

Study On Location and Layout Planning of Y Brand Chain Convenience Store Distribution Center

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Abstract

With the development of modern information society, the logistics industry has also been booming from all aspects, and the warehouse has always occupied an extremely important position in the whole logistics activities. Scientific warehouse location and layout planning has a positive effect on the operation and development of the whole company, and can improve the work efficiency and economic benefits of the whole company to a certain extent. This paper first analyzes the current situation of Y Company and finds out its demand for site selection. Taking the longitude and latitude of the regions where each store is located as coordinates, the ideal geographical location of the new warehouse is calculated by the center of gravity method, and the alternative plan of the warehouse is sought based on this geographical location. Then, the satisfactory location of the warehouse is obtained by the hierarchical weighted evaluation method. Then SLP method is used to design the layout of logistics center.

Keywords

The centre-of-gravity method, Distribution center, SLP.

1. Introduction

With the continuous development of China's economy, people's demand for material life is getting higher and higher, and all walks of life in the market have been continuously developed, among which campus convenience stores are more popular. Convenience stores originated in the United States and are most popular in Japan. In Japan, there is one convenience store for every 2,500 people on average, and about 50,000 convenience stores in Japan can meet their own needs. However, in China, the convenience store market is relatively vacant, and most of the convenience store market is controlled by foreign investors. Campus convenience stores are different from campus supermarkets in that the products provided by convenience stores are mostly fast-selling products and some ready-to-eat products, and the area is smaller than that of ordinary campus supermarkets. Therefore, the traditional supermarket built-in warehouse is not very suitable for convenience stores. Especially under the expansion of chain stores, it is not conducive to management and high cost to purchase goods according to the own needs of a single store.

The centre-of-gravity method is a common location method for distribution center or warehouse location, which has the advantage of simple calculation in the application of single facility location. SLP is a highly organized technology that combines logistics analysis with the analysis of the close relationship between operating units to obtain reasonable layout.

2. Case Introduction

Y Company is an enterprise specializing in campus chain convenience stores. There are 15 stores under Y Company, which are mainly distributed in various university campuses in Wenjiang District, Pidu District and Xindu District, Chengdu. Due to the growing of the company and the gradual increase in the number of chain stores, the purchase, goods management and warehousing mode carried out by a single store in the past become more complex and cumbersome with the increase of stores, which is not conducive to the overall management of the company and the cost is higher. If a new warehouse is built, the goods can be centrally purchased, and the larger purchase volume can allow the company to choose to sign a fixed supplier to obtain a lower purchase price, and is conducive to seeking after-sales service for the quality of goods. Having a common warehouse also allows the company to control its products to reduce some of the losses caused by shelf life. Therefore, building a new warehouse for the company is conducive to solving the current problem.

3. Site Selection

3.1. Model Hypothesis And Calculation Formula

It is the premise of barycentric method to calculate the warehouse location under ideal conditions, but the assumptions in the model will be limited in practice. The center of gravity method sets some assumptions to make the method applicable, mainly including the following aspects:

- (1) In reality, demand comes from multiple consumption points scattered over a wide area, while the assumption made in the barycentric method is to treat demand as coming from a coordinate point.
- (2) The center-of-gravity model does not focus on the capital costs of building warehouses in different locations, and other costs associated with operating in different locations are not concerned with the center of gravity model, but only the transportation costs are calculated.
- (3) In the formula, the transportation cost is linear and increases linearly with the increase of distance. The actual freight actually contains two parts, one of which is a fixed part that does not change with the change of transportation distance, such as construction costs, and the other is a variable part that changes with the change of transportation distance.

The calculation formula of center of gravity method:

$$c_x = \frac{\sum d_{ix}V_i}{\sum V_i}; c_y = \frac{\sum d_{iy}V_i}{\sum V_i} \quad (1)$$

In the formula:

C_x —The X-coordinate of the warehouse;

C_y —The Y-coordinate of the warehouse;

d_{ix} —x coordinates of location i;

d_{iy} —y coordinates of location i;

V_i —The flow of goods into or out of site i.

3.2. Data Collection And Sorting

According to the investigation of the company's 14 stores, the main distribution of its stores and the average daily volume of goods, see Table 1.

