storage space is sometimes not enough, and sometimes too empty. If the commodity replacement of warehouse space is not timely in the warehouse management system to update the warehouse code, it is easy to cause the picking staff cannot find the goods, wrong picking, leakage picking and so on.

(3) Commodity inventory is not timely

P e-commerce preposition warehouse conduct a comprehensive inventory once a month for general merchandise and frozen storage areas, and once a day for fruit and vegetable and fishpond storage areas. The long inventory frequency and the large number of inventoried goods can result in low stock and out-of-stock cold goods, affecting consumers' consumption experience.

4. EIQ-ABC Analysis and Application of P E-Commerce Preposition Warehouse Layout

4.1 The Process of EIQ-ABC Analysis

The main business of P Ecommerce is fresh products, daily department stores and alcoholic beverages and snacks. Since fresh goods require different environments and temperatures, the preposition warehouse are divided into ambient, low-temperature and frozen storage areas.

Next, an EIQ analysis table is created for the items in each area, and EIQ statistics are created by randomly selecting 10 sales orders and analyzing the data for EIQ. Based on the statistical data, the EQ (order quantity), EN (number of order items), IQ (number of items), IK (ordering times) are analyzed. Thus, the ABC classification level of the goods is derived, which is used to make suggestions for the warehouse planning

of the P e-commerce preposition warehouse.

1) ABC classification of goods in ambient storage areas

Ambient storage goods are mainly categorized into: I1-Bulk beverages, I2-Convenience foods, I3-Snacks, I4-Dried fruits, I5-Breads, I6-Pasta sauces, I7-Daily necessities, I8-Toiletries, I9-Baby products, I10-Paper products.

Table 3. EIQ Statistics for Ambient Cargo Orders

Customer Orders	Outgoing items										EQ	EN
	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10		
E1	1						1	2			4	3
E2	6	1								1	8	3
E3	7		4		1	1					13	4
E4	2		1							1	4	3
E5	1				4						5	2
E6	3						4	1		1	9	4
E7	4		2	1	1	1					9	5
E8	1	1		4							6	3
E9	1	2	1	1	4						9	5
E10						1	3			1	5	3
IQ	26	4	8	6	10	3	8	3	0	4	72	
IK	9	3	4	3	4	3	3	2	0	4		35

By randomly selecting 10 orders of ambient goods, the data were analyzed by EIQ and an EIQ statistical table was established, as shown in Table 3. Based on the statistical data, the EQ (order quantity), EN (number of order items), IQ (number of items), IK (ordering times) are analyzed.

IQ represents the number of goods out of stock, and all the IQs are arranged from largest to smallest, and the cumulative percentage is obtained by accumulating them sequentially, and the IQ-ABC analysis chart is drawn, as shown in Figure 1. Among them, the products corresponding to IQ1, IQ5, IQ3, and IQ7 account for 72.2% of the total number of products, which have a large number of goods out of the warehouse and need to deploy more inventory and require more shelf space. Products corresponding to IQ4, IQ2, and IQ10 accounted for 19.4% of the total, and the outgoing quantity of these products is average, which can be appropriately controlled by inventory and requires less shelf space. The products corresponding to IQ6, IQ8 and IQ9 only account for 8.3% of the total, and this kind of product has less outgoing volume, so the storage control can be more relaxed.

IK represents the number of times the goods have been ordered. Similarly, all the IKs are arranged in order from largest to smallest to get the cumulative percentage, and the IK-ABC analysis chart is drawn, as in Figure 2. The products corresponding to IK1, IK5, IK3, and IK10 account for 60% of the total number of picks, which are picked more often and therefore need to be placed closer to the shipping gate to shorten the picking distance and facilitate shipping. 28.5% of the total number of picks are corresponded to IK2, IK4, and IK6, which are picked moderately and can be placed in a location a little farther from the shipping gate. Products corresponding to IK7, IK8, and IK9 accounted for only 14.2% of the total number of picks, and their low picking

frequency allowed them to be placed at the far end of the shipping gate.

