Research Journal of Applied Sciences, Engineering and Technology 5(11): 3140-3143, 2013
DOI:10.19026/rjaset.5.4548
ISSN: 2040-7459; e-ISSN: 2040-7467

Submitted: September 27, 2012 Accepted: November 08, 2012 Published: April 05, 2013

Research Article

Comprehensive Evaluation on Logistics Capability of the Supply Chain in Manufacturing Enterprise

Xianming Liu and Yazhou Xiong
School of Economics and Management, Hubei Polytechnic University, Huangshi 435003, China

Abstract: Through the analysis of logistics capability of the supply chain in manufacturing enterprise, this study has established an evaluation system of logistics capability of the supply chain from four aspects. Rough sets theory is used to attribute importance to determine weights of the subspace dimension indicators and the membership function in fuzzy theory is used to determine the indicators of the level of the matrix. Combined with the theory of entropy, integrated weight of logistics capability of the supply chain of the matrix can be determined and quantified indicators will be achieved as an evaluation criterion. Finally, the established system of indicators and improved evaluation method are integrated to analyze the logistics capabilities of the supply chain in manufacturing enterprise; the evaluation method proves to be valid.

Keywords: Evaluation, fuzzy entropy, logistics capability, rough sets

INTRODUCTION

Logistics capability of the supply chain is a complex indicator, which can fully reflect the satisfaction of individual needs and competitiveness between the suppliers and customers. In order to improve enterprise management and the comprehensive competitiveness of enterprise, it is essential to study the evaluation system of logistics capability of the supply chain. The aim of the Logistics of supply chain logistics capabilities is to minimize cost and maximize the value of customers. The service ability of a series of activities with the logistics activities is called supply chain logistics capabilities, which includes the activities from procurement, processing and finished of raw materials to the final product into the hands of customers.

At present, most of the scholars at home and abroad have focused on a particular aspect of supply chain logistics management to perform the research and analysis. Patricia *et al*. (1998) analyzed logistics capability of the supply chain from the customer's response speed, customer service level, delivery on time and delay or shortage of the advance notice; Sameer (2008) divided the supply-chain logistics capability into two parts, which include processing ability and the value-added capacity of, and studied the relationship between them and the logistics performance; Daugherty and Pittman (1995) emphasized that speed of product distribution, information exchange and flexibility have influence on the logistics capability in the process of supply chain management. Shang *et al*. (2009) established the logistics capability evaluation system in manufacturing enterprise, summarized the logistics capability as the ability to control the logistics cost, the ability of logistics service, the ability of logistics elements and the ability of organizational ability and use the fuzzy comprehensive evaluation method to evaluate the logistics capability of a practical manufacturing enterprise. Huang (2008) thought optimization and integration of the talent construction; logistics strategy matching and ability can greatly improve the logistics capability of supply chain of the enterprise.

Generally speaking, scholars abroad performed some empirical studies on supply chain logistics capabilities from product cost, delivery capacity and market impact and the supply chain logistics management research still lacks integrity. At the same time, domestic scholars have made many methods, which are used to establish evaluation index systems, such as grey relational evaluation, fuzzy comprehensive evaluation and Data Envelopment Analysis (DEA) evaluation system. However, these methods have certain deficiencies, which include the lack of the universal commonality, tedious calculation and strong subjectivity. This study tries to solve these shortcomings and establish logistics capability of supply chain evaluation system in manufacturing enterprise through model calculation of rough set and fuzzy entropy from four aspects, including supply logistics capability, production logistics capability, sales logistics capability and capability of organization and management.

Corresponding Author: Yazhou Xiong, School of Economics and Management, Hubei Polytechnic University, Huangshi 435003, China

TO ESTABLISH LOGISTICS CAPABILITY OF SUPPLY CHAIN EVALUATION SYSTEM IN MANUFACTURING ENTERPRIS

Supply logistics capability: When manufacturing enterprises appear to be an out-of-stock phenomenon, they must send order to suppliers. And the supplier can prepare material preparation that manufactures enterprises need in the shortest possible time and take delivery of the goods to the manufacturing enterprise. The activity ability in the above is called supply logistics capability. The three elements which are used to evaluate supply logistics include supply capability of the raw materials, accuracy of providing materials, as well as time reliability from the notice to delivery.

