Advances in Economics, Business and Management Research, volume 91
1st International Symposium on Economic Development and Management Innovation (EDMI 2019)

Research on Location Selection of Agricultural Products Distribution Center based on Cost Optimal in E-commerce Environment

--Taking Aba Prefecture as an Example

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Abstract. In recent years, people pay more and more attention to food safety. In order to study the relationship between agricultural product safety and location selection of distribution centers, this paper studies the establishment mechanism of agricultural product distribution centers based on food safety in the e-commerce environment. Based on the cost optimization perspective, the analytic hierarchy process is used to qualitatively analyze the four influencing factors of transportation cost, storage cost, processing cost and human resource cost, and the relevant weights are obtained. Then the gray correlation degree is used to evaluate the four candidate towns. The selection of the optimal distribution center site is selected to provide reference for the research of fresh and perishable products such as yak meat, and the research on the safety mechanism of agricultural products is put forward.

Keywords: Agricultural Products; Distribution Center Location; Cost Optimization; Analytic Hierarchy Process; Grey Relational Analysis.

1. Introduction

With the development of social economy, people's consumption patterns have changed, and more and more attention has been paid to the quality of food. How to establish an effective household distribution model for fresh agricultural products, improve the efficiency of logistics distribution, and ensure the quality and freshness of products is an urgent problem to be solved in the development of household distribution of fresh agricultural products [1].

At present, many scholars at home and abroad have studied the influencing factors of agricultural product supply chain location. Li Lei [2] used GI method and entropy method to construct the smallest total distribution cost including the population of demand points. Site model; Xiao Jianhua [3] found that timeliness and responsiveness are two very important factors in the location of fresh agricultural products; So Zhilin [4] Hua [5] established a site with the lowest logistics cost Optimize the model and study the global balance search and local search distribution center location issues; Pawel [6] proposed that the transportation cost depends on the purchase price of the vehicle. In terms of agricultural product quality and safety research, Zhou Wencan [7] used the binary Logit model to identify the significant factors affecting farmers' safe supply of agricultural products, such as farmers' awareness of the national ban on pesticides. Zhang Xiaofeng [8] found that the supply of safe agricultural products is affected by economic factors such as agricultural product prices and risks, and is also subject to social factors such as policies and regulations. The lack of research in the above studies is that the scope of research is large, and there is a lack of targeted research on the location of a certain agricultural product supply chain.

Li Shengsheng [9] and others found that the increase in transport temperature affects the quality of yak meat, and the reduction of temperature fluctuations in the transportation of yak meat can maximize the quality of yak meat; meanwhile [10] also simulates the effect of transport temperature changes on the quality of yak meat. It is concluded that the increase in transport temperature will degrade the quality of yak meat; Li Shengsheng [11] and others found that the atmosphere and vacuum packaging significantly inhibited the growth of microorganisms in chilled beef and delayed the color and quality of chilled beef during storage. Deterioration of indicators. The above literature involves less research on the location of the distribution center. It is only the temperature packaging and other factors that make it difficult to locate the supply chain in the transportation process of the yak.

Based on the above research, it is found that the location of agricultural product distribution center is affected by multiple factors, among which the cost factor is particularly important for the location selection of agricultural product supply chain. Based on the principle of cost most preferred, this paper will use analytic hierarchy process and grey relational analysis method to comprehensively consider yak. Site selection of meat and agricultural products distribution center.

2. Comprehensive Evaluation Model based on Analytic Hierarchy Process and Grey Correlation Analysis

The research object selected in this paper is Sichuan Aba Prefecture. Four towns in the city are selected as the research destinations for the distribution center. Finally, qualitative analysis is used to select the best one to establish the distribution center.

2.1 Using Analytic Hierarchy Process to Determine Indicator Weights

The location of the logistics distribution center studied in this paper is a typical multi-level and multi-index comprehensive evaluation problem. Therefore, the AHP method is used to determine the weight of each index. This study, through field research in Aba Prefecture, combined with relevant literature research, With the goal of cost optimization, an evaluation system for local agricultural product distribution centers was established [18].

