Optimal Design of Appliance Storage Space in Company a Based on EIQ-ABC Dual Classification Model

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Abstract: In recent years, orders for home appliances have increased rapidly due to the development of B2C e-commerce platforms. The large size and wearing parts of home appliances make it difficult to automate home appliance warehouses and storage areas. In response to the inefficient picking operations caused by improper order management in household appliance logistics of storage operations, this paper addresses the issue by analyzing customer demand for products and developing a model based on the EIQ-ABC method, thus increasing storage operations' efficiency. Meanwhile, from company A's home appliance storage center and Xiaomi Home Appliance Warehouse, the orders are analyzed to determine item quantity (IQ), material storage space, turnover rate, and double ABC classification. Additionally, we are able to classify the goods and manage the layout of the storage facility. Finally, we review the picking methods and storage areas applicable to various types of goods in logistics warehouses.

1. Introduction

Due to the diversification of consumption, customers have increased requirements for logistics services. B2C business models are characterized by large and dispersed orders, resulting in short transaction times and a high frequency of inbound and outbound transactions. B2C business models are characterized by large and dispersed orders, resulting in short transaction times and a high frequency of inbound and outbound transactions. According to company A's home appliance storage center survey, 50% of workers' time is spent loading and unloading, handling, storing, and selecting, and 50% is spent walking statements, indicating that the recognized average labor is only 40%. To improve space utilization, cargo selection efficiency, and cost reductions, Company A must allocate storage spaces reasonably and optimize the design of the warehouse [1].

Based on the above analysis, this paper conducts an on-the-spot investigation and analysis of the shipment and storage of the appliance storage department of Company A and finally decides to use the storage location optimization method EIQ-ABC for optimization. At last, the paper analyzes and improves the product packaging.

2. Literature Review

In applying the EIQ method of storage space management, Xue Xiaolei and Lu Zhiqiang (2017) used the EIQ model to realize the statistics and analysis of the nature and type of the items in the warehouse and the status of the items out of the warehouse. The improvement has improved the economic effect of the enterprise.

According to Jiang (2018), China's home appliance logistics market exceeds one trillion yuan. Home appliance logistics is undergoing significant changes due to the changes in sales channels and

the advancement of logistics technology. Many new business entities and development models have emerged, as well as many unique needs and problems. Many new business entities and development models have emerged, as well as many unique needs and problems. Under the background of new tasks of transformation and upgrading, the industry will be towards omnichannel, integration, standardization, intelligence, synergy, and other aspects of development.

Researchers have examined warehouse management and household appliance logistics from a variety of perspectives. In spite of this, relatively little research has recently been conducted on semi-automation in-home appliance warehousing. Thus, by combining the EIQ-ABC dual classification model with the characteristics of home appliance goods, this paper optimizes storage space management for home appliance warehousing and promotes its effective control [2].

3. Construct a Warehouse Optimization Model Based on EIQ Analysis Method

Company A's home appliance storage center currently occupies approximately 40800 square meters, divided into self-owned warehouses, Xiaomi warehouses, Changhong warehouses, and other brand warehouses. The Xiaomi warehouse covers an area of 6000 square meters. Home appliance storage centers store various household appliances, including washing machines, televisions, air conditioners, refrigerators, treadmills, clothes dryers, gas stoves, purifiers, dishwashers, ovens, and more.

In accordance with their primary characteristics, the warehouse has been divided into thirteen storage areas: the washing machine area, the TV area, the air conditioning area, the refrigerator, the dryer (drying) machine area, the balance bike area, the gas stove area, the purifier area, the dishwasher area, the oven area, the range hood area, and the treadmill area. We chose Xiaomi Home Appliance Warehouse as the research object of this paper due to its similarity to other warehouses and the number of superior products it produces [3]. The ABC classification method, EIQ analysis method, and COI index method were all used fully in the study of storage space on the material placement area settings and how to improve the operational efficiency of the analysis. According to the basic principles of warehouse management and storage location setting, we adjusted and optimized the storage location after reading the layout of Company A's home appliance storage facility - Xiaomi Home Warehouse, and formed the final storage location optimization plan for Company A's home appliance storage center.