Production logistics capability: In the process of the supply chain management, a very important indicator used to evaluate logistics capability of supply chain is production logistics capability. Every aspect of operation coordination and operation ability directly affects the production logistics ability. Order processing capacity, material storage capacity as well as production equipment capacity is three important indexes, which are used to evaluate production logistics capability.

Sales logistics capability: Sales logistics capability is defined as the ability of how to deliver fast and completely the product to customers, which belongs to the distribution section in the manufacturing enterprises and it is also an important link which can embody the value of product. Freight distribution capacity, optimal selection capacity of transport path, delivery timeliness, service capacity of pre-sale and after-sale are made up of the evaluation indicators of sales logistics capability.

Capability of organization and management: People are the most important factor ability of organization and management, because people are the important participant in the entire logistics links, ability of people has a direct influence on the logistics capability in manufacturing enterprise. Evaluation indicator of the capability of organization and management includes three aspects: level of logistics technical personnel, operation skills of staff, the managers' level of the whole logistics activity.

Based on the above analyses on the logistics capability of the supply chain in manufacturing enterprise, an evaluation indicator system of supply chain logistics capabilities can be established from four aspects (Table 1).

Table 1: The evaluation indicator system of supply chain logistics capabilities

First-level indicators	Second-level indicators	No
Supply logistics capability (A_1)	Supply capability of the raw materials	B_1
	Accuracy of providing materials	B_2
	Time reliability from the notice to delivery	B_3
Production logistics capability(A_2)	Production equipment capacity	B_4
	Material storage capacity	B_5
	Order processing capacity	B_6
Sales logistics capability (A_3)	Freight distribution capacity	B_7
	Optimal selection capacity of the transport path	B_8
	Delivery timeliness	B_9
	Service capacity of pre-sale and after-sale	B_{10}
Capability of organization and management (A_4)	Level of managers	B_{11}
	Operation skills of staff	B_{12}
	Level of logistics technical personnel	B_{13}

TO DETERMINE THE WEIGHT COEFFICIENT OF SUBSPACE DIMENSION INDEX

Rough sets theory is a kind of mathematical tool, which is used to process the fuzzy and incomplete knowledge. After data collection of the required processing only needs to be provided, the method can analyze the uncertainty degree of knowledge (Yang *et al*., 2012). By the means of it, the weight coefficient of subspace dimension index can be obtained.

For a set S = (U, A, V, F), if the property subset α belongs to the set A, the importance of property subset α is:

$$S(a) = H(A - \{A\} - H(A) \quad (1)$$

When $S(a) = 0$, subset α is redundant; w Hen $S(a)$ $S(a) \succ 0$, subset a is essential to the set A. The bigger the value of $S(a)$ is, the more important the subset a is in the A.

Supposing the index set is $m = (m_1, m_2, m_3, \dots, m_n)$ $m = (n < s)$, according to the formula (1), the importance of each index can be calculated, which can be determined by grade standard. The number of 5, 4, 3, 2, 1 is used to represent respectively the higher, high, general, low, lower grade. Finally, each weight coefficient of subspace dimension index can be normalized by the formula (2).

$$W_i = \frac{S_m(m_i)}{\sum_{j=1}^{n} S_m(m_i)} \quad (2)$$

where,

m = 1, 2, 3, 4
n = Each indicator number of subspace dimension
S = The importance of the property subse.

TO DESIGN EVALUATION SYSTEM OF SUPPLY CHAIN LOGISTICS ABILITY BASED ON THE FUZZY ENTROPY MODEL

To determine the evaluation set: In the model of rough sets and fuzzy entropy, the evaluation set of the logistics capability of the supply chain is C = (C_1, C_2, C_3, C_4 , C_5), C_k (k = 1, 2, 3, 4, 5) represents respectively five grades including the higher, high, general, low, lower. And five grades are given the assignment A = {90, 80, 70, 60, 50}.

