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Research on the Construction of Northwest Cold Storage Based on Grey Relational Degree

Wenfang Chen

School of management, Shanghai University, Shanghai 200444, China

ABSTRACT. *In this paper, by analyzing the distribution of cold storage in the northwest region of Zheng Ming modern logistics company, the paper use SPSS software to cluster analysis based on five factors such as infrastructure, economic impact factors, natural environment, policy support and ecological benefit, and then using the improved grey relational degree model to prioritize the priority order of alternative points, and put forward constructive Suggestions for the construction of cold storage in northwest China.*

KEYWORDS: *Cold storage site selection, cluster analysis, grey relational degree*

1. Introduction

1.1 development status of cold storage

Cold storage is an important part of cold chain logistics network. Reasonable choice of cold chain logistics network nodes can not only improve efficiency but also reduce transport costs, improve customer service level and enhance the company's market competitiveness. However, as the leading enterprise of cold chain logistics, Zheng Ming logistics has the phenomenon of uneven regional distribution in its cold storage layout, which seriously hinders the comprehensive development of the company's cold chain logistics [1]. So far, the company has four industrial parks with an area of 10,000-20,000 square meters and 19 cold storage warehouses with an area of 6,000 square meters. However, most of these cold warehouses are distributed in the eastern coastal areas such as north, Shanghai and Guangzhou, while there are few cold warehouses in the central and western regions, which leads to the concentration of Zheng Ming cold chain logistics and transportation in the eastern coastal areas. However, the market in the eastern region gradually tends to be saturated and the development of enterprises is bound to shift to the central and western regions [2]. The construction of cold storage is to form a cold chain logistics

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network to achieve scale effect, which shows the importance of cold storage construction in the northwest region.

According to the statistics of China warehouse association, by the end of 2009, the distribution of total cold storage capacity in each region is shown in table 1

Table 1 Cold storage capacity distribution

Regions	Cold storage capacity (10,000 cubic meters)	Percentage of the total capacity of cold storage	percentage of the total population
Eastern Region	3960.46	64.53%	37.98%
Central Region	1255.10	20.45%	26.76%
Western Region	921.84	15.02%	27.04%

1.2 Location factors of cold storage

Generally, consideration should be given to economy, topography, water source, regional environment, transportation facilities, infrastructure and other conditions [3].

1. According to the economic basis, whether the supply, production and sales of raw materials have favorable conditions for warehouse construction.

2. Landform and geology, site selection should be based on the principle of saving land, occupying less farmland and not occupying good farmland

3. Water source cold storage is an enterprise that uses a lot of water, and water source is one of the important conditions to determine the storage site.

4. Regional environment, storage site should be far away from severely polluted factories and mining enterprises. Choose as far as possible upwind zone and sewage treatment plant upstream.

5. Traffic conditions, with convenient land and water transportation conditions, to facilitate the transfer of goods in and out.

6. For infrastructure construction, the power supply of cold storage belongs to the second type of load, which requires a reliable power supply with stable voltage.

2. Analysis of cold chain development in northwest China

2.1 Xinjiang cold chain logistics development advantages

Through the analysis of table 2, it can be concluded that the percentage of the increase of Xinjiang's total output value of agriculture, forestry, animal husbandry and fishery compared with that of the previous year is higher than that of other northwest provinces. In 2015, the total export value of Xinjiang exceeds that of other northwest provinces. Therefore, Xinjiang has advantages in developing cold

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chain logistics. At present, Xinjiang has more than 100 kinds of agricultural products with competitive advantages in the domestic and foreign markets, and the export of agricultural and sideline products accounts for about 1/4 of the total export of Xinjiang. The output of agricultural products is large and of good quality. In addition, the first and second Eurasian land bridge crosses from Xinjiang, which also creates a powerful opportunity for Zheng Ming to develop Xinjiang.

2.2 Alternative point under the preliminary planning of Xinjiang cold storage construction

As the map of Xinjiang is vast and the population distribution is not concentrated, the population and major cities of Xinjiang are firstly considered to preliminarily demarcate the scope, and the sources of goods of Urumqi, Karamay, Shihezi, Changji and Turpan region are respectively selected for analysis (see the table below). By further reducing the number of points through data analysis, the remaining cities are analyzed in terms of economy, topography, water source, regional environment, traffic conditions and infrastructure construction, and then a selection model is established. Finally, the most relevant areas are identified based on the gray relational analysis method to serve as the final cold storage construction points [4].

