

**Case Report**

# Fresh Food Distribution Center Storage Allocation Strategy Analysis Based on Optimized Entry-Item-Quantity-ABC

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**Abstract:** For labour-intensive field, appropriate storage location assignment is the best choice to increase order picking efficiency and reduce order cycle time, which satisfy customers and reduce cost at the same time. In this paper, we advance a storage location assignment for fresh food distribution center with a manual picker-to-parts picking system by using an optimized approach. To reflect the customer demand uncertainty, the orders received in a certain time range have been grouped and given the different coefficients according to the reference value of them. On that basis, the storage location can be designed optimally based on the Entry-Item-Quantity (EIQ) analysis, which can be used to resolve some orders picking issues, long-picking time and high inventory costs, caused by seasonal change of fresh food, unstable customer demand and repeat purchases. From the computational results, new storage allocation strategy achieves at most a 16% reduction in travel time.

**Keywords:** Orders Weighting Coefficient, EIQ-ABC, Storage Assignment

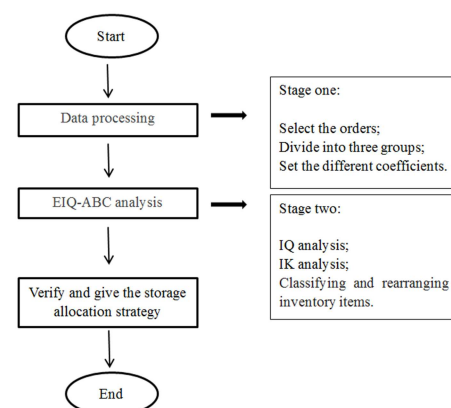
## 1. Introduction

Storage location assignment is critical to the warehouse management. Lack of scientific storage policy, any change in demand frequencies or addition to the product assortments leads to high costs-the very problems posed by fresh e-commerce enterprises.

Many scholars have conducted in-depth research about assigning products to storage location, resulting in a large number of research results. These researches are mainly focused on 3C products, tobacco, grain oil and so on. Compared with these products which requirements are static on the whole, fresh food requirements are with the characteristic of seasonal. Conventional methods of analyzing logistics centers mainly focus on examining data onto lump sums or single-period orders instead of multiple-period orders. Consequently, such methods are not appropriate for managing rapid changes in contemporary market orders.

Through the comprehensive analysis of e-commerce storage assignment policy, this paper makes an innovative research methods addressing fresh food seasonal demand. The proposed

method is divided into two stages. In the first stage, the orders in a certain time range have been grouped and given the different coefficients according to the reference value of them. In the second stage, the storage location can be designed optimally based on EIQ-ABC method. Figure 1 shows the proposed procedure with the optimized EIQ-ABC for classifying inventory items as A, B or C and rearranging them accordingly.



**Figure 1.** Order picking process.

## 2. Problem Formulation

The fresh food distribution center consists of storage zone (freezer), production zone and buffer zone, used to keep fresh meat, eggs, aquatic products, etc. Freezer is the most labour-intensive place of fresh food distribution center workforce. Some medium and small-sized fresh food distribution center usually needs to deal with 1000 orders a day and the number will expand to about 2000 orders during the holidays or promotions days. Order picking is the most important parts of a distribution center, which is the "heart" of the distribution center". There are usually some problems existed in the fresh food distribution center.

(1) The order picking efficiency is low. Among the warehousing activities in distribution centers, order picking is the most time-consuming and labour-intensive. Warehousing activities including picking, processing, sorting, packaging and distribution take 2h at least. Order picking (picking by article) generally accounts for 64%. As a result, order picking becomes a bottleneck preventing distribution centers from maximizing the effectiveness of their warehousing activities. There's the research data we got by tracking the warehouse activities, as shown in table 1 and table 2.

*Table 1. Genera, delivery 300 orders.*

	Worker	Time
Picking	5	60
Sorting	7	20 (check), 10-15 (labeling), 20-30 (sorting, check and packaging)
Total	125	

*Table 2. Holidays or promotions, delivery 500 orders.*

	Worker	Time
Picking	5	90-100
Sorting	7-9	20 (check), 15 (labeling), 30 (sorting, check and packaging)
Total	165	

(2) There's no reasonably effective storage assignment in freezer. Under the random-storage policy, pickers get accustomed to putting the goods in some empty storage location arbitrarily, which increases the difficulty of searching goods; any addition to the products leads cargo to occupy channels.

(3) There are mostly outdated equipped and inefficient picking system in warehouse, which makes the pickers spend a long time to get the order goods. Order picking error rates increase significantly with the growth of consumption demand.

Freezer storage location design has become important because of its impact on service to customers and total logistics costs. The performance of freezer deeply affects the competency of fresh food distribution center.