To construct the membership degree matrix: If any one of the elements of x in the domain is corresponding to a number of $A(x)$, the number of $A(x)$ is the fuzzy set in the domain. When the element of x changes in the domain, the number of $A(x)$ can be considered as the membership function. If the number of $A(x)$ is closer to 1, it denotes that membership degree of x to $A(x)$ is higher; and the number of $A(x)$ is closer to 0; it denotes that membership degree of x to $A(x)$ is lower (Yu *et al*., 2010).

Then membership functions are used to establish the membership of indicators on levels. It is calculated as follows:

- Supposing the number of each level indicator of logistics capability of the supply chain is n, the logistics capability of the index i is xi and the corresponding membership μ(xi) can be calculated by the formula (3):

$$\mu(x_i) = 1 - e^{-\frac{1}{x_i}(x_i - a)^2} \tag{3}$$

where,
i = 1, 2, 3, 4
α = 1, 0.75, 0.5, 0.25, 0

And subspace dimension indexes of supply chain logistics capabilities are either positive or negative, either high or low; the indicators will be converted into the same trend changes.

- To calculate the evaluation matrix of fuzzy membership degree:

$$T = \begin{bmatrix} \mu_{i11} & \mu_{i12} & \cdots & \mu_{i1n} \\ \mu_{i21} & \mu_{i22} & \cdots & \mu_{i2n} \\ \vdots & \vdots & \vdots & \vdots \\ \mu_{im1} & \mu_{in2} & \cdots & \mu_{imn} \end{bmatrix}_{m \times n}$$

when
i = The four aspects of supply chain logistics capabilities (i = 1, 2, 3, 4)
m = The indicator number of subspace dimension in the four aspects
n = The number of the evaluation grade (n = 5)
μ_{ijn} = The membership degree of the j to the grade of n in the aspect of i

To determine the entropy values and weight of evaluation index:

- To calculate the weighted coefficient of subspace dimension and normalize them by the formula (4):

$$T_i = W_i \times B_i \tag{4}$$

where,
W_i = The weight of the indicator
B_i = The membership of subspace dimension index

- To determine the entropy values of the first-indicator (Shi *et al*., 2009):

$$H(x_j) = -k\sum_{i=1}^{n} z_{ij} \log z_{ij}, \quad j = 1, 2, 3, 4 \tag{5}$$

where,
k = The adjustment coefficient (k = 1/log n)
n = The number of evaluation grade (n = 5)
z_{ij} = The element of a matrix which has been normalized

- To convert the entropy values into the weight values

$$d_j = \frac{1 - H(x_j)}{m - \sum_{j=1}^{m} H(x_j)}, \quad j = 1, 2, \cdots, m \tag{6}$$

where,

$$0 \le d_j \le 1, \sum_{j=1}^{m} d_j = 1$$

- To calculate the value of supply chain logistics capabilities:

$$F = di \times A^T \tag{7}$$

where,

$A^T = (90\ 80\ 70\ 60\ 50)^T$

CASE STUDY

In this study, the logistics capability of supply chain of a manufacturing enterprise in Hubei is evaluated by the models of rough sets and fuzzy entropy.

- According to the property importance and the scores which can be obtained from some managers, all values of second-indicator can be seen from the Table 2:

By the software of Rosetta and formula (2), the weight coefficient of subspace dimension index can be calculated:

W_1 = (0.235, 0.414, 0.351)
W_2 = (0.216, 0.264, 0.520)
W_3 = (0.240, 0.278, 0.354, 0.128)
W_4 = (0.522, 0.271, 0.207)

According to the formula (3), the membership of indicators can be calculated, which can be shown in Table 3:

Table 2: The values of second-indicator

Managers	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}
A	4.6	3.5	5	3.6	1.8	4.5	3	0.5	2.5	1.5	4	4	3
B	4	3	5	3.5	2	2.5	1.5	2	1.8	0.5	4	4	3
C	5	4	3	2.5	3	5	4	3	1	3	3.5	2.5	3
D	4	4	3	3	1.5	3.5	1.5	1.5	2	2	2	3	4
E	4	3	4	3	3	4	4	2	1	2	3	4	3

