Performance Evaluation of Logistics Based on Fuzzy Neural Network

Lin Wang, Dongqin Zeng*
School of Transportation, Wuhan University of Technology, Wuhan, China
***EMAIL: zengdongqin2008@163.com**

Abstract: According to the principles of selecting evaluation indicators, an evaluation indicator system of logistics performance is built at first. Next, a fuzzy neural network model is established according to its performance indicator system, which has a multi-input and single-output structure. Then, Matlab7.0 is used to analyze empirical sample data. At last, the training results show it is suitable for performance evaluation of logistics.

Keywords: performance evaluation; indicator system; logistics enterprise; fuzzy neural network.

I. Introduction

With the rapid development of the logistics, the study of performance evaluation method of logistics is increasingly deeper. The key to evaluate performance of logistics is how to create the evaluation model. How to establish evaluation indicator system is also important [1]. At present, the existing evaluation methods of logistics enterprises are mainly fuzzy comprehensive evaluation methods and comprehensive evaluation methods of neural network, and so on [2]. Fuzzy comprehensive evaluation is a multi-attribute evaluation method. It mainly relies on experts scoring to decide the weights. Not only has it no self-learning ability, but also has too large man-made subjective effects. The weight of its membership function has certain subjectivity. BP artificial neural network slows down algorithm and is likely to fall into local minimum. In this paper, neural network and fuzzy system are combined together [3].

II. The Establishment of Indicator System of Performance Evaluation

The Principles of Selecting Performance Evaluation Indicators

The design of performance index system is the basic premise of performance evaluation. And comprehensive, rational indicator system is the key to ensuring comprehensive and objective evaluation results [4]. The establishment of logistics performance evaluation system should obey the following principles:

(1) The principle of purpose. The system of logistics performance evaluation is designed to measure the level of enterprise management. It can put forward tools to improve the level of enterprise management. It ultimately enhances the competitiveness of enterprises.

(2) The system principle. Logistics performance evaluation can not only consider a single factor, but also adopt the principles of system evaluation. Only through this approach, comprehensive and objective evaluation is made to logistics enterprise performance.

(3) The principle of operation. The principle of operation matches with business statistics and various statements as much as possible. It also avoids misunderstanding and ambiguity as soon as possible.

(4) The principle of comparability. The establishment of evaluation index system not only considers the time longitudinal comparability of data, but also should pay attention to the horizontal comparability of performance evaluation indicator system.

(5) The principle of the combination of quantitative and qualitative indicators.

Indicator System of Logistics Performance Evaluation

According to the principles of selecting indicators of logistics performance evaluation and the basis of the critical study and succession of indicators of past performance evaluation, this article establishes mainly evaluation indicator system of logistics performance from four aspects, such as inventory function, distribution function, market power, customer satisfaction.

(1) Indicators of inventory function. They mainly include indictors of inventory, sending and receiving accurately goods and inventory turnover and so on.

(2) Indicators of distribution function. It includes indictors of transport capacity, transport economy, product availability, timely delivery capabilities, transport security and control of distribution costs and so on.

(3) Indicators of market power. There are many factors for market power. The key indicators on behalf of market power are market share, market growth, the success rate of new customer development and market adaptability

(4) Indicators of customer satisfaction. Indicators that reflect the customer satisfaction are mainly the credibility of market, the rate of meeting orders, the ratio of return, the average lead time of order and customer retention and so on.

III. The Construction of Fuzzy Neural Network

Fuzzy Neural Network Model

Fuzzy neural network combines fuzzy theory with NN technology. The essence of FNN is assigning routine NN to fuzzy signal and fuzzy weight [5]. By the analysis of many fuzzy-neural networks, a network model of a multi-input and single-output structure of the 4 layers is established. The 4 layers are input layer, fuzzy layer, rule layer, output layer. Its network structure is shown in Figure 1.