2.1.1 Construction of Evaluation Index System

Table 1. Evaluation index system

Criteria Layer	Indicator Layer	Key Points
Transportation Cost A1[12][13]	Rental cost of transportation tools P1	Quantitative indicators
	Operating costs, management fees, financial expenses P2	Quantitative indicators
	Fuel consumption of transportation tools P3	Quantitative indicators
	Transportation vehicle maintenance fee P4	Quantitative indicators
	Toll fee P5	Quantitative indicators
Storage Cost A2[14]	Establish cold storage facility cost P6	Quantitative indicators
	Warehouse handling fee P7	Quantitative indicators
	Equipment management maintenance cost P8	Quantitative indicators
Processing Cost A3 [15]	Cost of electricity, water heat, etc. P9	Quantitative indicators
	Sewage and solid waste treatment costs P10	Quantitative indicators
Human Resource Cost A4[16] [17]	Worker salary P11	Quantitative indicators
	Personnel security cost P12	Quantitative indicators

2.1.2 Determining the Weight Vector

1) Construct a judgment matrix

Based on the field research in A County, combined with the existing national policies and literature research, the 1~9 scale method is used to construct the two-two judgment matrix between the various factors $\boldsymbol{A}=(A_{ij})_{n\times m}$; where: the scale of the judgment matrix , A_{ij} = 1~9. As the number of 1~9 increases, the importance of the indicator increases. 1 means the indicator is equally important, 9 means the indicator is absolutely important,

$$A_{ij}=1, A_{ij}=1/\ A_{ij};\ i=(1,2,......,n), j=(1,2,..., n). \tag{1}$$

2) Hierarchical single sorting calculation weight

Calculating the geometric mean of the judgment matrix A by using the geometric mean method.

$$\overline{w_i}=n_j\sqrt{\prod_{j=1}^{n}a_{ij}} \tag{2}$$

Normalize the vector $\overline{W}$ to get the weight of matrix A.

$$w_i=\frac{\overline{w_i}}{\sum_{i=1}^{n}\overline{w_i}} \tag{3}$$

The evaluation index weight vector

$$\boldsymbol{W}=[w_1\quad w_2\quad \cdots\quad w_n]^{\mathrm{T}} \tag{4}$$

Whether the weight distribution obtained above is reasonable or not, it is necessary to perform consistency check on the judgment matrix. Test formula

$$\mathrm{CR}=\frac{\mathrm{CI}}{\mathrm{RI}} \tag{5}$$

CR is the random consistency ratio of the judgment matrix; CI is the general consistency index of the judgment matrix

$$.\ \mathrm{CI}=\frac{\lambda_{\max}-n}{n-1} \tag{6}$$

3) RI is the average random consistency index of the judgment matrix, and the RI values of the judgment matrix of the 1st to 9th order are as follows:

Table 2. Determines the matrix RI value

n	1	2	3	4	5	6	7	8	9
RI	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46

When the judgment matrix CR<0.1 or $\lambda_{\max}=n$, CI=0, It is considered that A has satisfactory consistency, otherwise the elements in A need to be adjusted to have satisfactory consistency [19].

4) Level total ordering

The hierarchical total ranking, that is, the sub-criteria layer relative to the target layer, has a comprehensive weight of:

$$\boldsymbol{W}^{(0)}=W^{(2)}\bullet W^{(1)}=(W_0^{(0)},W_2^{(0)},\cdots,W_m^{(0)}) \tag{7}$$

2.2 Determine the Most Preferred Address

1)Determine the evaluation index system according to the purpose of evaluation, and construct an evaluation matrix. Let n data sequences form the following matrix:

$$\left(X_1', X_2', \cdots X_n'\right)=\begin{pmatrix} X_1'(1) & X_2'(1) & \cdots & X_n'(1) \\ X_1'(2) & X_2'(2) & \cdots & X_n'(2) \\ \vdots & \vdots & \cdots & \vdots \\ X_1'(m) & X_2'(m) & \cdots & X_n'(m) \end{pmatrix}$$ among them $X_i'=\left(X_i'(1), X_i'(2), \cdots X_i'(m)\right)^T$, i=1, 2,⋯, n

2) Collect evaluation data and perform dimensionless processing on the data

Due to the difference in magnitude and nature between the various rating indicators, it is necessary to perform dimensionless processing on the evaluation matrix to obtain a dimensionless evaluation matrix.