## 3. Storage Allocation Strategy

### 3.1. Analysis of Influence Factors and Principles

The best location assignment scheme is usually satisfied the operational requirements that it supports. Du Zizheng believes that frozen products storage is based on the shelves system, which reasonable design and layout not only can be convenient to the operation, but also takes full advantage of storage space. It is very necessary to analyze the influencing factors. We take three factors into account:

(1) The quality of fresh food makes greater demands on the logistics technology and management. Their main target customer groups are the generation after 80 and 90, the so-called "net born generation". Besides enjoying the convenience of online shopping, they pay greater attention to the experience of online shopping and goods quality.

(2) Fresh food is highly sensitive to the logistics cost and effectiveness. Perishability requires more rapid delivery, so as to improve the satisfaction degree of the target customer groups.

(3) Fresh food includes four principal features: big quantity of order, small quantity of a single order, high order frequency and high repurchase rates. The storage layout should reflect the demand characteristics of products, which means we should consider some decision variables, such as the frequency of goods delivery, the correlation of demand and so on.

At the same time, some principles should also be considered when storage equipment, sorting tools and sorting strategy in certain circumstances:

(1) Matching Job requirements principle. The storage location of goods is built on its demand frequency. The higher ones are stored closer to the I/O point and the lower ones are located farther away from the I/O point, by which the response time of the system can be reduced.

(2) Matching product features principle. By storing fresh food according to the correlation of customers demand, pickers can quickly search for the goods in demand.

(3) Be mindful of "outside line" principle. Generally speaking, there are one or two kinds of goods with low frequency in each order. If you worried about traveling through the "outside line" to fetch goods, it should be setting the special storage position according to distribution centers situation.

### 3.2. Data Processing

Order data from late January to mid-February is selected from WMS. The order data are divided into three groups (1.15-1.23, 1.24-1.31, 2.1-2.7) and set weights. For the latest order data can reflect the customer's consumption better, group one (1.15-1.23) weighted coefficient is 0.2, group two (1.24-1.31) weighted coefficient is 0.3 and group three (2.1-2.7) weighted coefficient is 0.5.

Partial screenshots of the processing order data are shown as table 3, table 4 and table 5:

**Table 3.** Group one order data (1.15-1.23).

Description of goods	Outgoing quantity	Weight outgoing quantity
Sole fillet (peeled bone to stab the 300-400g/ package)	1552	310.40
Shrimp and scallop (8-10cm)	809	161.80
Spring Chicken Inner Mongolia (600g) (Beijing)	694	138.80
Australian grain fed sirloin block 500g	678	135.60
The raw meal of Whiteleg Shrimp (small, small package)	677	135.40
Raw meal smoked salmon (slice) 80g	619	123.80

**Table 4.** Group two order data (1.24-1.31).

Description of goods	Outgoing quantity	Weight outgoing quantity
Stewed sirloin 1kg (flagship store)	6	1.8
Miss big bone pork dumpling in soup 500g	14	4.2
Three pumpkin pie 300g/ bag	30	9
Miss authentic mellow black sesame Glutinous Rice Balls	24	7.2
Children's Sanquan spinach chicken 300g Boiled dumplings	1	0.3
Sanquan rabbit Nai Huang Bao 375g	31	9.3

**Table 5.** Group three order data (2.1-2.7).

Description of goods	Outgoing quantity	Weight outgoing quantity
Australia Valley feed Angus West cold steak 100g*2 Beijing	3	1.5
Australian grain fed finishing hip leg core 400g	1	0.5
Australian beef tendon 1kg	13	6.5
Miss authentic mellow black sesame Glutinous Rice Balls	2	1
Grand Uruguay refinement boneless meat 400g	10	5
Hormel export record 500g (Beijing) frozen lean meat stuffing	3	1.5

### 3.3. EIQ-ABC Analysis

According to the EIQ analysis demand, the weighted processed data is sorted out:

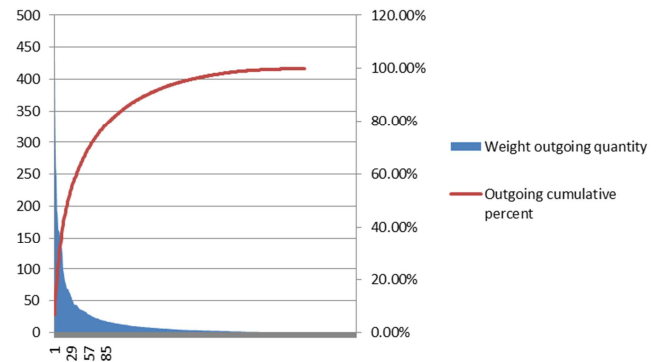
#### (1) IQ analysis

Make IQ analysis table and partial screenshots of the table, as shown in table 6:

**Table 6.** IQ analysis table (2.1-2.7).

Description of goods	Weight outgoing quantity	Outgoing cumulative percent
Sole fillet (peeled bone to stab the 300-400g/ package)	481.1	6.67%
Shrimp and scallop (8-10cm)	327.5	11.21%
Spring Chicken Inner Mongolia (600g) (Beijing)	262	14.85%
Australian grain fed sirloin block 500g	246.1	18.26%
The raw meal of Whiteleg Shrimp (small, small package)	194.1	20.95%
Raw meal smoked salmon (slice) 80g	184.9	23.52%

Sincere the products name is too long, we set up different code-name for fresh food respectively to facilitate the statistics. Pareto Analysis chart is shown as figure 2:

**Figure 2.** IQ Pareto analysis chart.

As can be seen from the graph 2, A-items products account for only 20%, while its outgoing cumulative percent reach 80%; B-items account for 15% and its outgoing cumulative percent is 10%; C-items products are a small proportion of outgoing cumulative percent, while the percentage of product up to 63%.

