Research on Site Selection Model of Distribution Center of Agricultural Products

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Abstract In the light of the practical situation of logistics distribution of agricultural products, we primarily select transportation factor, economic factor, environment factor, and other factors, to establish evaluation index system of site selection of distribution center of agricultural products. And then we adopt the analytic hierarchy process method to calculate weight of site selection of distribution center of agricultural products. Under the circumstance that the evaluation information is interval number, we use uncertain and multiple attribute decision making method to establish site selection model of distribution center of agricultural products. Finally, taking one city as an example, we discuss the application of this model in site selection of distribution center of agricultural products. The results of empirical analysis show that the model we established fully considers the randomness and uncertainty in the process of evaluation, so as to make the results of evaluation more objective, in line with reality. So the effect of evaluation is better as against the former real number evaluation calibration.

Key words Distribution center of agricultural products, Model, Interval number, China

Logistics of agricultural products, taking agricultural products as objects, through the logistics links of processing, packaging, storage, transport and distribution of agricultural products, is to realize inflation-proofing and appreciation of agricultural products and finally send these agricultural products to consumers. With China's WTO accession, the opening up of rural markets and the accelerated process of internationalization of agriculture, the poor logistics caused by traditional Chinese agricultural production, management modes and technologies, laggard relevant research on agricultural logistics, scanty input in infrastructure of agricultural logistics, unsound information system of agricultural logistics, prohibitive price of logistics, and poor-quality agricultural products, will make the rural areas suffer serious economic panic. The emergency measures and long-term strategy to change the status quo is to promote agricultural productivity and establish scientific agricultural logistics system. Due to the characteristics of the agricultural product itself, and scattered and vast production sale areas, it poses higher requirements on planning, ways and means of agricultural products. The process of logistics is the key part of realizing market value of agricultural products currently. The logistics of agricultural products, as new form of modern logistics, are to organize commodity supply, conduct the procedures of test, quarantine, sorting, cleaning, separation, and packaging, deliver these agricultural products to consumers directly according to the requirements of order, and complete the whole process service from "field' to "dining table", with the characteristics of safety, high efficiency and convenience[1,2].

In the whole process of logistics of agricultural products, decision-making of site selection of distribution center of agricultural products plays an important role. The distribution center of agricultural products is the bridge connecting production base of agricultural products and consumers, whose site selection ways often determine distribution distance and distance model of agricultural products logistics, and further impact operation efficiency of logistics system of agricultural products. The current researches on logistics distribution center of agricultural products focus on site selection of distribution center of agricultural products, layout of distribution center of agricultural products, and selection of transport path of agricultural products[1-4]. Considering that the evaluation indices are qualitative indices, people's consciousness has ambiguity and uncertainty in the process of obtaining data regarding site selection of distribution center of agricultural products, and experts acquire qualitative or imprecise evaluation value by experience in the process of judging the alternative sites, the evaluation value of alternative sites under all indices is denoted by interval number, which is more reasonable, in line with reality, and finally makes the evaluation of the distribution center of agricultural products conform to objective law, thus the evaluation results are more persuasive. Under the circumstance that the evaluation information of distribution center of agricultural products is interval number, we use the uncertain and multiple attribute decision making method to establish site selection model of distribution center of agricultural products.

1 Establishment of evaluation system of site selection of distribution center of agricultural products and establishment of evaluation model

1.1 Basic definition and theorem

1.1.1 Reciprocal matrix. We call the matrix $A = (a_{ij})_{n\times n}$ as reciprocal matrix. For any $i, j \in N$, $a_{ij} \cdot a_{ji} = 1$[5].

1.1.2 Positive interval number. $b_{ij} = [b_{ij}^-, b_{ij}^+] = \{b_{ij} | 0 \leqslant b_{ij}^- \leqslant$

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$b_{ij} \leqslant b_{ij}^{+}\}$, $i, j=1, 2, \cdots, n$, and we name b_{ij} as positive interval number[6].

1.1.3 Interval number[7]. We assume $[b_{ij}^{-}, b_{ij}^{+}]$ as interval number, and $f_{\rho}([b_{ij}^{-}, b_{ij}^{+}]) = \int_0^1 \frac{d\rho(y)}{dy}(b_{ij}^{+} - y(b_{ij}^{+} - b_{ij}^{-}))\,dy$. In the form, function ρ:[0, 1]→[0, 1] is the function with the following attributes: ① $\rho(0)=0$, $\rho(1)=1$; ② if $x>y$, then $\rho(x) \geqslant \rho(y)$. Then we call arithmetic operator f as continuous interval data *OWA* arithmetic operator, *C-OWA* arithmetic operator for short. Function ρ is called basic unit interval monotone function. If $\rho(y)=y^{r}(r \geqslant 0)$, then $f_{\rho}([b_{ij}^{-}, b_{ij}^{+}]) = b_{ij}^{+} + rb_{ij}^{-}/(r+1)$.