3.1 Plotting IQ Curves for Storage Areas

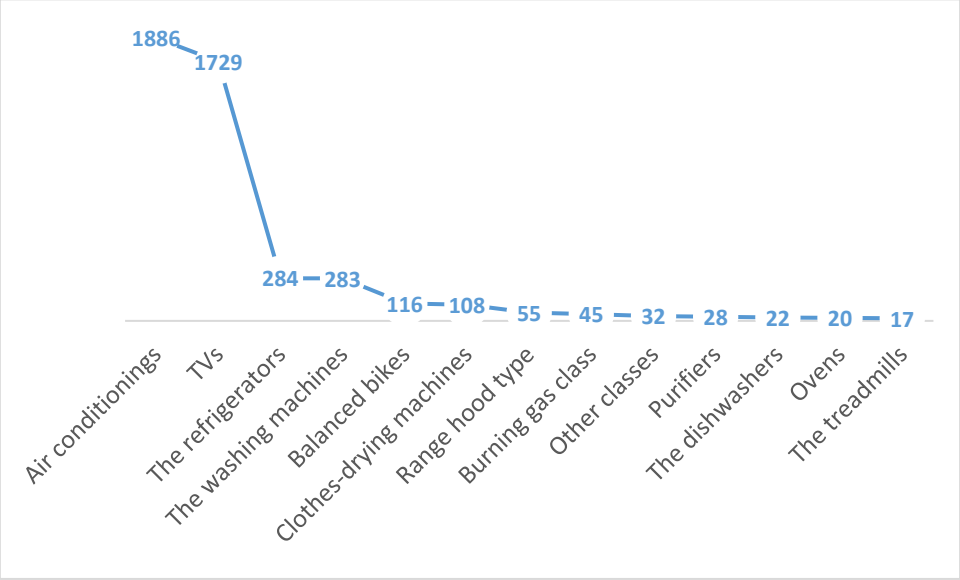

Figure 1 IQ curve of each storage area of Xiaomi Home Appliance Warehouse

In the EIQ analysis method, IQ analysis mainly solves the problem from the two aspects of material category and shipment volume. Through the analysis of different types of material shipments, the

material's importance is determined to provide a powerful tool for the rational arrangement of locations. According to the survey, except for shopping festivals such as Double Eleven and 618 festivals, Company's total sales volume is relatively stable throughout the year, so the outbound volume in 2021 is taken as the total sample. The research objects are the average weekly material shipments from April 22 to 28, 2021. Referring to the single-day loads of various materials, first sort the materials according to the size of the shipments and then make an IQ curve of the shipments of materials in each storage area of the Xiaomi Warehouse. (See Figure 1)

3.2 IQ-ABC Classification Design of Materials in Storage Area

ABC taxonomy is used to distinguish between primary and secondary factors that affect material properties. As a starting point, A-type materials account for about 10% of all material types under normal circumstances. The shipment volume can reach about 70% of the total shipment volume. In the storage system, it is the most important management object. Keep storage areas as close to the shipping area as when arranging storage areas. Next, the quantity of category B materials usually only accounts for about 20% of the total materials, and the shipments also account for about 20% of the total shipments. They are the secondary key management objects of warehouse materials and are generally stored in the middle of the warehouse. Third, the number of categories of C-type materials usually accounts for about 70% of the total material types. In comparison, the shipment volume is only about 10% of the total [4].

