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Service Capability Evaluation of Third Party Logistics Enterprise in A Cluster Environment

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Abstract: As third-party logistics enterprises play an important role in the development of the cluster enterprises and become a new growth source of the regional economy, it is important to study the service capability of the third-party logistics enterprises. To this end, firstly, in the cluster environment, the evaluation index system of third-party logistics enterprise service capability are constructed, which includes basic service capability, information service capability, flexible service capability and value-added service capability. Secondly, the evaluation model of third-party logistics enterprise service capability is established based on the entropy weight Topsis method. Finally, an example is used to illustrate the application of the evaluation index and evaluation algorithm, which shows that the proposed evaluation system and evaluation algorithm can improve the service capabilities of logistics enterprises and lower the cluster logistics cost. And it is of great significance for the logistics enterprises and the cluster to develop logistics service capacity.

Key words: Service capability, third-party logistics enterprise, cluster environment, entropy weight method, topsis method

INTRODUCTION

As economic globalization and the increasingly shortage of resources, third-party logistics providing services for cluster enterprises is becoming a new regional economic source, which can break through the geographical boundary, expand the radius of cluster enterprise market and support cluster enterprises in global manufacturing networks. Third-party logistics enterprises make cluster enterprises concentrate their core business, reduce logistics cost, improve customer satisfaction and reshape cost advantage. Thus, third-party logistics plays a very important role in the cluster and its corresponding service capacity greatly influences the cluster market competitiveness. What reflects logistics service ability? And what logistics enterprises should make improvements on? How do enterprises in the cluster environment choose logistics service providers? These questions ultimately boil down to the third party logistics enterprise service capability evaluation. So the evaluation on the third party logistics enterprise service capability in cluster environment has important practical significance.

There are many researches about the logistics service capability at home and abroad. So far, researches on logistics enterprise service have focused on: The study of logistics service concepts (Liu *et al*., 2013; Murphy and Poist, 2000; Li and Zhao, 2010), logistics capability construction (Ma and Chen, 2007; Liu and Xie, 2013), logistics capability assessment (Ding, 2012; Du and He, 2007; Huang and Wang, 2012) and so on (Huang *et al*., 2010; Tan and Ibrahim, 2010). Among those various studies, the evaluation methods of logistics service capabilities include expert evaluation method, customer questionnaire method, analytic hierarchy process, factor analysis and fuzzy comprehensive evaluation method (Huang and Wang, 2012) and so on. For example, Huang and Wang (2012) proposed the comprehensive evaluation of fuzzy matter-element combined with entropy method to determine the weight of the object and calculate the close-degree of each object. Du and He (2007) evaluated logistics service capability by hybrid genetic algorithm. Though the evaluation method can evaluate logistics services capability in a certain extent, the method or calculation is complicated. Or it has a great deal of subjectivity to determine the weight values and lack of scientific quantitative analysis.

Based on the entropy weight method and Topsis method, this paper proposed the logistics service index system of the third party logistics enterprise in the cluster environment and established a service capacity evaluation model. Using the entropy weight method, the weight of different index is determined, at the same time the key factors which affected the development of logistics service ability are detected, so as to promote the coordinating development of cluster enterprises and logistics enterprises.

EVALUATION INDEX SYSTEM

For logistics enterprises, logistics service capability is a kind of intangible assets uneasy to directly observe. All logistics activities in clusters are around the manufacturers and customers and they form the supply logistics, production logistics and distribution logistics. In a manufacturing cluster, the third-party logistics enterprise mainly provides supply logistics and production logistics, that is, namely providing accurate quantity and quality of materials timely for the cluster enterprises. Thus, the third party logistics enterprise service capacity in the cluster environment is evaluated from four aspects including basic service capacity, information service capacity, flexible services capacity, value-added services capacity, as shown in Fig. 1.