1.2 Selection of evaluation index concerning site selection of distribution center of agricultural products China's logistics industry is emerging industry, but through research and application in recent years, China's logistics industry develops rapidly. Logistics of agricultural products is a national fundamental industry. The agriculture couples with logistics so as to blaze new road, which not only conforms to policy of "agriculture – countryside – farmer" of China, but also reduces the financial burden of farmers and improves the production activity and creativity of farmers.

In the process of designing index evaluation system of site selection of distribution center of agricultural products, we should also comply with five principles, namely purposefulness, coordination, economy, adaptability and strategy. Referring to the research results of modern logistics, planning design of logistics distribution system of agricultural products, and actual situation of transport and China's logistics, the evaluation index in the process of site selection of distribution center of agricultural products should consider the following four aspects.

First, transportation factor: we conduct evaluation in terms of transport time, transport crowding degree, transportation convenience and status of public accommodation.

Second, economic factor: the logistics of agricultural products aims at obtaining added value, so we should consider the investment profiting rate, and consider logistics cost, conditions of labor forces, land price and development potential of the region.

Third, environment factor: it mainly researches local preferential policy and statute, service level and impact of weather, topography and landscape.

Fourth, other factors: whether the use of land resources, ecological environment, humanity environment or surrounding circumstance is suitable for establishing distribution center of agricultural products.

1.3 The determination method of weight of evaluation index of site selection of distribution center of agricultural products In the process of evaluating alternative sites of distribution center of agricultural products, we should first determine the weight of each index. There are many researches on determination method of index weight, but the analytic hierarchy process method is used most. The analytic hierarchy process method[5] (analytic hierarchy process, AHP) was put forward by famous American operational research expert T. L. Satty in the 1970s, which is a systemized, hierarchical and multi-rule decision-making method, integrating qualitative analysis and quantitative analysis. It is the modeling and quantitative process of decision-maker's thinking of decision-making on complicated system. AHP method combines qualitative analysis and quantitative analysis, which can not only guarantee the systematicity and reasonability of model, but also make decision-makers fully use the valuable experience and judgment, in order to provide powerful decision-making support for many problems of rules and decisions. The main steps of determining weight of evaluation index concerning alternative site of distribution center of agricultural products by using AHP method can be seen in Fig. 1.

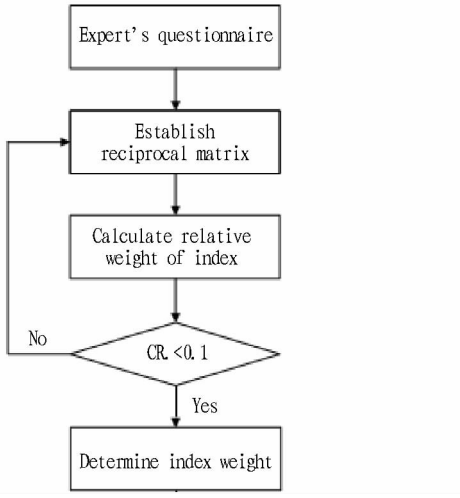

Fig. 1 Schema of calculation of weight of evaluation index concerning site selection of distribution center of agricultural products

1.4 Evaluation model Assuming that we conduct evaluation on alternative site of m distribution centers of agricultural products, select interval number as evaluation calibration, and invite relevant experts to conduct field survey and research on alternative site and offer evaluation on alternative site. Assuming that we denote the index value of the ith alternative site under the jth evaluation index as interval number r_{ij}, and $r_{ij}=[r_{ij}^{l}, r_{il}^{r}]$, so we can get that evaluation matrix of alternative site of distribution centers of agricultural products $R=(r_{ij})_{m\times 4}$.

Considering that the dimension of each index in evaluation index system is different, we should standardize evaluation information of alternative site of distribution centers of agricultural products and remove the dimension, and weight each line of data, so as to get comprehensive evaluation model of site of the ith distribution center of agricultural products:

$$z_i = \sum_{j=1}^{4} w_j r_{ij}$$

In the form, w_j is the weight of the jth index; r_{ij} is the evaluation value of the alternative site of the ith distribution center of agricultural products under the jth evaluation index; z_i is the comprehensive evaluation value of the ith alternative site.

As r_{ij} is interval number, so z_i, the comprehensive evaluation value of the ith alternative site, is also one interval number. We cannot see the size of interval numbers directly, so we can use *C – OWA* arithmetic operator to collect interval numbers,

so as to realize the size comparison of interval numbers.