According to the analysis, Xiaomi Home Appliance Warehouse materials shipments are obviously in a two-tier trend. Concerning each storage area in a single day, the various types of materials out of the table can be known through the ABC classification analysis of storage materials, and the attributes and importance of storage materials are clarified. In addition, material selection and storage location can be obtained scientifically and reasonably according to the characteristics of the three types of materials. We create a statistical table of the ABC classification of Xiaomi Home Appliance Warehouse materials. (See Table 1)

Table 1. IQ analysis ABC classification statistical table

Classification	Range of Shipment	Category Number	The Proportion	Shipment of Goods	Proportion of Shipments
Class A	>1000	2	15.4%	3615	78.8%
Class B	100-1000	4	30.8%	791	17.2%
Class C	<100	7	53.8%	183	4%

Table 1 shows only two categories of materials belonging to category A, namely air conditioners and TVs, account for 15.4% of the total material categories. At the same time, their shipments reach 78.8% of the total, basically in line with the ABC classification method. Air conditioners and TVs are critical objects of Xiaomi Home Appliance Warehouse management. The reasonable layout of this kind of storage area has the most significant impact on warehouse management, which is the key to managing the whole warehouse well. Four categories belong to Category B: refrigerators, washing machines, clothes-drying machines, and balancing cars. These four categories of materials account for 30.8% of the total category of materials. Their shipments also account for 17.2%, fully conforming to the ABC classification's determination standard of class B materials. These two kinds of materials are warehouse materials' secondary key management objects. On the premise of giving priority to class A materials, the processing, packaging, and shipping needs of these two kinds of materials are guaranteed as far as possible. There are seven categories of class C materials, which account for only 4% of the shipment volume, fully conforming to the definition of class C materials in the ABC classification. Among them, the weekly shipment of treadmills is only 17 pieces, which accounts for a low proportion and can be almost ignored [5].

3.3 COI-ABC Classification Design of Materials in Storage Area

When it comes to the storage space settings of Xiaomi Home Appliance Warehouse, due to the characteristics of its home appliances, it focuses on carefully considering different categories of material shipments, storage area and space requirements, and other factors. For some materials, it is

pointed out that the frequency and turnover rate of goods is high. A single large and a variety of materials, large volume of shipments, need to be as close as possible to the location of the shipping port to arrange storage. In contrast, shipment frequency and turnover rate are low for some materials [6]. With a small volume and a single category of materials, the importance of shipments is not significant. It is necessary to reduce inventory as far as possible, reduce the backlog and occupy storage space and away from the location of the shipping port to arrange storage space.

The COI index is equal to the average space required for material storage divided by the average shipment of the product. It is an indicator used to measure the demand for each storage space in the warehouse. This indicator also considers the volume and turnover rate of the material. The COI index is adopted when analyzing the storage space of warehousing materials. The ratio of the daily average storage area demand and daily average shipment volume of various materials is used to measure the space utilization rate of Xiaomi Home Appliance Warehouse materials. In general, for material categories with low COI index, because of their relatively large daily shipments per unit of storage space, priority should be given to arranging storage locations, and the storage locations should be placed as close to the shipping port as possible. According to the COI index calculation formula, COIP= CP/FP. CP refers to the total storage space required to store materials in a warehouse within a specific time range. FP refers to the shipment volume of goods within this period, usually the turnover rate. Calculate the COI index value of 13 types, and get the COI index ranking table of all materials in the Xiaomi warehouse [7]. (See Table 2)

Table 2. The COI index ranking table of all kinds of materials in Xiaomi Home Appliance Warehouse

Numerical Order	Item	Space requirement (sqm)	Shipment volume (pieces)	COI index
1	Balance Bikes	10	116	0.09
6	Air Conditioners	400	1886	0.21
4	Dishwashers	5	22	0.23
9	TV	450	1729	0.26
10	Washing Machines	80	283	0.28
5	Purifier	10	28	0.36
2	Gas Stoves	20	45	0.44
11	Cooker Hoods	30	55	0.55
12	Clothes Dryers	60	108	0.56
7	Treadmill	10	17	0.59
3	Ovens	15	20	0.75
13	Refrigerators	250	284	0.88
8	Others	30	32	0.94

According to the COI values in Table 2, analysis in conjunction with the ABC classification gives the materials with index values less than 0.25 classified as Class A. Those with index values between 0.25 and 0.4 are classified as Class B. Those with index values greater than 0.4 are classified as Class C materials. The materials in category A are balance bikes and air conditioners [8]; materials in category B are TVs, dishwashers and washing machines, and purifiers; materials in category C are treadmills, gas stoves, ovens, cooker hoods, (drying) clothes dryers, refrigerators, and others.