This paper adopts the mean method for dimensionless processing.

$$X_i(k) = \frac{x'_i(k)}{\bar{x}_i} (i = 0,1, \ldots \ldots, n;\ k = 1,2, \ldots \ldots, m) \quad (8)$$

3) Determine the reference sequence

The reference data column should be an ideal comparison standard. The reference data column can be formed by the optimal value (or the worst value) of each indicator, and other reference values can be selected according to the evaluation purpose. This paper selects the minimum value of each indicator sequence to form a reference sequence, which is recorded as $X_0'=\left(X_0'(1), X_0'(2), \cdots X_0'(m)\right)$

4) Calculate the absolute difference between each of the evaluated target index sequences (comparative sequences) and the corresponding elements of the reference sequence one by one, that is,

$$|\, x_0(k) - x_i(k)\, | \ (k = 1, \ldots, m; i = 1, \ldots, n, \text{n is the number of objects to be evaluated}) \quad (9)$$

define $\min_{i=1}^{n} \min_{k=1}^{m} | x_0(\kappa) - x_i(\kappa) |$ and $\max_{i=1}^{n} \max_{k=1}^{m} | x_0(\kappa) - x_i(\kappa) |$

5) Calculate the correlation coefficient

The correlation coefficient of each comparison sequence and the corresponding element of the reference sequence is calculated by the following formula, and the correlation coefficient matrix of each index is obtained.

$$\xi_i(\kappa) = \frac{\min_{i=1}^{n} \min_{k=1}^{m} | x_0(\kappa) - x_i(\kappa) | + \rho \cdot \max_{i=1}^{n} \max_{k=1}^{m} | x_0(\kappa) - x_i(\kappa) |}{| x_0(\kappa) - x_i(\kappa) | + \rho \cdot \max_{i=1}^{n} \max_{k=1}^{m} | x_0(\kappa) - x_i(\kappa) |} \ (K=1,2\ldots, m) \quad (10)$$

In the formula, ρ is the resolution coefficient and takes values in (0, 1). If the ρ is smaller, the difference between the correlation coefficients is larger, and the discrimination ability is stronger. Usually ρ takes 0.5.

The correlation coefficient is calculated by the above formula to form a matrix of correlation coefficients of each index.

6) Determine the comprehensive evaluation matrix.

$$R=E \times W^0= [r1\ r2\ \ldots\ldots\ rm] \quad (11)$$

Where R is the comprehensive evaluation result matrix of m schemes, $r_k=\sum_1^m \xi kl \times wl$(k=1, 2, ……, m) is the weighted evaluation result of the kth scheme; wl (l=1, 2, ..., n) is the weight of the first indicator.

According to the results calculated by formula (11), the advantages and disadvantages of each scheme are ranked. The larger the degree of relevance of the weighted scheme, the closer to the virtual optimal reference scheme, the scheme is optimal [20].

3. Empirical Analysis

1) Determine the indicator weight vector

Based on the field research and reference to a large number of literatures, this study compares the indicators to establish a judgment matrix, and derives the total weight of each indicator according to formulas (1) ~ (7), as shown in the following table:

Table 3.Total weight of each indicator

The Weight of A to		Indicator Layer P	The Weight of P to	The Weight of P to C
A1	0.2083	P1	0.1310	0.027
		P2	0.6293	0.131
		P3	0.0712	0.015
		P4	0.1217	0.025
		P5	0.0469	0.010
A2	0.5963	P6	0.5499	0.328
		P7	0.2098	0.125
		P8	0.2402	0.143
A3	0.0861	P9	0.2500	0.022
		P10	0.7500	0.065
A4	0.1093	P11	0.8000	0.087
		P12	0.2000	0.022

Based on the weight values obtained by C-Ai and Pi-Ai, the weight values of the evaluation indexes in the index layer (P) for the target layer (C) are calculated. It can be seen from Table 6 that in the criterion layer, the storage cost is an important factor affecting the location of the distribution center, and its weight value is 0.5963; the transportation cost is second. Among the selected 12 indicators, the cost of establishing cold storage facilities has the greatest impact on the location of logistics distribution centers, with a weight of 0.328; followed by equipment management and maintenance costs, with a weight of 0.143; operating costs, management costs, financial expenses and Warehouse handling fees are also an important factor affecting the location of distribution centers, with weights of 0.131 and 0.125 respectively; tolls and fuel consumption of transportation vehicles have little impact on distribution center selection, and their weight values are 0.01 and 0.015, respectively. Therefore, the establishment of cold storage facility costs and equipment management and maintenance costs are the two most important indicators affecting the location of the distribution center. This result is in line with the optimal requirements for site selection.

$$W^0(\ 0.0273\ \ 0.1311\ \ 0.0148\ \ 0.0254\ \ 0.0098\ \ 0.3279\ \ 0.1251\ \ 0.1432\ \ 0.0215\ \ 0.0646\ \ 0.0874\ \ 0.0219\ )$$