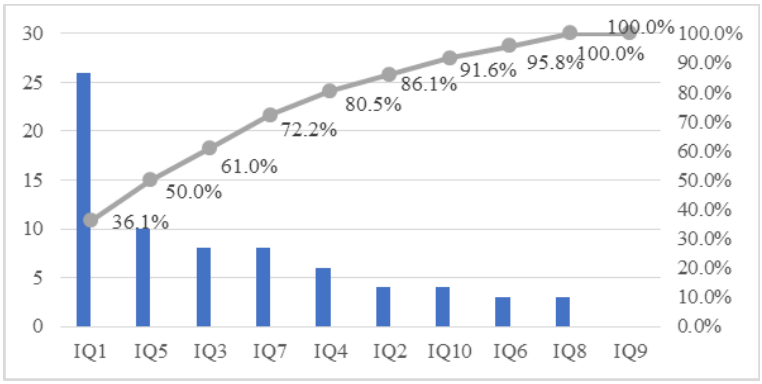

Figure 1. Pareto Analysis of IQ-ABC in Ambient Storage Area

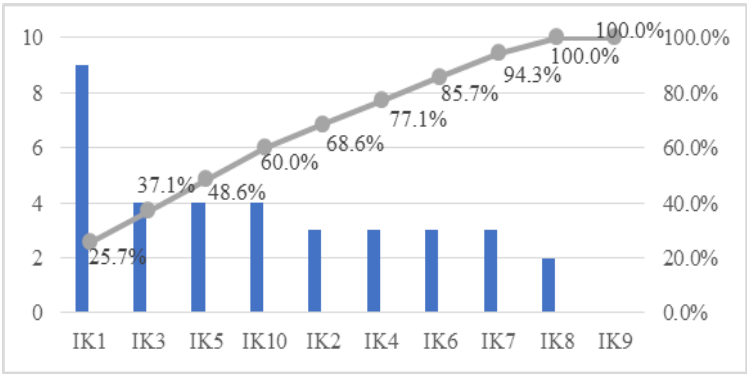

Figure 2. Pareto Analysis of IK-ABC in Ambient Storage Area

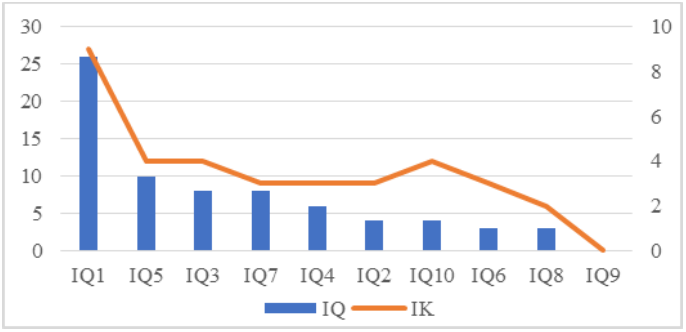

Figure 3. IQ-IK Cross-analysis Plot in Ambient Storage Area

Finally, the IQ-IK cross-tabulation analysis was performed, as shown in Figure 3. The categories of bulk beverages, bread, snacks, and daily necessities accounted for 72.2% of the total number of products, and the number of picking times accounted for 57.1% of the total number of picking times, which were classified as Category A products according to the ABC classification. Convenience foods, dried fruits, and paper products accounted for 19.4% of the total number of products, and the number of picks accounted for 28.5% of the total number of picks and were classified as Category B products. Noodle sauces, toiletries and baby products accounted for 8.3% of the total

number of products and 14.2% of the total number of picks and were classified as Category C products.

2) ABC classification of goods in low-temperature storage areas

Low-temperature storage goods are mainly categorized into: I1-fresh meat, I2-leafy vegetables, I3-tomato melons and fruits, I4-root and stem vegetables, I5-fruits, I6-pure vegetables, I7-beans, I8-legumes, I9-yoghurt, I10-mushrooms.

Table 4. EIQ Statistics for Low-temperature Cargo Orders

Customer Orders	Outgoing items										EQ	EN
	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10		
IQ	8	13	4	2	9	1	2	4	3	4	50	35
IK	5	7	4	2	5	1	2	4	2	3		

Similarly, 10 orders of products in the low-temperature storage area were randomly selected, and the data were analyzed by EIQ to establish an EIQ statistical table, as shown in Table 4. IQ-ABC analysis and IK-ABC analysis are performed based on the data in the EIQ statistical table, as shown in Figures 4.

Combined with the above figure and table analysis to conclude the classification of goods in the low-temperature warehouse area. Leafy vegetables, fruits, fresh meat, tomatoes and fruits accounted for 68% of the total number of products, the number of picking times accounted for 60% of the total number of pickings, according to the ABC classification method is classified as Class A products. Soybean products, mushrooms and yogurt accounted for 22% of the total number of products, and the number of picking times accounted for 25.7% of the total number of picking times, which were classified as B products. Root vegetables, beans, and net vegetables accounted for 10% of the total number of products, and the number of picking times accounted for 14.3% of the total number of pickings times, and were classified as C products.