3.4 Double Standard ABC Classification Design for Storage Location in Storage Area

When the ABC classification of the warehouse materials in Xiaomi Home Appliance Warehouse was carried out, according to the classification standard of IQ and the standard of COI, the classification results were different because the change of focus led to the difference in the results. Therefore, ABC classification is performed on the classification results again. The multi-standard

ABC classification theory is used for recombination, the importance of materials is reordered, and the ABC classification of materials is re-determined [9]. (See Table 3)

Table 3. Xiaomi Home Appliance Warehouse storage materials double standard ABC analysis

Classes of Supplies	Air Conditioners	TV	Balance Bikes	Washing Machines	Refrigerators	Clothes Dryers	Purifier	Gas Stoves	Dishwashers	Others	Cooker Hoods	Ovens	Treadmill
IQ-ABC Classification	A	A	B	B	B	B	C	C	C	C	C	C	C
COI-ABC Classification	A	B	A	B	C	C	B	C	C	C	C	C	C
Combination results	AA	AB	BA	BB	BC	BC	CB	CC	CC	CC	CC	CC	CC
Final Results	A	A	B	B	B	B	B	C	C	C	C	C	C

Table 3 shows that the results of the regrouped classification of goods are slightly different from the IQ-ABC analysis conducted above. The COI-ABC study is somewhat further in the degree of importance, but it is consistent. According to the double standard ABC analysis, combined with the category and quantity of goods and materials in the Xiaomi Home Appliance Warehouse and the influence of the occupied warehouse area on the management difficulty, the final classification is shown in the table 4 above.

Table 4. Xiaomi Home Appliance Warehouse storage materials required storage area and storage space relationship comparison

Classes of Supplies	Air Conditioners	TV	Balance Bikes	Washing Machines	Refrigerators	Clothes Dryers	Purifier	Gas Stoves	Dishwashers	Others	Cooker Hoods	Ovens	Treadmill
Double ABC Classification	A	A	B	B	B	B	B	C	C	C	C	C	C
The Required Storage Area	1600	1800	40	320	1000	240	40	80	20	120	120	60	40
The Number of Storage Bits Required	80	90	2	16	50	12	2	4	1	6	6	3	2

Xiaomi warehouse layout optimization plan shows that the general warehouse area is about 6,000 square meters, and the actual storage area is 4,932 square meters. According to the layout and basic requirements of the storage area, the utilization area is divided into 274 storage spaces, each of which is about 20 square meters. According to the weekly average shipping space demand table of Xiaomi warehouse, the storage space ratio of thirteen types of materials is calculated as 80:90:2:16:50:12:2:4:1:6:6:3: 2. Then, according to the total storage area, the actual area required for the thirteen types of materials is obtained, as shown in the above table [10].

3.5 Draw the Layout of Storage Location Management Optimization

According to the above double ABC classification of Xiaomi Home Appliance Warehouse storage, Class A materials such as air conditioners and TVs have a large volume of shipments and a high

circulation rate, and the priority is to arrange the storage space in a position close to the shipping port. Class B materials are placed in the middle position in turn. Class C materials are relatively small shipments arranged far from the shipping port. As dishwashers, treadmills, and ovens occupy a small area, they can be consolidated and stored. Due to the small footprint of dishwashers, treadmills, and ovens, they can be integrated and stored. When arranging storage positions, due to the characteristics of home appliances, only the same type of products can be placed vertically and cannot be placed crosswise. At the same time, standard gaps should be left when placed vertically. On the one hand, the model of the goods can be distinguished, and on the other hand, it is convenient for the clamping of the machine to pick. After considering various factors comprehensively, we produced an optimized plan for large-scale storage location management of Company A. (See Figuref 2)