According to Baidu map data, the latitude and longitude of each store and the redefined coordinates are shown in the Table 2.

Table 2 Latitude and longitude by region

Serial number	store locator	Longitude and latitude	coordinate
1	Chengdu University of TCM	103.814010,30.692594	81,69
2	University of Electronic Science and Technology of China	103.937404,30.756035	93,75
3	Chengdu Textile College	103.962651,30.763164	96,76
4	Sichuan Technology and Business University	103.992488,30.825562	99,82
5	Xihua University	103.962133,30.782454	96,78
6	Chengdu Normal University	103.835336,30.682110	83,68
7	Sichuan Conservatory of Music	104.184528,30.812358	118,81
8	Chengdu Jincheng College	103.956421,30.731225	95,73
9	Southwestern University of Finance and Economics	103.827675,30.687832	82,69

Calculated by the calculation formula:

$$Cx = \frac{81 * 3 + 93 * 2 + 96 * 2 + 99 * 2 + 96 * 1 + 83 * 1 + 118 * 1 + 95 * 0.5 + 82 * 0.5}{13}$$

=92.65

$$Cy = \frac{69 * 3 + 75 * 2 + 76 * 2 + 82 * 2 + 78 * 1 + 68 * 1 + 81 * 1 + 73 * 0.5 + 69 * 0.5}{13}$$

=74.69

The ideal latitude and longitude of the warehouse site is 103.9265,30.7469, and the coordinate location is near Chengdu Heyuan Community by searching the map coordinates,see Fig. 2.

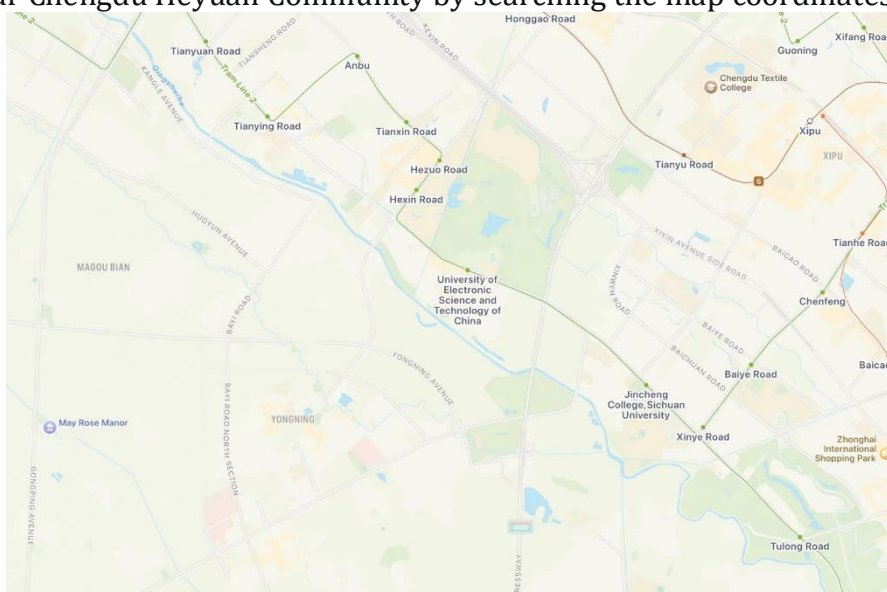


Fig. 2 Approximate location of the warehouse site

Through the analysis of the location of the map, it is found that on the right side of Chengdu Heyuan Community in the above figure are commercial streets, residential communities and university campuses. These areas are not suitable for warehouse construction due to the large

flow of people, heavy traffic and high land price. On the left side of the map of Chengdu Heyuan Community, there are large villages with relatively small flow of people nearby. It is more suitable for warehouse construction. (Source: Baidu Map)

Through the information search on the website of 58.com, we found four warehouse houses near Yilin Village on the left side of Chengdu Heyuan Community, numbered as alternative warehouse and A, B, C and D respectively.

Alternative warehouse A is located at 78 Xingde Street, Pidu District, Chengdu. The warehouse area is about 1800 square meters, and the internal aspect ratio of the warehouse is 5:3. The alternative point of the warehouse is located next to the sub-district office of the town, and there is a certain flow of people nearby but not much, which has a certain impact on daily transportation activities.