2 Example analysis

One city wants to establish one distribution center of agricultural products, and finally determines five regions of A_1, A_2, A_3, A_4, A_5 as alternative sites. It invites experts to use interval number calibration to conduct evaluation on five alternative sites, and uses reciprocal matrix R to determine weight of evaluation index. In order to unify dimension, the evaluation value after we standardize information offered by experts can be seen in Table 1.

Table 1 The standardized value of evaluation information of distribution centers of agricultural products

Alternative site	Transportation factor	Other factors	Economic factor	Environment factor
Alternative site A_1	[0.82, 0.88]	[0.62, 0.70]	[0.31, 0.37]	[0.66, 0.72]
Alternative site A_2	[0.81, 0.85]	[0.47, 0.51]	[0.68, 0.733]	[0.81, 0.85]
Alternative site A_3	[0.11, 0.21]	[0.91, 0.95]	[0.67, 0.74]	[0.56, 0.61]
Alternative site A_4	[0.42, 0.48]	[0.86, 0.91]	[0.54, 0.60]	[0.34, 0.37]
Alternative site A_5	[0.82, 0.86]	[0.53, 0.59]	[0.82, 0.89]	[0.52, 0.59]

Meanwhile, the experts finally conduct comparison of importance degree of transport factor, other factors, economic factor and environment factor of evaluation index, and get the following reciprocal judgment matrix:

$$R=\begin{bmatrix} 1 & 3 & 2 & 1 \\ 1/3 & 1 & 1/2 & 1/3 \\ 1/2 & 2 & 1 & 2 \\ 1 & 3 & 1/2 & 1 \end{bmatrix}$$

As for the reciprocal judgment matrix R, we use characteristic value method to determine the weight vector of transport factor, other factors, economic factor and environment factor as follows:

$w=(0.335\ 7,\ 0.107\ 4,\ 0.281\ 6,\ 0.255\ 3)$.

We weight alternative site A_1 and calculate the comprehensive evaluation value of alternative site A_1 as follows:

$z_1=[0.820.88]\times 0.355\ 7+[0.620.70]\times 0.107\ 4+[0.310.37]\times 0.281\ 6+[0.660.72]\times 0.255\ 3=[0.614\ 1,\ 0.676\ 2]$

Likewise, we can calculate the comprehensive value of alternative sites from A_2 to A_5 as follows:

$z_2=[0.736\ 9\quad 0.780\ 5]$, $z_3=[0.468\ 5\quad 0.540\ 8]$,

$z_4=[0.480\ 6\quad 0.531\ 9]$, $z_5=[0.712\ 3\quad 0.770\ 5]$ We select $\rho(y)=y^3$, and use $(C-OWA)$ arithmetic operator to collect the comprehensive evaluation value so as to get the comprehensive value after collection as follows:

$\tilde{z}_1=0.629\ 6$, $\tilde{z}_2=0.747\ 8$, $\tilde{z}_3=0.486\ 6$, $\tilde{z}_4=0.493\ 4$, $\tilde{z}_5=0.726\ 9$

By comparing the comprehensive evaluation value of five alternative sites after collection, we can find that the sequence of five alternative sites of distribution center of agricultural products is as follows:

$A_2>A_5>A_1>A_4>A_3$

From above we know that in the five alternative sites, the alternative site of distribution center agricultural products A_2 is optimal, so we should establish distribution enter of agricultural products in alternative site of distribution center agricultural products A_2. By comparison, we can also see that in the alternative site of distribution center agricultural products A_2 the evaluation of other factors is relatively low, but the evaluation of other three indices is relatively high, so it is reasonable to establish distribution center agricultural products in the alternative site of distribution center agricultural products A_2.

3 Conclusion

China is a large agricultural country. As the times develop and people's living standards are gradually improved, in order to improve the living standards of farmers, issue concerning agriculture, countryside and farmers is always one problem the state lays stress on. The Twelfth Five-Year Plan re-emphasizes the importance of issues concerning agriculture, countryside and farmers. With the establishment and development of farms and wholesale markets of agricultural products, selling the agricultural products rapidly is the effective guarantee in promoting farmers' income.

In the whole process of logistics distribution of agricultural products, site selection of distribution center is a key link. In the process of considering evaluation of site selection of distribution center of agricultural products, on the basis of ambiguity of evaluation experts' individual consciousness, lots of uncertainties and other factors, the thesis proposes that we can use interval number as evaluation calibration, and offers evaluation method of logistics distribution center which can conduct effective treatment, but full of uncertain information, under the premise of comparing and judging matrix to determine weight of evaluation index. The method fully considers the randomness and uncertainty in the process of evaluation, which can make the results of evaluation more objective, in line with reality. So the effect of evaluation is better as against the former real number evaluation calibration.

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