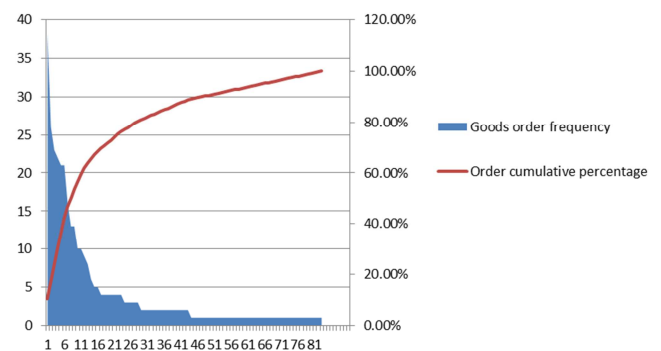
#### (2) IK analysis

Make IK analysis table and partial screenshots of the table, as shown in table 7

**Table 7.** IK analysis table (2.1-2.7).

Description of goods	Goods order frequency	Order cumulative percent
The small yellow croaker (12 bar) (Mao Chao) Beijing	38	10.58%
Canadian Arctic sweet shrimp cooked frozen 500g	26	17.83%
Hokkaido saury 500g	23	24.23%
Shrimp and scallop (8-10cm)	22	30.36%
The raw meal of chicken meat in small servings	21	36.21%
Raw meal smoked salmon (slice) 80g	21	42.06%

Then, make Pareto analysis chart, as shown in Figure 3:

**Figure 3.** IK Pareto analysis chart.

As can be seen from the graph 3, A-items products account for only 10.71%, while its order cumulative percent reach 50.14%; B-items account for 20.24% and its order

cumulative percent is 27.86%; C-items products are a small proportion of order cumulative percent, while the percentage of product up to 69.05%. The difference is not so significant in goods order times. So during analyzing how to classify the freezer fresh food, we mainly tend to the results of IQ analysis.

Combining the analysis above, items are clustered into three classes in such a way that 93 items are called A-items, 61 items are called B-items and 263 items are called C-items. Locations closer to the depot are used to store A-items, aiming at shorter traveling distance and less handling workload. The storage locations are arranged according to travel distance to the I/O point in an ascending order: Location A should be the largest storage area, using dedicated storage. In order to cope with the explosive growth of orders, inventories can be increased to a certain extent; In the Location B, the storage area should be large, which can employ class-based storage; The shipments of the fresh food in Location C is not high, random storage should be used. C-items are assigned to a small number of shelves located in a small area or in the fixed area to improve the freezer space utilization (figure 4).

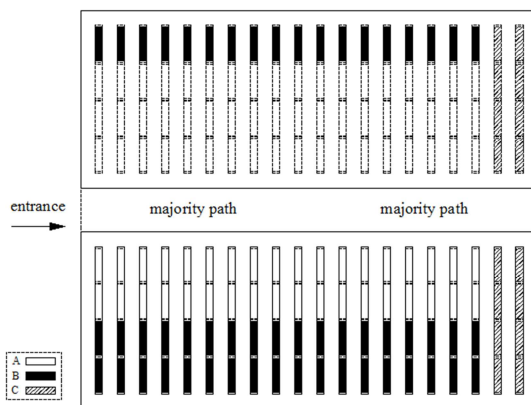


Figure 4. Layout of the freezer.

## 4. Conclusion

At present, random storage assignment is adopted in the freezer. And there's no fixed picking route, pickers find goods according to their preference for picking and familiarity with the warehouse.

Under the storage strategy the paper proposed, orders need to be generated A-items batches and other items batches separately, which are picked by different pickers at the same time.

Table 8. Picking efficiency analysis table.

	Freezer picking	Time difference	Efficiency optimization
Existing solutions	56000/v	8960/v	16%
Optimized solutions	47040/v		

Note: Suppose that all the pickers walk at speed of  $v$  meters an hour

The table 8 shows that with the new storage policy, a significant reduction in travel time can be achieved. Operation efficiency of the whole logistics center has been optimized with the new freezer storage location strategy, which also could reduce increasing pressure of fresh food distribution centers.

Today, order picking is more difficult because distribution centers have to store more types of products to fulfill more small orders within a shorter response time. To be more effective means corporations have stronger competitive ability.

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