2) From (8), the normalized matrix after dimensionless processing is as shown in equation (12)

3) Determine the reference sequence

$$\mathrm{X}_0 = (0.66,0.65,0.67,0.85,0.48,0.46,0.51,0.55,0.68,0.68,0.60,0.71)$$

4) Available from (9)

$$\min_{i=1}^{n}\min_{k=1}^{m}|x_0(\kappa) - x_i(\kappa)| = 0.00\ ,\ \max_{i=1}^{n}\max_{k=1}^{m}|x_0(\kappa) - x_i(\kappa)| = 1.65$$

5) The correlation coefficient matrix obtained by (11) is as shown in equation (13)

$$X = \begin{pmatrix} 1.52 & 1.06 & 0.76 & 0.66 \\ 1.49 & 1.09 & 0.77 & 0.65 \\ 1.69 & 0.85 & 0.79 & 0.67 \\ 1.44 & 0.86 & 0.85 & 0.86 \\ 1.45 & 1.18 & 0.48 & 0.89 \\ 2.11 & 0.85 & 0.46 & 0.57 \\ 1.95 & 0.89 & 0.65 & 0.51 \\ 1.72 & 1.06 & 0.55 & 0.67 \\ 1.46 & 1.03 & 0.83 & 0.68 \\ 1.38 & 1.23 & 0.68 & 0.71 \\ 1.59 & 1.01 & 0.60 & 0.80 \\ 1.24 & 1.05 & 1.01 & 0.71 \end{pmatrix} \tag{12}$$

$$X = \begin{pmatrix} 0.49 & 0.68 & 0.89 & 1.00 \\ 0.50 & 0.66 & 0.88 & 1.00 \\ 0.45 & 0.82 & 0.87 & 1.00 \\ 0.58 & 0.99 & 1.00 & 0.98 \\ 0.46 & 0.54 & 1.00 & 0.66 \\ 0.33 & 0.68 & 1.00 & 0.89 \\ 0.36 & 0.69 & 0.85 & 1.00 \\ 0.41 & 0.62 & 1.00 & 0.86 \\ 0.52 & 0.71 & 0.85 & 1.00 \\ 0.54 & 0.60 & 1.00 & 0.96 \\ 0.45 & 0.67 & 1.00 & 0.80 \\ 0.61 & 0.71 & 0.73 & 1.00 \end{pmatrix} \tag{13}$$

6) Get the comprehensive evaluation matrix from (10)

$$R = (0.4173\ 0.6718\ 0.9517\ 0.9182) \tag{14}$$

Result analysis

It can be known from (14) that in the towns 1, 2, 3, 4, the gray correlation degree town 3 > town 4 > town 2 > town one, so based on the best cost, in the four towns, the town three is better The location of the agricultural product distribution center is followed by the town four.

4. Conclusion

In this paper, in view of the oversupply of domestic production of yak meat in Malcolm, it is necessary to rely on the e-commerce market to propose the research on the location selection of agricultural product distribution center based on cost optimization in the e-commerce environment. In this paper, the analytic hierarchy process is combined with the gray correlation degree, and the location selection scheme of the distribution center is obtained based on the model with the lowest cost. Based on the results of the study, the following recommendations are made:

1) In the location and establishment of the distribution center, it is necessary to consider the establishment cost of the cold storage facility.

2) Equipment management and maintenance costs also need to be considered. This is the continuous expenditure of the distribution center from establishment to operation.

3) Operational costs and warehouse handling fees are also factoring that need to be considered in the selection of the distribution center. This is about whether the distribution center can exist for a long time.

In the research process of this subject, this paper determines the most preferable location of the distribution center with the goal of cost optimization. However, in actual research, the safety of agricultural products is also an important factor affecting the establishment of distribution centers. Based on this, relevant to the future the research direction is proposed:

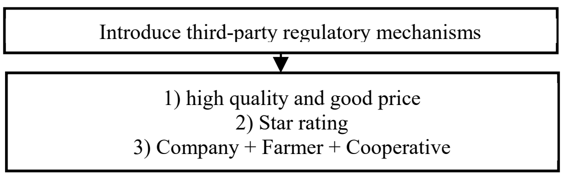

Figure 1. Security regulatory mechanism

The location of agricultural product distribution center is a complex cross-disciplinary problem. Limited to its own ability, the research in this paper still has many defects and deficiencies, and more scholars need to invest in research to draw more complete conclusions.

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