Alternative warehouse B is located at No. 131, Qianwang East Road, Pidu District, Chengdu, with an area of about 2,400 square meters. The internal aspect ratio of the warehouse is 5:3, but there are more internal beams and columns, which has a certain impact on the daily storage of goods. This alternative site is also in a small town, surrounded by other companies and residential facilities, which is not very conducive to daily transportation operations. The pedestrian flow is higher than that of alternative warehouse A.

Alternative warehouse C is located in Pingping village, Picong Street, Pidu District, with an area of about 1500 square meters, and the internal aspect ratio of the warehouse is 5:3. The difference between this warehouse option and the previous two is that it is located in a village. Because of its remote location, this alternative point has certain advantages in traffic, which is not prone to traffic jams and other situations, and the flow of people around it will be relatively small, which will have little impact on the daily operations in the future.

Alternative warehouse D is located in Chengdu high-tech zone Kangqiang Road No. 1188, an area of about 20000 square meters, the warehouse area is the largest of the four alternative points, and alternative point C is also located in a relatively remote location in the traffic has a certain convenience, and the surrounding environment is relatively empty, more suitable for normal operations.

From the perspective of convenient transportation, warehouse A and Warehouse B are located in small towns with fewer people, but the traffic flow of warehouse A is slightly lower than that of warehouse B, while warehouse C and Warehouse D are located in wastland far away from the crowd gathering place, by contrast, warehouse C and warehouse D are less susceptible to traffic congestion, so they get a higher evaluation. In terms of area and shape, the area and shape of warehouse A and C are relatively more in line with the expectations of the managers of company Y, although the area of warehouse B is similar, its shape is more slender, and the area of warehouse D is too large and not applicable. In terms of the surrounding environment, the warehouse C and D are located away from the crowd and the location is more biased, and the rent will be lower than the first two. In the location of the site, the four are not far away from the coordinates obtained by the previous center of gravity method, and A and B are closer to the points obtained by the center of gravity method. Therefore, the C warehouse is more suitable as the warehouse choice of Y company.

4. Warehouse Layout Planning Based On SLP

4.1. Operation unit and operation process analysis

According to the types of goods operated by each store and the daily operation of the warehouse, the warehouse can be divided into 9 operating units: loading and unloading area, stocking area, cold reservoir area, beverage area, daily merchandise area, flavored grain and oil area, snack area, imported goods area, office area and truck parking area, see Table 3.

Table 3 Division of work units

Number	Name	Feature
1	Loading area	Loading and unloading of goods and warehouse entrances and exits
2	Storage area	Temporary storage area for goods after sorting is completed
3	Cold storage area	For storing cooked food and frozen products
4	Beverage area	Store all kinds of drinks
5	General merchandise section	Store general merchandise
6	Seasoning grain and oil area	Store condiments and grain and oil for kitchen use
7	Snack section	Store all kinds of snacks
8	Import area	Store imported goods
9	Office area	Handling invoices and office work

Warehouse incoming and outgoing instructions as well as purchasing instructions are controlled by office managers through network workgroups. First of all, the manager of each store predicts the demand for the next day or longer according to the sales situation of the store and holidays and other factors, and plans to send the shipment order to the warehouse management. Then, the warehouse management personnel after purchasing, purchasing, unloading, acceptance, storage, in accordance with the order requirements of each store to prepare goods, ready goods in the store as a unit of stacked in the preparation area. In order to avoid the interruption of the cold chain, the products in the frozen area are finally loaded into the delivery truck when the truck is divided into piles in the cold storage (the delivery trucks mentioned in this article are all refrigerated trucks). Finally, under the premise of not overweight and not dangerous driving, the delivery truck is delivered to each store according to the needs of each store and reasonably planned distribution routes.

According to the flow process of the product in the warehouse, the corresponding work flow table is drawn, see Table 4.

