Performance Appraisal Method of Logistic Distribution for Fresh Agricultural Products

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Abstract Through the initial selection, screening and simplification, a set of performance appraisal system of logistic distribution suited to fresh agricultural products is established. In the process of establishing the appraisal indicator, the representative appraisal indicator of logistic distribution of fresh agricultural products is further obtained by delivering experts' survey and applying the ABC screening system. The distribution costs, transportation and service level belong to the first level indicator; packing fees, distribution processing fees, full-load ratio, haulage capacity, customer satisfaction and the strain capability of delivery personnel belong to second level indicator. At the same time, the weighing of each indicator is determined. The quantification is conducted on indicators. The qualitative indicators applies ten-point system and then coverts these indicators into percentage, that is the number between [0,1]; as for the quantitative indicators, they are concluded to the interval [0,1] according to the actual value range of the indicators and by applying the grade of membership in the vague mathematics. Through the analyses of the advantages and disadvantages of the frequently used performance evaluation method and its applicable conditions, the comprehensive evaluation of logistic distribution of agricultural products obtained by using the method of fuzzy comprehensive appraisal. The results show that, in terms of reducing distribution costs, the packaging and distribution processing technology of fresh agricultural products should be improved, so as to reduce distribution costs. In the process of introducing the application of advanced technology, the high automatic logistic equipments should be introduced.

Key words Logistic distribution of fresh agricultural products, Logistic distribution, Performance appraisal, Appraisal indicators, Fuzzy comprehensive appraisal, China

Since the middle 1990s, logistics in China have developed rapidly, but most of them were still limited in the fields of industrial products, rare of them have interfered in the fresh agricultural products[1]. At present, among the research results of domestic logistic theories, many of them emphasize on the process and functions of logistics but rare on performance appraisal of logistics. The determination of the performance appraisal indicators of logistic distribution of agricultural products can mirror the performance appraisal indicators of modern logistics enterprises. Generally speaking, the wider the indication range, the more the quantity of the indicators is, the variation among the cases will be more obvious and it will be more beneficial to judge and to evaluate; however, the indicator categories and indicator weighing will be harder to determine and the process of handling and establishing model will be more complicated, therefore, the possibility of distorting the appraisal method will be bigger[2]. Hence, the appraisal system should not only comprehensively reflect the specific demands on appraisal subjects and try to achieve scientific, reasonable and valid evaluation as far as possible, but also need to have the measurable, simple and comparable characteristics and the aggregate indicators should be as less as possible. Through the initial selection, screening and simplification of indicators, I establish a set of appraisal system and conduct quantification on these indicators, and then a set of performance appraisal system of logistic distribution for fresh agricultural products, which aims at providing references for the performance appraisal of logistics distribution of fresh agricultural products are worked out.

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1 The establishment of appraisal system

1.1 The initial selection of indicators In the performance appraisal of logistics distribution, the primary problem needed solving is how to select appraisal indicator in view of the distribution process of logistics distribution center of agricultural products and by mirroring the transportation model of agricultural products. Besides, the characteristics of large amount, various types, hard to load and unload and easy to become rotten should be taken into consideration when selecting the indicators. Combining with the contents reflected by the selected indicators, cost indicator and transportation indicator are selected as two important indicators[3]. In addition, as for the distribution system, internal operation and service level are two important factors which affected the operational efficiency of distribution system, so the internal operation and service grade are selected as the reference indicator and they belong to first level indicator and second grade indicator respectively. The first grade indicator includes four indicators: distribution costs, transportation, service grade and internal operation. The first grade indicator is followed by the second grade indicator. The distribution indicator includes eight second grade indicators: sorting fees, distributing fees, packaging fees, processing fees, transportation fees, inventory turnover ratio, loading and unloading fees and equipment depreciation rate; transportation indicator includes nine second grade indicators: the total number of cars, full-load ratio, carrying capacity, security of distribution, rate of timely delivery, accuracy of delivery, uniformity

of distribution and delivery, flexibility of distribution and delivery and breakage rate in the way; service level includes six second grade indicators: consumers' satisfactory degree, flexibility of the delivery personnel, competence of the driver, processing ratio of customers' problems , the quality of the personnel involved and information requirement of users. Internal operation includes seven second grade indicators: time used for processing orders; use ratio of staff; use rate of equipment; level of information technology application; survival rate in the inventory; accuracy of documentation transmission and fulfillment rate of orders.

1.2 The selection and simplification of indicators The above mentioned appraisal system is an AHP hierarchical analysis model with large scale and heavy task. So a simple and effective AHP decision-making computing method——ABC screening procedure is introduced. By using the ABC screening method, the AHP evaluation with large scale and computing process can be simplified.