Table 2 Xinjiang region supply situation

Region	Fruit per ton	Livestock inventory per million	Milk / 10,000 tons	Meat / 10,000 tons	Aquatic products / 10,000 tons	Eggs/ton
Urumqi	-	82.5	10.0996	-	8743	1.407
Karamay	1.7132	14.16	0.7972	1.0714	-	788
Shihezi	3.5383	17.7	4.8569	2.4135	3373	-
Changji	38.33	-	84.23	53.02	1.77	8.64
Turpan	24.7	96.5	2.3	4.1	400	0.2398
Hami	28.08	114.4	5.61	5.27	0.11	0.33
Yili	52.39	0.1362	109.58	49.55	-	10.49
Tacheng	-	-	20.14	16.42	-	2.46
Taylor	-	-	22.84	7.65	0.71	0.38
BoZhou	4.114	108.61	1.85	2.2	-	1.25
Bayin	76.3	-	8.6	11.63	1.55	2.1
Aksu	162.63	467.14	10.22	19.28	1.36	3.23
Basque	1.8429	164.67	2.5844	3.7989	-	-
Kashgar	433.06	831.71	25.41	36.6	0.88	7.75
Hetian	12.42	503.45	3.72	9.72	2300	1.64

We use the five aspects of GDP, logistics cost, topographical hydrology, regional priority development, and the ratio of local fiscal revenue to local fiscal expenditure to reflect the improvement of infrastructure, economic factors, natural environment,

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policy support and ecological benefits respectively. The following tree graph is obtained by data analysis using SPSS software for these five indicators.

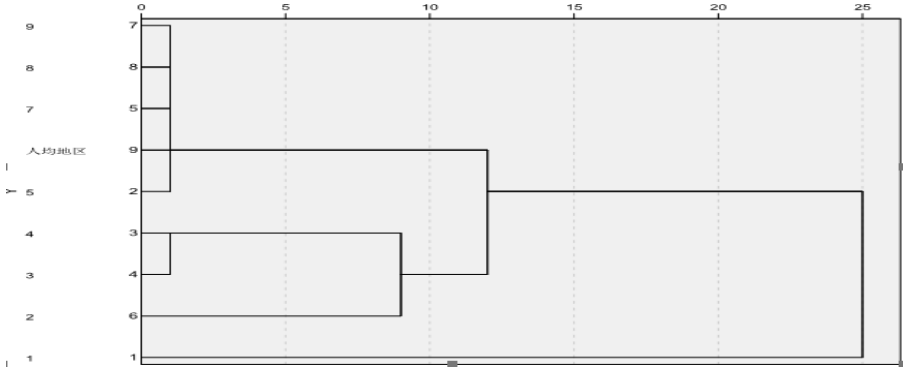

Figure. 1 Cluster analysis tree graph

Through the chart and cluster analysis of various regions, it can be seen that the fruits, vegetables, fresh meat, transportation conditions, policies, economy, infrastructure construction and ecological benefits are relatively dominant in Kashi, Bayin, Aksu, Changji and Yili. Which of these five regions has the advantage of cold storage construction, this paper will make specific analysis and make the most reasonable decision.

3. Logistics distribution center location method based on improved grey relational degree

3.1 model introduction

Cold storage node location design of various factors, grey correlation model is widely used, the grey correlation degree is based on a series of geometric similarity measure vector correlation, and geometric features can generally by the slope of the curve, therefore, in the improvement process of grey correlation degree, can through the calculation of the slope of the comparative sequence to improve, given below based on improved grey correlation calculation process of site selection of logistics distribution center [5-7]:

(1) Data collection of alternative addresses of logistics distribution centers

For after primary 15 m alternative distribution center, hire experts to evaluate, the expert evaluation results after eliminating outliers, using the method of calculating mean to compute the second of the five evaluation indexes of evaluation of the economic factors affecting the main consideration is the logistics cost, should be as small as possible, while the other four factors should be bigger is excellent, so

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to inverse the second evaluation index, get five evaluation indexes of evaluation matrix of the:

$$X = \begin{pmatrix} x_{11} & \cdots & x_{15} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{m5} \end{pmatrix} \tag{1}$$

(2) Selection of reference sequence

In the reference sequence of site selection, the maximum value of each evaluation index can be selected to form the corresponding reference sequence:

$$X_0 = \left(x_0(1), x_0(2), ...x_0(5)\right) \tag{2}$$

$$x_0(j) = \max_{i=1,2,..,m} x_i(j) \quad j = 1,2,3,4,5 \tag{3}$$

(3) Generation by subtraction

In order to make the model more in line with the requirements of objective facts, it is necessary to improve the existing grey relational degree. Considering that the similarity of geometric characteristics is best described as whether the slope is the same or not, the slope of the evaluation data can be obtained after the reduction of the evaluation data, so it is necessary to carry out the reduction generation of the evaluation sequence.