Table 4 Work flow

Product type	Flow
Refrigerated goods	3→1
beverage	4→2→1
General merchandise	5→2→1
Flavoured grain and oil	6→2→1
Snack	7→2→1
Imported goods	8→2→1

4.2. Analysis of interrelation between operation areas

According to the previous operation flow in the warehouse, the logistics intensity is drawn from to the table, see Table 5.

Table 5 Logistics intensity from to table

From- to	1	2	3	4	5	6	7	8	Total
1									
2	11050								11050
3	1950								1950
4		6500							6500
5		650							650
6		650							650
7		2600							2600
8		650							650
Total	13000	11050							

The logistics correlation diagram of each operation unit of the distribution center is obtained. The following non-logistics correlation diagram is obtained according to the comprehensive classification table of non-logistics relationship of operating units and the close relationship between operating units, see Fig. 3.

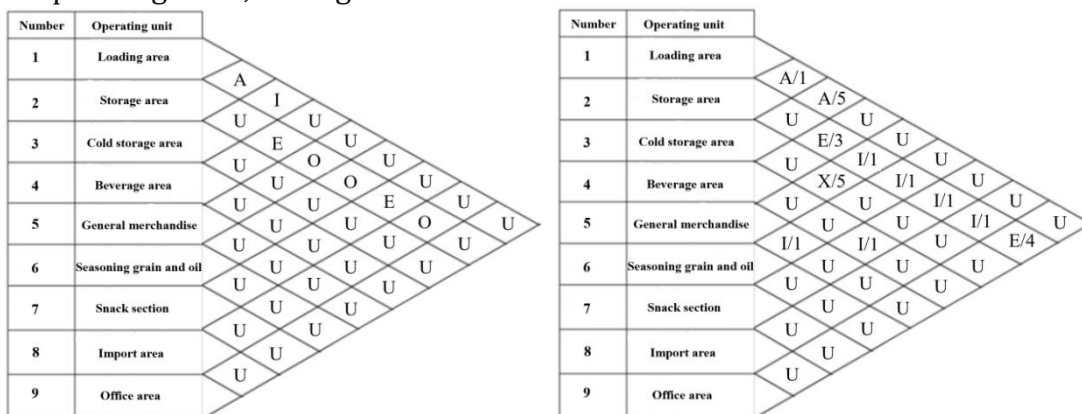


Fig. 3 Logistics correlation diagram(left), Non-logistics correlation diagram(right)

To quantify the level of logistics and non-logistics relationship between operating units, here set as A=4, E=3, I=2, O=1, U=0, X=-1, set any two operating units as A_i and A_j , logistics mutual relationship level as MR_{ij} , and non-logistics mutual relationship level as NR_{ij} , then the comprehensive mutual relationship level TR_{ij} between operating units and is:

$$TR_{ij} = mMR_{ij} + nNR_{ij} \tag{2}$$

According to the level of logistics and non-logistics relationship between each operation unit, the level of quantification is taken as a weighted value $m:n=2:1$; The comprehensive interrelation is obtained, and the calculation table of the comprehensive interrelation between operating units is obtained, see Table 6.

Table 6 Calculation of comprehensive interrelation between operating units

Number	Work unit pair	Relationship level				Comprehensive relation	
		Logistics relationship		Non-logistic relationship		rank	score
		rank	score	rank	score		
1	1-2	A	4	A	4	12	A
2	1-3	I	2	A	4	8	E
3	2-4	E	3	E	3	9	E

4	2-5	O	1	I	2	4	O
5	2-6	O	1	I	2	4	O
6	2-7	E	3	I	2	8	E
7	2-8	O	1	I	2	4	O
8	2-9	U	0	E	3	3	O
9	3-5	U	0	X	-1	-1	X
10	4-7	U	0	I	2	2	U
11	5-6	U	0	I	2	2	U

According to the results of the operation unit comprehensive relationship calculation, the operation unit comprehensive correlation diagram is obtained, see Fig. 4.