Table 3: The membership of indicators

Indicator	Higher	High	General	Low	Lower
B_1	0.446	0.311	0.158	0.068	0.017
B_2	0.431	0.298	0.213	0.059	0.001
B_3	0.438	0.362	0.166	0.029	0.010
B_4	0.571	0.306	0.058	0.042	0.013
B_5	0.401	0.392	0.121	0.008	0.001
B_6	0.812	0.179	0.131	0.002	0.001
B_7	0.412	0.359	0.121	0.098	0.015
B_8	0.493	0.235	0.186	0.042	0.029
B_9	0.644	0.208	0.154	0.011	0.001
B_{10}	0.476	0.358	0.141	0.021	0.001
B_{11}	0.419	0.288	0.222	0.051	0.001
B_{12}	0.413	0.356	0.121	0.076	0.021
B_{13}	0.681	0.301	0.027	0.020	0.001

According to the formula (4), weighted coefficient of subspace dimension can be obtained.

$T_1 = W_1 \times (B_1\ B_2\ B_3) = (0.437, 0.324, 0.184, 0.051, 0.008)$
$T_2 = W_2 \times (B_4\ B_5\ B_6) = (0.652, 0.263, 0.113, 0.012, 0.004)$
$T_3 = W_3 \times (B_7\ B_8\ B_9\ B_{10}) = (0.525, 0.271, 0.153, 0.042, 0.012)$
$T_4 = W_4 \times (B_{11}\ B_{12}\ B_{13}) = (0.472, 0.309, 0.154, 0.051, 0.006)$

- (According to the formula (5), the entropy values of the first-indicator can be obtained:

  $H(x_j)\ (j = 1, 2, 3, 4) = (0.763, 0.591, 0.724, 0.738)$

- According to the formula (6), weight values can be obtained:

  $d_j(j = 1, 2, 3, 4\ ) = (0.271, 0.210, 0.257, 0.262)$

According to the formula (7), value of supply chain logistics capabilities can be obtained:

$$F = di \times A^T = di \times (90.80\ 70\ 60)^T = 74.90$$

The evaluation of calculation results: By the above calculation, the conclusion can be drawn that the capability of the enterprise in manufacturing enterprise is at the secondary level and the capability of four aspects is in general, which is consistent with the actual situation.

CONCLUSION

In this study, an evaluation system of supply chain logistics capabilities is established from four aspects. A model of rough sets and fuzzy entropy is used to analyze the logistics capabilities supply chain in manufacturing enterprise. And the result of an empirical analysis proved the evaluation methods to be valid. So the evaluation method is worth promoting in the manufacturing enterprise.

ACKNOWLEDGMENT

This study was financially supported by the 12th five-year plan funding areas of Hubei Province Social Science Foundation Projects and Teaching Research Projects of Huangshi Institute of technology under Grant No. 201130.

REFERENCES

Daugherty, P.J. and P.H. Pittman, 1995. Utilization of time-based strategies: Creating distribution flexibility/responsiveness. Int. J. Oper. Prod. Man., 15(2): 54-60.

Huang, Y., 2008. Building and promotion of logistics capability of enterprise. J. Guangxi Univ. Philos. Soc. Sci., 30(5): 35-38.

Patricia, J.D., P.S. Theodore and E.E. Alexander, 1998. Leveraging logistics/distribution capabilities: The effect of logistics service on market share. J. Bus. Logist., 19(2): 35-51.

Sameer, K., 2008. A study of the supermarket industry and its growing logistics capabilities. Int. J. Retail Dis. Manage., 36(3): 192-211.

Shang, L., L. Sun, M. Li and X. Li, 2009. The logistics capability evaluation system in manufacturing enterprise. Sci. Technol. Eng., 9(19): 5933-5936.

Shi, T., S. Guo, X. Zhang and X. Cui, 2009. Pure water quality evaluation model of language is based on the fuzzy math and entropy weight. Sci. Technol. West China, 8(27): 38-39.

Yang, C., H. Ge and Z. Wang, 2012. Overview of attribute reduction based on rough sets. Appl. Res. Comput., 29(1): 16-20.

Yu, J., H. Qian, W. Shi and Y. Zhang, 2010. Optimal selection of plans for expressway asphalt pavement structures based on fuzzy membership function. Tech. Highway Transport., 16(6): 33-36.