In order to obtain the simplified model, the indicators selected in "**1.1**" section and the ABC selection method should be used; the indicators of the same level should be shifted to survey form by applying expert grading method, judged by experts and then the weight should be worked out excluding the factors of B type and C type.

The first level of the appraisal indicators uses the ABC method. By conducting the questionnaires on 10 experts, the average level of weight can be obtained. The following Table 1 takes one of the experts' survey results as an example and calculates the weight of the superior performance indicators.

Table 1 The matrix and weighing of the most superior performance indicators

The superior performance	Distribution and delivery costs	Transport indicators	Service level	Internal operation	Weighing ω
Distribution and delivery costs	1	1/2	3	5	0.324 8
Transport indicators	2	1	3	5	0.459 4
Service level	1/3	1/3	1	3	0.149 1
Internal operation	1/5	1/5	1/3	1	0.066 7

It can be obtained by using AHP software that: $CI=0.035\ 1$; $CR=0.039\ 0$; $\omega = (0.324\ 8, 0.459\ 4, 0.149\ 1, 0.066\ 7)$.

$CI<0.1$, $CR<0.1$, which indicates that the experts' judgments have consistency and the survey is effective. After analyzing the survey forms of the other nine experts, the average weighing of each indicator can be obtained in the end. $\bar{\omega} = (0.329\ 2, 0.451\ 3, 0.154\ 2, 0.065\ 3)$.

According to the data, the Pareto effective distribution figure of the superior performance can be obtained(Fig.1).

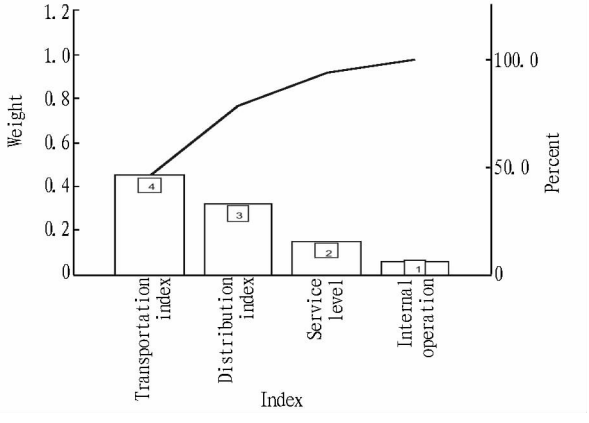

Fig.1 The Pareto effective distribution of the most superior performance

It can be seen from Fig.1 that, the internal operation indicator (A_4) which affects the distribution performance is the C type indicator, that is to say, it is the non-major factors, so this type of indicator and its second level indicators will not be analyzed temporarily. At the same time, normalization should be conducted on A_1, A_2, A_3. After the normalization the weighing $\omega' = (0.352\ 3, 0.482\ 8, 0.164\ 9)$.

In a similar theory, conducting the same processing method on the second level indicators of the appraisal indicators, the final selected indicators can be obtained, which can be seen on Table 2.

2 Quantification of indicators

Generally speaking, as for the maxim indicators, the large the value, the better they are, for example, the timely rate of transportation, accuracy of distribution and so on; as for the minimum indicators, the minimum the value, the better they are, for example, the costs indicators, breakage rate in the way and so on.

Due to the different units, the appraisal results can not reflect the real situation in the process of analyzing. So in order to avoid the mistakes, each indicator should be standardized and normalized to make indicators being dimensionless. The method uses a certain mathematic manipulation to eliminate the influence of target dimension, that is to say, changing the indicators with different features and dimensions into a relative number——quantized value. According to the nature of appraisal indicators, indicators can be divided into qualitative indicators and quantitative indicators.

Dimensionless of indicators in the research is mainly for quantitative indicators, but as for the qualitative indicators, the ten-point system is applied, then the indicators are coverted into percentage, the numbers are among [0,1]; as for the quantitative indicators, the indicator data are normalized to the interval of [0,1] by applying the grade of membership theory in vogue mathematics according to the actual value range of indicators. Thus wise, the accuracy of the change can be improved and the rules among the original indicators can be presented, at the same time, the influence of individual abnormal data on the overall evaluation can be avoided as well[4].