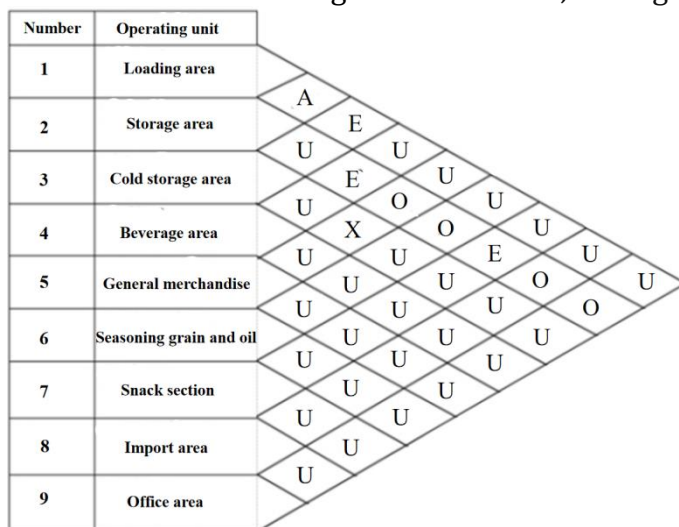


Fig. 4 Operation unit comprehensive correlation diagram

In the position correlation diagram of working units, the geometric shape is not considered, and the units are arranged in order according to the comprehensive proximity between them. The closer the two operating units are, the closer they are, and the more lines there are between them. The position correlation diagram of operation unit is obtained, see Fig. 5.

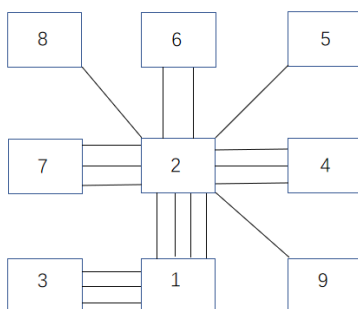


Fig. 5 Operation unit position correlation diagram

The area of each storage unit was obtained through a survey with the management of the company and a field study of the purchase cycle of each storage unit and the maximum area demand for storage, see Table 7.

Table 7 Storage unit area

Name	Quantity per purchase (t)	Purchase cycle	Area required for goods (m ² /t)	Area required (m ²)
Refrigerated	6.63	Once every three days	1.4	9.28

goods				
beverage	45.5	Once a week	1.2	54.60
General merchandise	9.75	Twice a month	6.0	58.50
Flavoured grain and oil	9.75	Twice a month	4.8	46.80
Snack	70	Once a month	12.0	840.00
Imported goods	19.5	Once a month	8.0	156.00

In order to ensure the daily operation of the warehouse and the normal conduct of sorting activities, the area of the storage unit needs to be appropriately increased, and the comprehensive operation unit area table is obtained, and give these areas a symbol, see Table 8.

Table 8 Consolidated operating unit area

Symbol	Name	Area requirement(m ²)
A	Loading area	25
B	Storage area	50
C	Refrigerated goods	12
D	beverage	60
E	General merchandise	65
F	Flavoured grain and oil	50
G	Snack	850
H	Imported goods	160
I	Office area	20
	Total	1287

According to the above table and the information of each diagram, a better operation unit area correlation diagram scheme is finally obtained, see Fig. 6. It is 50 meters long, 30 meters wide and 1500m² in area.

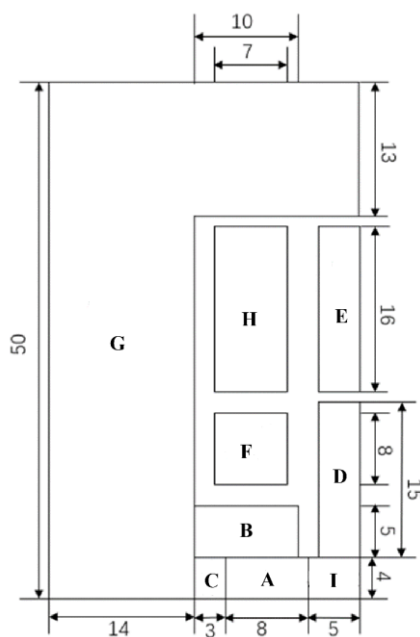


Fig. 6 Operational unit area correlator scheme

5. Conclusion

In this paper, Y company as the research object, combined with the gravity center method and hierarchical weighted evaluation method for the new warehouse location. Then, SLP method is

used to design the layout of the warehouse. Through the design of this paper, theoretically meet the current development needs of Y company.

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