The slope matrix formed by the slope of the reduced comparison sequence is:

$$Y = \begin{bmatrix} y_1(1) & y_1(2) & \cdots & y_1(5) \\ y_2(1) & y_2(2) & \cdots & y_2(5) \\ \vdots & \vdots & \ddots & \vdots \\ y_m(1) & y_m(2) & \cdots & y_m(5) \end{bmatrix} \tag{4}$$

(4) Calculate the standard deviation between the comparison sequence and the reference

First, calculate the evaluation sequence of ideal logistics distribution center, namely the reference sequence:

$$\text{Mean } X_0 = \left(x_0(1), x_0(2), ...x_0(5)\right) \tag{5}$$

$$\overline{x_0} = \frac{1}{5}\left(x_0(1) + x_0(2) + ... + x_0(5)\right) = \frac{1}{5}\sum_{i=1}^{5} x_0(j) \tag{6}$$

Then calculate the standard deviation of the evaluation value of ideal logistics distribution center:

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$$\sigma_{X_0} = \sqrt{\frac{1}{5}\sum_{j=1}^{5}\left[\left(x_0(j) - \overline{x_0}\right)\right]^2} \tag{7}$$

The mean and standard deviation of the evaluation value (i.e. comparison series) of alternative distribution center are also calculated for each row respectively. The calculation formula of the mean and standard deviation of the evaluation value (i.e. comparison series) of the ith alternative distribution center is:

$$\overline{X_1} = \frac{1}{5}\left(x_i(1) + x_i(2) + \ldots + x_i(5)\right) = \frac{1}{5}\sum_{j=1}^{5} x_i(j) \tag{8}$$

$$\sigma_{X_i} = \sqrt{\frac{1}{5}\sum_{j=1}^{5}\left[\left(x_0(j) - \overline{x_i}\right)\right]^2} \quad (i = 1, 2, \ldots, m) \tag{9}$$

(5) Calculate the correlation coefficient between the evaluation value of alternative logistics distribution center and ideal logistics distribution center

$$\xi\left(x_0(j), x_i(j)\right) = sign\left(y_0(j) * y_i(j)\right)\frac{1}{1 + \left\|\left|\frac{y_0(j)}{\sigma_{X_0}}\right| - \left|\frac{y_i(j)}{\sigma_{X_i}}\right|\right\|} \quad (j = 2,3,\ldots,n) \tag{10}$$

Where sign(x) is the symbol function

$$sign(x) = \begin{cases} 1(x > 0) \\ 0(x = 0) \\ -1(x < 0) \end{cases} \tag{11}$$

It can be proved that, for the grey correlation coefficient, it satisfies the symmetry and does not involve the discrimination parameter, so it has the uniqueness of calculation and effectively avoids the deficiency of grey correlation degree.

(6) Calculate the grey relational degree between alternative logistics distribution center and ideal logistics distribution center

The grey correlation between the alternative logistics distribution center i and the ideal logistics distribution center is:

$$\eta_i = \frac{1}{4}\sum_{j=2}^{5}\xi\left(x_0(j), x_i(j)\right) \tag{12}$$

(7) Rank and select the best

Based on the improved grey relational degree, the center with the largest grey relational degree is selected as the building address of the final logistics distribution center.

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3.2 Model application

Select the optimal construction point from the alternative points of Kashi, Bayin, Aksu, Changji and Yili city. According to the five factors, the weight is given by experts.

Five influencing factors :(1) the perfection of infrastructure construction; (2) economic factors; (3) natural environment; (4) degree of policy support; (5) ecological benefits.