Basic service capability: Basic service ability refers to the third party logistics enterprise utilizing logistics facilities, equipment and staff skills to complete the basic logistics services. Indicators of the basic service capacity are as follows:

- **Raw material supply timely rate:** This indicator refers to the timely supply rate of raw materials according to the requirement of the cluster enterprises. The indicator can be measured by the ratio of the timely raw materials supply to the total supply
- **Raw material supply accuracy:** The indicator refers to whether the raw materials are accurately provided according to the requirement of the cluster enterprise. The indicator can be measured by the ratio of accurate raw materials supply to the total supply
- **Product wasting rate:** The indicator refers to the degree of loss in the process of product delivery, which mainly shows whether the transportation mode and carrier is reliable. The indicator can be measured by the ratio of the damaged products

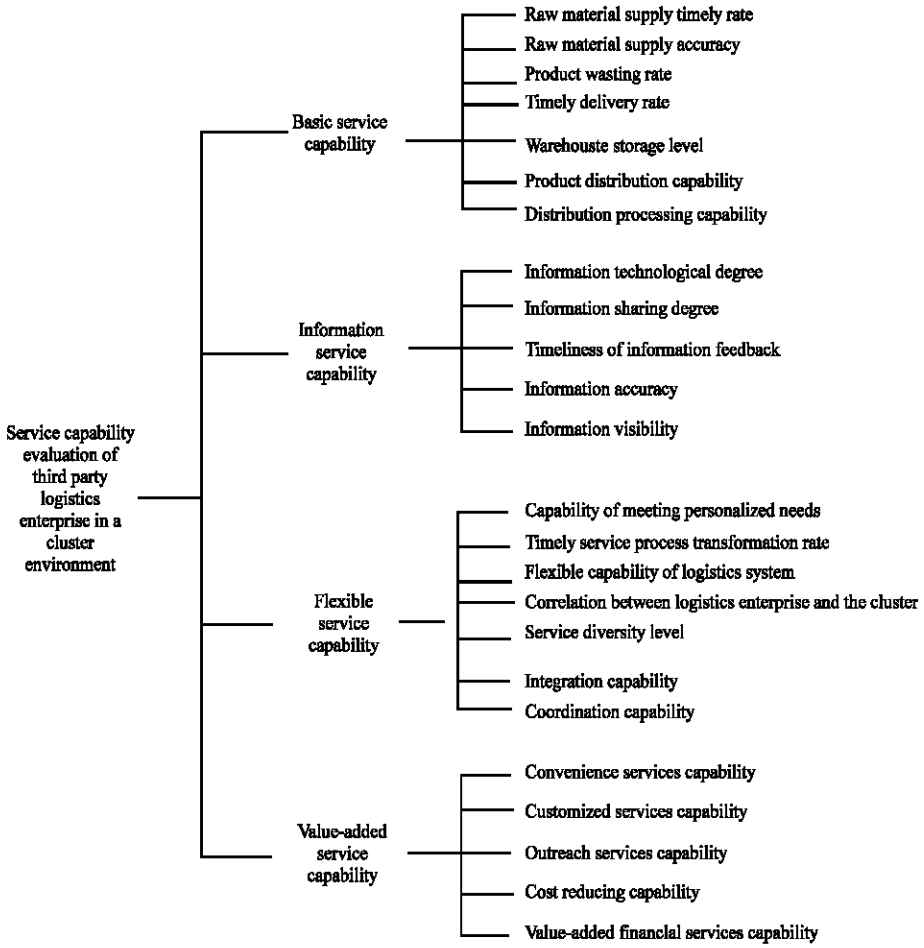

Fig. 1: Service capability evaluation index system

- **Timely delivery rate:** The indicator refers to degree of delivering product on time by the third party logistics enterprise. The indicator can be measured by the ratio of the timely delivery to the total delivery
- **Warehouse storage level:** The indicator can be measured through three sub-indicators including the warehouse storage modernization, automation and standardization degree
- **Product distribution capability:** Distribution capability can be measured by the responding speed of the distribution. The indicator can be measured by the ratio of the customer demand solving time to the whole time from the customer requirements to complete. The ratio is as small as possible.
- **Distribution processing capability:** The indicator can be measured by the ratio of the product differentiation, commodity inspection, labeling

Information service capacity: In the cluster environment, logistics management can not live without timely information including order quantity, inventory quantity, variety, quality, specifications and transport optimization. Information service can promote the integration of logistics, improve logistics performance and reduce the logistics cost. It can be measured through the following indicators:

- **Information technological degree:** The indicator can be measured by the usage of bar code technology, network technology, identification technology, advanced logistics technology by third-party logistics enterprises
- **Information sharing degree:** It mainly refers to information sharing status in various departments of enterprises or in the supply chain. Sharing information helps to monitor production in logistics and production enterprises in the cluster, thus to reduce logistics time and improve the demand and supply accuracy. The indicator can be measured through the ratio of the timely information access to total information
- **Timeliness of information feedback:** It refers to the duration process from the customer's demand information, until the solution and feedback of the information. The shorter the time is, the stronger the information timeliness, the greater the value to the customer and the faster the third party logistics response to the market. The indicator can be measured by the ratio of timely feedback to total feedback information
- **Information accuracy:** It mainly refers to the logistics information platform can be effective in time, handle relevant information, accurately transferred to the participation body and complete all kinds of operations and transactions. The indicator can be measured by the ratio of accurate deliver information and total number of information within a certain period of time
- **Information visibility:** It refers to whether the relevant information of the goods can be inquired, browsed, tracked timely by enterprise and customers. The indicator can be measured by cargo information level of visibility

Flexible service capability: Flexible service capacity refers to the capacity of meeting cluster enterprise's changing needs effectively when facing with the rapid change of the external environment, multiple clusters enterprises and integration of enterprise resources. It can be measured through the following indicators:

- **Capability of meeting personalized needs:** The indicator can be measured by the ratio of the personalized service to total service in certain period of time. The higher rate of individual needs to be satisfied, the higher flexible level is
- **Timely service process transformation rate:** The indicators can be measured by the ratio of the service process adjustment to total service in a certain period of time. The more timely the process changes, the higher flexible level is
- **Flexible capability of logistics system:** The indicator can be measured through whether the logistics system can utilize resources effectively, cope with changes and keep system performance
- **Correlation between logistics enterprise and the cluster:** The indicators can be measured by the correlation level of the third party logistics specialization. Cluster logistics system and logistics enterprises must be highly correlated with the leading industries of the cluster
- **Service diversity level:** As various transverse or longitudinal associations of enterprises in clusters belong to different industries, function requirement and service quality on transportation, warehousing, distribution are different. The indicator can be measured by the degree of multi-level, diversification and decentralization
- **Integration capability:** This indicator can be measured by the integration capacity of a variety of logistics resources, knowledge, technology, skills and processes and control by logistics enterprises
- **Coordination capability:** In a cluster environment, facing with changes and fluctuations in demand, the

third party logistics enterprise need to have the capacity of high coordination and effectively usage of resources. And it has to adjust resources combination according to the environment changes, resolve incidents timely and maintain enterprise competitive advantage. The indicator can be measured by the ratio of emergencies in a certain period of time

Value-added service capability: Value-added service capability refers to the capability of providing the customers with special services according to the specific requirement of cluster enterprises, such as custom service and outreach services. It can be measured through the following indicators:

- **Convenience services capability:** The indicator can be measured by the capacity of extending functions and providing more complete or comprehensive logistics services for the cluster enterprises. For example, providing free training, agency business and operation tips can simplify procedures or logistics services operations for cluster enterprises so as to increase the convenience of cluster enterprises
- **Customized service capability:** The indicator can be measured by the usage of owned and controlled logistic resources to meet the personalized requirements of cluster enterprises
- **Outreach services capability:** The indicator can be measured by the capability of market research, forecasting, purchasing, logistics consulting, logistics systems design etc
- **Cost reducing capability:** The indicator can be measured by the capability of common technology taken by third party logistics enterprise
- **Value-added financial services capability:** The indicator can be measured by the capability of third party logistics enterprise solving the loan money for cluster enterprises.

EVALUATION MODEL AND ALGORITHM

Evaluation model: Suppose SR = $\{\theta_1, \theta_2,..., \theta_m\}$ is a set of evaluation objects m. And θ_1 is the ith third-party logistics enterprise. Suppose evaluation index set is R = $\{t_1, t_2,..., t_n\}$ and t_n is the jth evaluation index ($1 \le j \le n$). Indicators matrix is $A_1 = (x_{ij})$ and x_{ij} is the jth index of the ith third party logistics enterprise. Then by the entropy weight method, the index weight can be determined, the comprehensive evaluation can be made based on Topsis method.