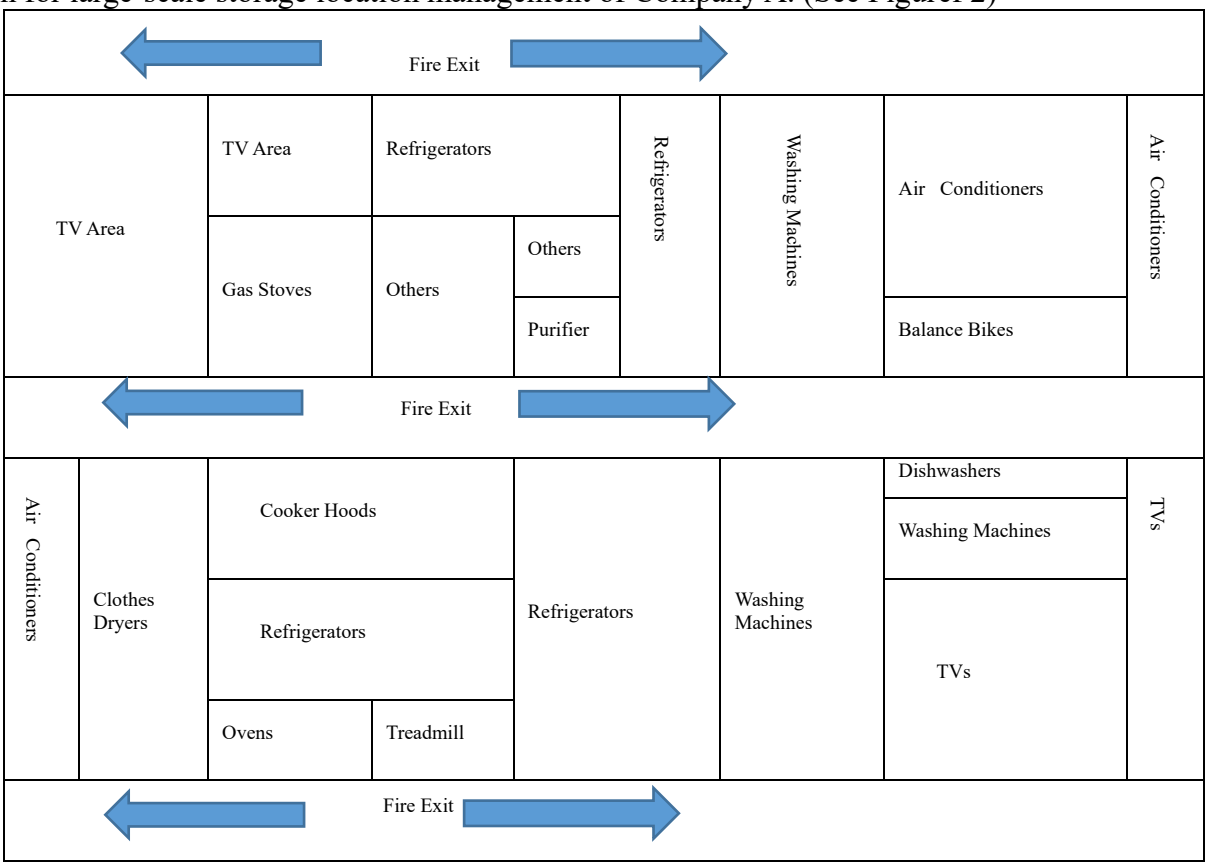

Figure 1. Optimization plan of Xiaomi Home Appliance Warehouse storage location management

4. Conclusion

The main purpose of this paper is to improve the efficiency of warehousing by constructing an EIQ-ABC model for analyzing order data and optimizing picking operations. For example, the paper discusses Xiaomi Home Appliance Warehouse in Company A's home appliance storage center. First, the number of orders and the COI index is calculated through the EIQ analysis method, and then the goods are classified according to the ABC classification method. Following that, picking strategies are determined for different categories of goods to maximize the efficiency of loading and unloading goods in the inbound process. In order to improve the efficiency of storage operations, the unreasonable inventory cycle of goods in the inbound process and the extended order service time in the outbound process are optimized.

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