Table 2 The simplified system of the most superior evaluating indicator

Targets	First level indicator	Weighing	Second level indicators	Weighing
The most superior performance (A)	Distribution and delivery costs (A_1)	$\omega_1=0.352\ 3$	Packing fees(A_{13})	$\omega_{13}=0.154\ 7$
			Processing fee (A_{14})	$\omega_{14}=0.258\ 8$
			Transportation fee (A_{15})	$\omega_{15}=0.373\ 7$
			Inventory turnover ratio (A_{16})	$\omega_{16}=0.212\ 8$
	transportation (A_2)	$\omega_2=0.482\ 8$	Full-load ratio (A_{22})	$\omega_{22}=0.096\ 4$
			Haulage capacity (A_{23})	$\omega_{23}=0.222\ 9$
			Timely delivery rate (A_{25})	$\omega_{25}=0.210\ 2$
			Accuracy of delivery (A_{26})	$\omega_{26}=0.210\ 2$
			Breakage rate in the way (A_{29})	$\omega_{29}=0.260\ 3$
	Service level (A_3)	$\omega_3=0.164\ 9$	Customers' satisfactory degree (A_{31})	$\omega_{31}=0.458\ 6$
			Flexibility of distribution personnel (A_{32})	$\omega_{31}=0.117\ 5$
			Customer requirement information (A_{36})	$\omega_{36}=0.180\ 4$
			Handling rate of consumers' problems (A_{34})	$\omega_{34}=0.243\ 5$

3 The method of performance appraisal

After analyzing the advantages, disadvantages and the complementarities of existing appraisal methods, I apply the weighing obtained by using the ABC method as the indicator weighing and appraise them comprehensively by using vogue mathematics theory. Fuzzy comprehensive evaluation system is used for the single-layer and multi-layers evaluation based on the problems caused by the fuzzy transformation theory on multi factors, it is the beneficial quantitative analysis tool used for solving the fuzzy problems[5-6].

Through selecting about 20 experts, who have participated in the distribution and delivery process by themselves, sending E-mails to consult them, appraising the above mentioned data, the relevant single-factor appraisal matrix can be obtained:

$$R_1=\begin{pmatrix}0.1&0.4&0.4&0.1\\0.1&0.4&0.3&0.2\\0.2&0.4&0.2&0.2\\0.4&0.2&0.2&0.2\end{pmatrix}$$

$$R_2=\begin{pmatrix}0.3&0.4&0.2&0.1\\0.2&0.4&0.3&0.1\\0.3&0.5&0.1&0.1\\0.3&0.5&0.1&0.1\\0.2&0.3&0.3&0.2\end{pmatrix}$$

$$R_3=\begin{pmatrix}0.4&0.3&0.2&0.1\\0.1&0.3&0.3&0.3\\0.5&0.2&0.2&0.1\\0.1&0.2&0.4&0.3\end{pmatrix}$$

After that, the calculation can be conducted according to the fuzzy comprehensive appraisal, the process is as follows:

$$B_1=A_1\cdot R_1=(0.154\ 7,0.258\ 8,0.373\ 7,0.212\ 8)\cdot\begin{pmatrix}0.1&0.4&0.4&0.1\\0.1&0.4&0.3&0.2\\0.2&0.4&0.2&0.2\\0.4&0.2&0.2&0.2\end{pmatrix}=(0.20,0.36,0.26,0.18)$$

$$B_2=A_2\cdot R_2=(0.096\ 4,0.222\ 9,0.210\ 2,0.210\ 2,0.260\ 3)\cdot\begin{pmatrix}0.3&0.4&0.2&0.1\\0.2&0.4&0.3&0.1\\0.3&0.5&0.1&0.1\\0.3&0.5&0.1&0.1\\0.2&0.3&0.3&0.2\end{pmatrix}=(0.25,0.42,0.20,0.13)$$

$$B_3=A_3\cdot R_3=(0.458\ 6,0.117\ 5,0.180\ 4,0.243\ 5)\cdot\begin{pmatrix}0.4&0.3&0.2&0.1\\0.1&0.3&0.3&0.3\\0.5&0.2&0.2&0.1\\0.1&0.2&0.4&0.3\end{pmatrix}=(0.33,0.25,0.26,0.16)$$

$$B=A\cdot R=(0.352\ 3,0.482\ 8,0.164\ 9)\cdot\begin{pmatrix}0.20&0.36&0.26&0.18\\0.25&0.42&0.20&0.13\\0.33&0.25&0.26&0.16\end{pmatrix}=(0.24,0.38,0.23,0.15)$$

4 Conclusion

It can be seen from the results of fuzzy comprehensive appraisal that the overall operational performance of the logistic distribution center is above the average. In the appraisal grade, the grade of excellent and good accounts for 62%. In the three first level indicators, the appraisal result of service level indicator is relatively good and the appraisal grade is excellent. But the appraisal of distribution costs and transportation indicator is good, among them the general and poor appraisal of distribution costs indicators of the degree of membership account for 44%. Therefore, in terms of reducing costs, the packaging and processing technology of fresh agricultural products should be improved. In terms of improving the technology application, the logistic equipments with high automatic degree should be introduced into.

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