Factors: infrastructure perfect degree, represented by the city's GDP, the economy represented by the logistics cost, the major influencing factors of natural environment represented by topography and hydrology, and policy support to the principle of priority to the development of regional ecological environment factors in local fiscal revenue and local fiscal expenditure, represented by two factors on local fiscal revenue than the size of the local fiscal expenditure. The weight values of the five factors in Kashi, Bayin, Aksu, Changji and Yili are sorted out. The following are the five alternative comment values listed in the matrix.

$$X = \begin{bmatrix} Kashi \\ Bayin \\ Aksu \\ Changji \\ Yili \end{bmatrix} = \begin{bmatrix} 25.7 & 2.1 & 8.0 & 18 & 16.1 \\ 36.4 & 6.7 & 15.4 & 22 & 46.4 \\ 8.4 & 2.7 & 17.2 & 18 & 43.8 \\ 19.9 & 4.4 & 51.7 & 20 & 33.3 \end{bmatrix}$$

Reference sequence:

$$X_0 = (36.4,\quad 84.1,\quad 51.7,\quad 22,\quad 57.1)$$

$$\overline{X}_0 = 50.26$$

$$\sigma_{x_0} = 20.90$$

The ideal evaluation vector is reduced to:

$$Y_0 = (36.4,\quad 47.7,\quad -32.4,\quad -29.7,\quad 35.1)$$

Subtract the evaluation of each alternative point:

$$Y = \begin{bmatrix} 25.7 & -23.6 & 5.9 & 10 & -1.9 \\ 36.4 & -29.7 & 8.7 & 6.6 & 24.4 \\ 8.4 & -5.7 & 14.5 & 0.8 & 25.8 \\ 9.6 & 74.5 & -76.4 & 14.3 & 35.1 \\ 19.9 & -15.5 & 47.3 & -31.7 & 13.3 \end{bmatrix}$$

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Calculate the mean and variance of each alternative point:

$$\overline{x_1} = 1.98 \quad \sigma_{x_1} = 8.18$$

$$\overline{x_2} = 25.38 \quad \sigma_{x_2} = 14.30$$

$$\overline{x_3} = 18.02 \quad \sigma_{x_3} = 14.09$$

$$\overline{x_4} = 36.1 \quad \sigma_{x_4} = 29.84$$

$$\overline{x_5} = 25.86 \quad \sigma_{x_5} = 15.83$$

Calculate the correlation coefficient between each alternative point and the ideal construction point:

$$\xi\left(x_0(j), x_i(j)\right) = sign\left(y_0(j) * y_i(j)\right) \frac{1}{1 + \left\| \left| \frac{y_0(j)}{\sigma x_0} \right| - \left| \frac{y_i(j)}{\sigma x_i} \right| \right\|}$$

$$j = 2, 3, ..., n$$

Get the matrix of correlation coefficient:

$$\xi = \begin{bmatrix} 0.4167 & -0.6239 & -0.5468 & -0.8343 & -0.4084 \\ 0.5544 & -0.8296 & -0.5150 & -0.5103 & 0.9739 \\ 0.4661 & -0.3463 & -0.6574 & -0.4230 & -0.8684 \\ 0.4132 & 0.8234 & 0.4975 & -0.5150 & 0.6653 \\ 0.6737 & -0.4342 & -0.4102 & 0.6323 & 0.5437 \end{bmatrix}$$

The grey correlation degree between alternative points and ideal construction points can be calculated by the correlation coefficient matrix:

$$\eta_1 = -0.3993$$

$$\eta_2 = -0.0653$$

$$\eta_3 = -0.01844$$

$$\eta_4 = 0.37188$$

$$\eta_5 = 0.20106$$

The priority cold storage points can be obtained by comparing the grey correlation coefficient:

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$$\eta_4 > \eta_5 > \eta_3 > \eta_2 > \eta_1$$

Therefore, through the grey correlation analysis method, this paper obtains that Changji is the preferred construction site for cold storage in northwest China.

4. Conclusion

This paper analyzes the Zheng Ming modern logistics companies in the northwest cold storage distribution imbalance phenomenon, build infrastructure, economic factors, natural environment, policy support, ecological five factors index clustering analysis, and using cluster analysis and improved grey correlation model of candidate points priorities for sorting, finally it is concluded that the northwest cold storage construction should be the priority choice of Changji, the layout of logistics base for Zheng Ming logistics in northwest China provide constructive meaning, further optimization and laid a solid foundation for the subsequent cold chain network.

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