Index weight determination: As there are both quantitative indicators and qualitative indicators, the basic principle of information theory is utilized to determine the weight of evaluation indexes. From the viewpoint of information theory, entropy is a measurement of disorder. The smaller the information entropy, the greater the amount of information provided by the indicators in the comprehensive evaluation and the greater the weight is. Thus the entropy can be used as attribute weights. And the greater the entropy weight, the greater the corresponding to the indicator is:

- **Multiple attribute decision matrix:** $A_1 = (x_{ij})_{max}$ (i = 1, 2,..., m; j = 1, 2,..., m), m is the evaluation scheme and n is the indexes. x_{ij} is the jth index of the ith third party logistics enterprise:

$$A_1 = \begin{pmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{pmatrix} \quad (1)$$

- **Data standardization:** As each index has different dimension, they cannot be directly compared, thus, data must be processed with dimensionless and standardization as follows:

$$P_{ij} = X_{ij} / \sum_{i=1}^{m} x_{ij} \quad (j = 1, 2, \cdots, n) \quad (2)$$

where, P_{ij} is the contribution of ith scheme under the jth indicators.

- **Entropy of each index:**

$$E_j = -k \sum_{i=1}^{m} p_{ij} \ln p_{ij} \quad (i = 1, 2, \cdots, m; j = 1, 2, \cdots, n) \quad (3)$$

where, k is an constant associated with m, $k = (\ln m)^{-1}$, $0 \le e_j \le 1$. The information deviation degree d_j is as follows:

$$d_j = 1 - E_j \quad (4)$$

- **Entry weight of indexes:** Entropy weight of evaluation indexes can be obtained as follows:

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \quad (j = 1, 2, \cdots, n) \quad (5)$$

TOPSIS evaluation algorithm: TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is an effective multi-objective decision method. TOPSIS method

can evaluate a finite number of objects by ideal solution and negative ideal solution, which is clear, intuitive and removes the influence of different index dimension. Specific steps of TOPSIS method are as follows:

- Weighted normalized matrix:

$$R = \begin{pmatrix} a_{11}w_1 & \cdots & a_{1n}w_n \\ \vdots & \ddots & \vdots \\ a_{m1}w_1 & \cdots & a_{mn}w_n \end{pmatrix} = \begin{pmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{pmatrix} \quad (6)$$

Determine the ideal solution and negative ideal solution:

$$r^+ = \begin{cases} \min r_{ij} & \text{indicators whose low value are better} \\ \max r_{ij} & \text{indicators whose high value are better} \end{cases}$$

$$r^- = \begin{cases} \max r_{ij} & \text{indicators whose low value are better} \\ \min r_{ij} & \text{indicators whose high value are better} \end{cases} \quad (7)$$

Calculate the distance between the evaluation objects and the ideal solution r_J^+ and negative ideal solution r_J^- and labeled by d_I^+ and d_i^-, respectively:

$$d_i^+ = \sqrt{\sum_{j=1}^{n}\left(r_{ij} - r_j^+\right)^2}$$
$$d_i^- = \sqrt{\sum_{j=1}^{n}\left(r_{ij} - r_j^-\right)^2} \quad (i = 1, 2, \cdots, m) \quad (8)$$

- Calculate indicators evaluation vector of close degree:

$$c_i = \frac{d_i^-}{\left(d_i^+ + d_i^-\right)} (i = 1, 2, \cdots, m) \quad (9)$$

Sort it according to the size of c_i. The bigger the values c_i is, the more optimal the method is.

EXAMPLE

A manufacturing industry cluster is taken as an example to show the application of the evaluation method. Here, three third-party logistics enterprises (labeled as: A, B, C) are investigated to obtain the relevant quantitative data. The qualitative indicators of the third party logistics enterprises are assessed by domain experts, with a 10-point scale in each indicator. Resulting data is shown in Table 1:

Data is standardized according to Eq. 2. According to Eq. 3-5, the weight of each indicator is calculated:

w = (0.0133, 0.0086, 0.2411,0.0052, 0.0825, 0.0243, 0.0163, 0.0205, 0.0209, 0.0115,0.1334, 0.0074, 0.0642, 0.0058, 0.0127, 0.0117, 0.0300, 0.0472, 0.0290, 0.0159, 0.1270, 0.0479, 0.0126, 0.0109)