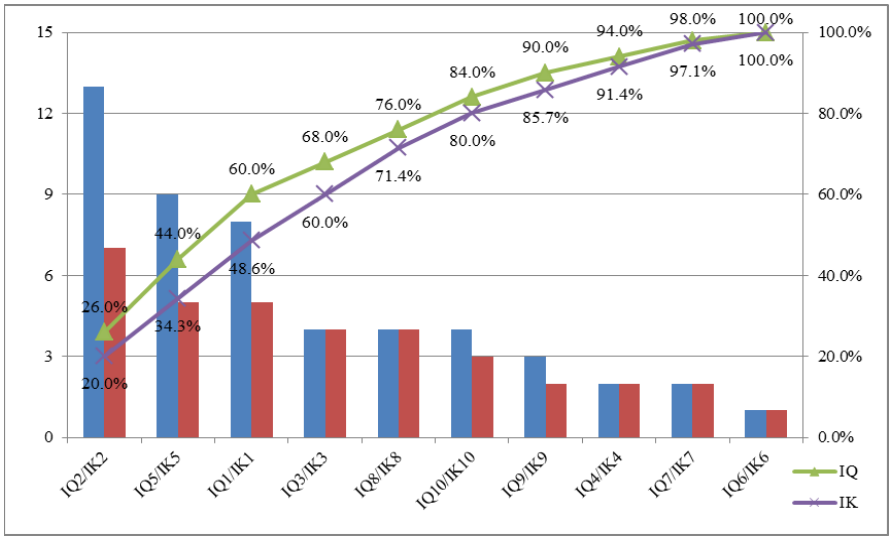

Figure 4. Pareto Analysis of IQ-ABC and IK-ABC in Low-temperature Storage Area

3) ABC classification of goods in frozen storage areas

The goods stored in the frozen area are mainly categorized into: I1-ice-cream, I2-hotpot meatballs, I3-frozen dumplings, I4-frozen aquatic products, I5-frozen meats,

and I6-frozen cakes. As above, 10 orders of products in the frozen storage area were randomly selected, and the data were analyzed by EIQ to establish an EIQ statistical table, as shown in Table 5. IQ-ABC analysis and IK-ABC analysis are performed based on the data in the EIQ statistical table, as shown in Figures 5.

Table 5. EIQ Statistics for Frozen Cargo Orders

Customer Orders	Outgoing items						EQ	EN
	I1	I2	I3	I4	I5	I6		
IQ	2	2	13	1	8	1	27	18
IK	1	2	7	1	6	1		

Combined with the above figure and table analysis to conclude the classification of goods in the frozen warehouse area. Frozen dumplings and frozen meat accounted for 72.2% of the total number of products, and the number of picking times accounted for 72.2% of the total number of pickings times and were classified as Category A products according to the ABC classification. Hot pot meatballs and ice cream accounted for 19.4% of the total number of products, and the number of picking times accounted for 16.7% of the total number of picking times, which were classified as category B products. Frozen aquatic products and frozen cakes accounted for 8.3% of the total number of products and 11.1% of the total number of picks and were categorized as Category C products.

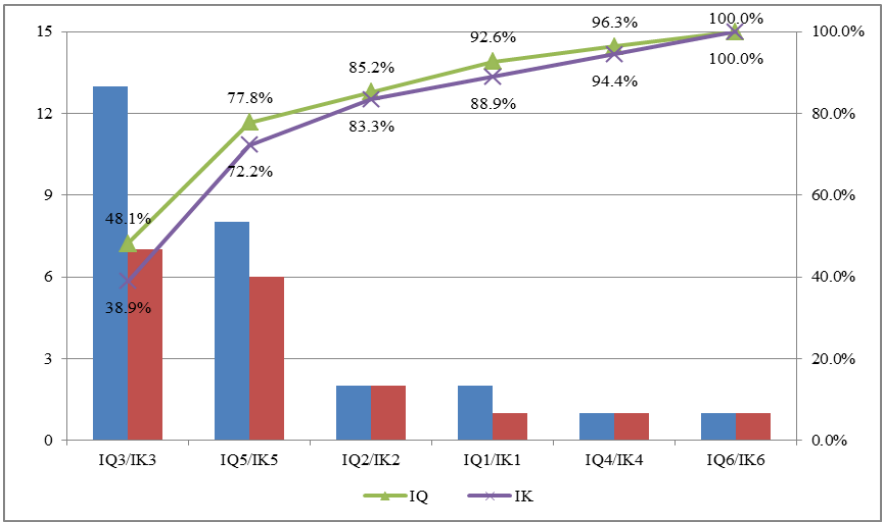

Figure 5. Pareto Analysis of IQ-ABC and IK-ABC in Frozen Storage Area

4.2 Analysis of Optimization Effect Based on EIQ-ABC Taxonomy

The layout after ABC classification of the goods in the warehouse is shown in Figure 6. The new warehouse layout is conducive to shortening the picking distance of the best-selling goods, shortening the distance between the hot-selling goods and the packing table, and shortening the distance between the related goods, which facilitates the store picking staff to improve the efficiency of picking, thus shortening the picking time and improving the service quality.