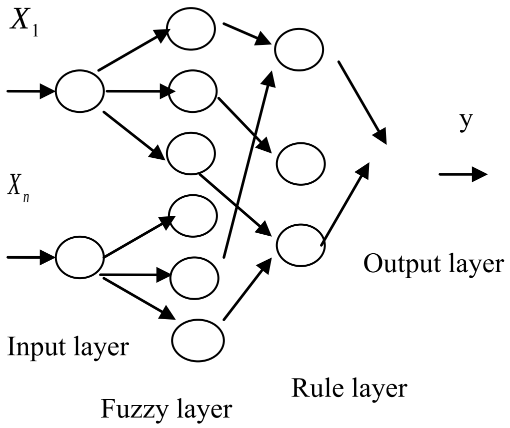

Figure 1 The Structure Model of Fuzzy Neural Network

The first layer is an input layer. Every node in this layer represents an input variable X_i of fuzzy model. The number of nodes is equal to the number of variables appearing in the premise of rules of fuzzy mode. That is, $X^T = [X_1, X_2, \cdots, X_n]$ is a network input variable. Here are the various scoring indicators, that is X^T = [inventory function, distribution function, market power, customer satisfaction]. Indicators adopt percentile system, that is $X_n \in [0,100]$, n=5.

Suppose that I_i and O_i are separately input and output of the ith node every layer. Moreover, the input of every layer is equal to the output of the previous layer. That is,

$$I_i^1 = O_i^1 \quad (i = 1, 2 \cdots, 5) \qquad (1)$$

The second layer is a fuzzy layer. Every node represents a fuzzy language variable, which is "excellent, good, in general, poor". Because the Gaussian function has a good smoothness, the membership function uses Gaussian function.

$$\begin{cases} O_{ij}^2 = \exp\left[-\dfrac{(O_i^1 - m_{ij})^2}{\delta_{ij}^2} \right] (1 \le j \le s) \\ I_i^2 = O_i^1 \end{cases} \qquad (2)$$

Among formula (2), m_{ij} and δ_{ij} are separately the center and the width of the membership function.

The third layer is a rule layer. This layer obtains the vector e of evaluation by weighted Computing. The connection weight from the Second layer neurons to the third layer neuron is the weight w of evaluation index. That is,

$$\begin{cases} I_i^3 = O_{ij}^2 \\ I_z^3 = \sum W_{ij} \cdot I_i^3 \end{cases} \qquad (3)$$

Where w_{ij} denotes the connection weight from the ith rule to the jth output node.

The fourth layer is an output layer. In the vector e of evaluation, the corresponding level to the acquired maximum of membership is to be the evaluation rating of logistics performance.

Network Training

The c-means clustering algorithm is to determine the center parameter m_{ij} and the width δ_{ij} of membership function by the average difference. Suppose there are m sets of data, then

$$\delta_{ij} = \frac{1}{m} \sum \left| X_i - m_{ij} \right| \quad i=1,2, \quad ,m \qquad (4)$$

The indicator Weight is determined by the percentage of the total number. The data whose output is z is got from n sets of data, for example, the output z is "excellent". Assume there are m sets of data and the output membership of the first layer output is the input u_{zik}, $i = 1, 2, \cdots, 5$, $k = 1, 2, \cdots, m$, then

$$W_{zi} = \sum (\mu_{zik}) / \sum (\mu_{zik}) \quad z = 1, \ldots, 5 \qquad (5)$$

Algorithm Realization

Use Matlab7.0 program to realize the above steps as following as Figure 2.

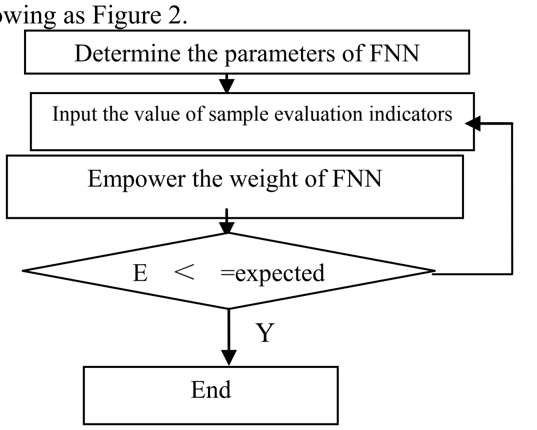

Figure 2 Flow of Package Evaluation Based on Fuzzy Neural Network

IV. Empirical Analysis

Take example of a certain logistics enterprise. It is further illustrated that the fuzzy neural network is applied in the evaluation of logistics performance. The sample data in Table 1 is got by 20 staffs scoring the main factors of the four evaluations.