According to Eq. 6-7, weighted normalized matrix and determined ideal solution and negative ideal solution can be obtained. Basic service

Table 1: Index data of the third party logistics enterprise

Indicators	A	B	C
Raw material supply timely rate (%)	80.000	90.00	85.000
Raw material supply accuracy (%)	95.000	87.00	91.000
Product wasting rate (%)	00.009	00.01	0.015
Timely delivery rate (%)	86.000	91.00	88.000
Warehouse storage level	05.600	06.50	04.700
Product distribution capability (%)	80.000	70.00	82.000
Distribution processing capability	78.000	89.00	85.000
Information technological degree	06.700	07.80	07.200
Information sharing degree (%)	85.000	91.00	78.000
Timeliness of information feedback (%)	78.000	79.00	86.000
Information accuracy (%)	79.000	91.00	60.000
Information visibility	08.000	08.50	07.900
Capability of meeting personalized needs	67.000	80.00	89.000
Timely service process transformation rate (%)	76.000	81.00	79.000
Flexible capability of logistics system	07.8.0	08.50	08.700
Correlation between logistics enterprise and the cluster	08.000	08.90	08.600
Service diversity level	07.7.0	09.30	08.600
Integration capability	06.7.0	06.90	05.500
Coordination capability (%)	66.000	70.00	79.000
Convenience services capability	07.5.0	08.30	08.500
Customized service capability	05.000	06.20	07.500
Outreach services capability	07.100	08.70	08.900
Cost reducing capability	08.800	08.10	07.900
Value-added financial services capability	06.900	07.60	07.500

capability is taken as an example, whose positive ideal solution and negative ideal solution are as follows:

$$r^+ = (0.0047, 0.0030, 0.0638, 0.0018, 0.0319, 0.0073, 0.0057)$$

$$r^- = (0.0042, 0.0027, 0.1064, 0.0017, 0.0231, 0.0086, 0.0050)$$

According to Eq. 8, the distance between three logistics enterprises and the ideal solution, negative ideal solution are respectively calculate as follows:

$$d_1^+ = 0.0204,\ d_2^+ = 0.0117,\ d_3^+ = 0.0472,$$
$$d_1^- = 0.0443,\ d_2^- = 0.0421,\ d_3^- = 0.0185$$

According to Eq. 9, the relative close degree of logistics enterprises and the ideal solution is determined:

$$c_1 = 0.6849,\ c_2 = 0.7829,\ c_3 = 0.2815$$

According to logistics enterprise service capability evaluation in this case, the following conclusions can be obtained:

- According to calculation results of the weight, in the evaluation indicators of the third party logistics enterprise service capability in cluster environment, the weight of four indicators are larger, that is, Product wasting rate, Information accuracy, Customized service capability, warehouse storage modernization level. They are, respectively 0.2411, 0.1334, 0.1270, 0.0825, which play key roles in the comprehensive evaluation. Thus, it is important for the third party logistics enterprises to improve the service capability in these aspects
- From the comprehensive evaluation result, the logistics service capability of B is best, followed by A and C is poor. As to A and C, these two logistics enterprise can make improvement taking B as a benchmark, to improve their logistics services capability. At the same time, B should continuously reduce logistics cost based on the original characteristics of manufacturing enterprises in the cluster to provide better service for the cluster enterprises and to enhance the competitiveness of clusters. In the meantime, the manufacturing enterprises in the cluster can choose the appropriate third-party logistics enterprise to provide logistics services so as to improve their core competitiveness

CONCLUSION

This study proposed a set of service capability evaluation index system of third-party logistics enterprises in the cluster and realizes the enterprise logistics service level evaluation. The evaluation index system is constructed from four aspects: the basic service capability, information service capability, flexible service capability, value-added service capability. Then the index weight is calculated by entropy method and the third party logistics enterprise service capability in cluster environment is quantitatively evaluated using Topsis method. The results show that the entropy weight method can be utilized to determine the index weight and to obtain the key factors. The third party logistics enterprises can make improvements to improve the service capability. The cluster can achieve sustainable growth for the production and marketing environment, enhance the cluster brand value and increase the cluster resource utilization rate as well as turnover rate. This study can also provide reference for different types of industrial cluster to construct different evaluation index system and their evaluation model according to their own characteristics.

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