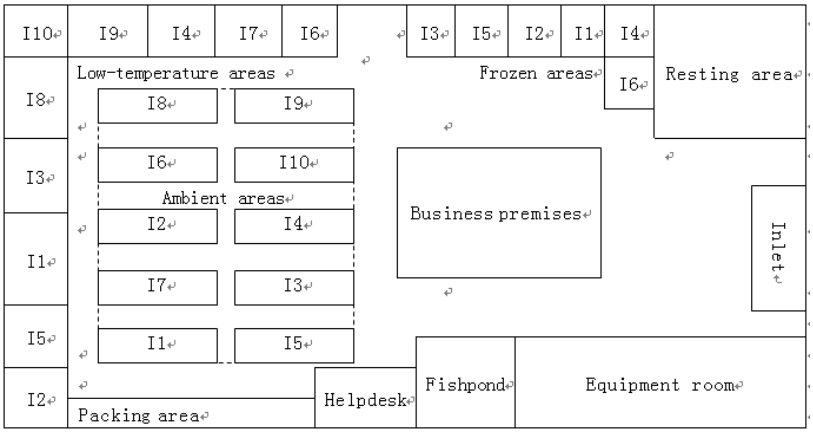

Figure 6. Optimized Layout of P E-commerce Preposition Warehouse

Table 6. Statistics of Order Picking Anomalies in a Store of P Ecommerce, August 2023

anomaly	pick more	pick less(in stock)	pick less (out of stock)	faulty pick	damaged	order picking timeout	lack of supplies	total
quantity	3	6	0	6	45	114	31	205
percentage	1.46%	2.93%	0.00%	2.93%	21.95%	55.61%	15.12%	

After the optimization of the layout of the preposition warehouse, the picking order anomalies of the store were counted again. As can be seen from Table 6, the order picking timeout in August was greatly reduced compared to July, and the cases of faulty picking were also reduced.

Thanks to the shortening of the picking time and the rationalization of the goods layout, the customer complaints about the delivery time and out-of-stock leakage problems in this store during August were also greatly reduced, as shown in Table 7, which further improved the service quality of the P-commerce company and brought a better shopping experience to the consumers.

Table 7. Statistics of Customer Complaints in a Store of P Ecommerce, August 2023

grounds for complaint	quality	delivery timeout	lack of supplies	pick less	delivery service	irregular packaging	total
quantity	31	12	2	0	23	0	68
percentage	45.59%	17.65%	2.94%	0.00%	33.82%	0.00%	100%

5. Conclusion

This paper analyzes the storage layout within the preposition warehouse of a store of P e-commerce and combines the operational data and abnormalities of P e-commerce to analyze the problems existing in its preposition warehouse layout. In response to these problems, EIQ-ABC analysis is carried out on the goods in different temperature zones within the store of P e-commerce, so as to obtain the optimized layout within the store, and the effectiveness of the optimization is analyzed.

The main research conclusions are as follows:

(1) Through the research on abnormal orders and customer complaints, the current

situation of P E-commerce's preposition warehouse has been deeply analyzed, and its current problems such as the arbitrary placement of goods, commodity warehouse space is not updated in time, and the commodity inventory is not timely have been understood.

(2) Based on the analysis of the current situation, for the problems existing in the warehouse layout, the EIQ-ABC classification method is used to optimize the cargo space, placing the category of goods with a larger shipment volume and a greater frequency of shipments closest to the exit, and so on for emissions, positioning each type of goods for storage, and each type of goods has a fixed position in order to improve the efficiency of picking.

(3) After the optimization of the layout, the research on abnormal orders and customer complaints was conducted again, and it was found that the abnormal situations and customer complaints were reduced, and the optimization effect was more obvious.

Through the optimization of the layout of the P e-commerce preposition warehouse, the operational efficiency of the store is further improved, and the purpose of improving the service quality of the store is finally achieved.

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