Table 1 Network Training Sample Data

inventory	distribution	market power	customer satisfaction	rank
95	100	96	96	excellent
96	98	93	90	excellent
90	89	89	92	excellent
93	93	90	90	excellent
82	80	81	80	good
82	86	80	80	good
85	80	84	82	good
80	86	83	85	good
79	80	80	75	medium
76	79	73	79	medium
71	74	72	78	medium
75	74	70	76	medium
49	59	38	40	poor
50	53	41	47	poor
38	48	47	41	poor
40	47	38	35	poor

Assume η=0.96, α=0.8, and error is limited as 0.001. The result of network training is in Table 2.

Table 2 The Result of Network Training

parameter	Center value m_{ij}	Width δ_{ij}	Weight W_{ij}	rank
inventory function	92.213	4.294	0.153	excellent
	79.091	5.204	0.149	good
	70.216	3.23	0.125	medium
	49.318	3.790	0.103	general
	12.319	17.48	0.149	poor
distribution function	93.129	3.592	0.142	excellent
	81.840	2.731	0.138	good
	70.382	1.549	0.132	medium
	58.164	16.790	0.162	general
	11.390	30.62	0.153	poor
market power	92．002	4.179	0.128	excellent
	84.904	3.806	0.156	good
	71.944	1.040	0.148	medium
	51.720	17.30	0.148	general
	10.72	31.061	0.140	poor
customer satisfaction	91.72	3.520	0.162	excellent
	73.72	4.763	0.189	good
	69.108	7.253	0.136	medium
	50.220	10.72	0.126	general
	16.938	21.19	0.131	poor

The expert evaluation of logistics performance is shown in Table 3.

Table 3 Expert Scoring

inventory function	distribution function	market power	customer satisfaction
90	80	76	75

Input the expert scoring and receive the score vector：e=[0.271，0.318，0.351，0.194]. The largest degree of membership is 0.351, that is, the evaluation result of logistics enterprise performance is general.

V. Conclusions

The performance evaluation of logistics has a guiding significance on management of logistics enterprises. In this paper, the establishment of logistics performance evaluation model and algorithm is based on fuzzy comprehensive evaluation method. In addition, the case study is conducted according to the specific circumstance and data of an enterprise, and the research results have a certain reference value.

References

[1] Chen, X. H., Yang, Q., 2008. The Evaluation Method of Enterprise Facility Layout Based on Fuzzy Neural Network Model. *Computer and Applied Chemistry,* (6):95-97.

[2] Zhang, X. Q., Zhang, F. M., Hou, Y. X., 2005. The Analysis of the Structure of Fuzzy Neural Network. *Taiyuan University of Technology*, (6):80-83.

[3] Chen, C., Shen, J. Z., Li, Y. R., 2000. The research on Fuzzy Neural Network Modeling Method. *Computer and Applied Chemistry*, (6):501-504.

[4] Du. Y. X., Tian, Q. H., 2005. Comprehensive Evaluation Method Based on Fuzzy Neural Network Fuzzy. *Systems Engineering and Electronic Technology*, (9):1583-1586.

[5] Wang, S. T., 1998. Fuzzy Systems, Fuzzy Neural Network and Application Design. *Shanghai Scientific and Technological Literature Publishing House*.

Background of Authors

Wang Lin received a Bachelor from Wuhan University in 1988. And in 2005, she got a Master from Wuhan University. Nowadays, she is an associate professor in School of Transportation in Wuhan University of Technology. Her research direction is planning and managing of transportation and logistics management. In recent years, she has taken on a total 9 research projects including 4 state assigned and 5 provincial projects.

Zeng Dong qin received a Bachelor from Wuhan University of Science and Technology in 2008. Now, she is studying in in School of Transportation in Wuhan University of Technology. Her research direction is logistics management. During postgraduatation, she took part in a lot of research projects, such as “Hubei Tax Capacity Scale Mathematical Model” and “Planning and Research of Combinatorial Ports” and so on.