Logistics Enterprise Evaluation Model Based On Fuzzy Clustering Analysis

Pei-hua Fu, Hong-bo Yin

Abstract

In this thesis, we introduced an evaluation model based on fuzzy cluster algorithm of logistics enterprises. First of all, we present the evaluation index system which contains basic information, management level, technical strength, transport capacity, informatization level, market competition and customer service. We decided the index weight according to the grades, and evaluated integrate ability of the logistics enterprises using fuzzy cluster analysis method. In this thesis, we introduced the system evaluation module and cluster analysis module in detail and described how we achieved these two modules. At last, we gave the result of the system.

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Keywords: fuzzy clustering, logistics enterprise, evaluation, algorithm

1. Introduction

Logistics, this reflects the efficiency of the present era, as a link connecting material production and demand, its effective performance measures for the supervision of enterprise and rational allocation of resources is extremely important. With the deepening of the market economy and global economic integration, logistics companies, only scientific and effective manner to assess their own performance can make themselves accurately understand the development of their own, and to find out the right way forward to ensure that enterprises in an invincible position in a complex market environment. Therefore, how to scientifically and comprehensively, effectively analyze and evaluate performance of logistics, has become an urgent problem to be solved for modern logistics industry.

Logistics Performance mainly refers to the capacity of logistics to exercise of the procurement, transportation, warehousing and distribution functions; is a relationship between labor consumption by logistics in the process of organizing logistics operation based on the logistics needs of the customer and the real value created by logistics. There are many ways in logistics performance measurement, such as AHP [1], multivariate statistical analysis (principal component analysis [2], factor analysis, etc.), fuzzy comprehensive evaluation method [3,4] and so on, various methods has its own advantages and disadvantages and the scope of application. Fuzzy cluster analysis provides a more practical method of
analysis for logistics performance measurement because it is more holistic, comparative and practical.

This paper presents a logistics enterprise evaluation system, including seven index: basic information, management level, technical strength, transport capacity, informatization level, market competition and customer service, on this basis, make quantitative evaluation of logistics enterprises with fuzzy clustering method.

2. Evaluation index system of logistics enterprises

Logistics enterprises, while in the production and operation, on business performance of scientific analysis and evaluation, judge the actual operating level, accurately identify the advantages and disadvantages of continuous consummate and improve management, increase overall efficiency, and enhance the overall strength of the logistics enterprises is of great significance. Therefore, scientific, systematic and comprehensive analysis and evaluation of the efficiency of logistics enterprises, the establishment of a logistics operation efficiency evaluation methods and metrics is very necessary. Establish an effective evaluation of the logistics enterprise competitiveness condition index system, the general should follow the following principles: the representation of targets, the comparability of relative stability of index, and science of index [6]. We designed a comprehensive evaluation index system that includes seven one-level index such as basic information, management level, technical strength, transport capacity, informatization level, market competition, customer service, and the associated 27 secondary index based on referencing literature [3,7,8,9], as shown in Table 1.

3. Mathematical Model of Fuzzy Clustering Analysis

Fuzzy clustering analysis is a widely used mathematical methods. Theoretically, it can be divided into three types: the first is washall method based on fuzzy equivalence relation, the second is direct clustering method based on fuzzy similarity relation and the third is fuzzy clustering based on fuzzy C-partition.

<table>
<thead>
<tr>
<th>One-level Index</th>
<th>Secondary Index</th>
</tr>
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</table>

Using fuzzy clustering analysis to classify things, usually by the following four steps:

1) Select the statistical index
2) Data standardization (normalization)
   Process the data that represent the index of the various features of things, make it is easy to analysis
and compare, data standardization can be done like this: $x' = \frac{x - \bar{x}}{\sigma}$. Where, $x$ is the original data, $\bar{x}$ is the average value of original data, $\sigma$ is the standard deviation of the original data.

3) **Calibration**

4) **Clustering analysis**

Choose the right one from the various methods in clustering, we can obtain the best classification results. Using washall method to get fuzzy equivalence matrix, and then draw a clustering picture, find an appropriate $\lambda \in [0, 1]$, from level matrix, We can draw the classification results.

### 4. Application of logistics evaluation model based on fuzzy clustering

A production enterprises consider to outsource their transport business to a third-party logistics, plan to select a comprehensive strength, management with high levels of cooperation from seven carriers A, B, C, D, E, F, G.

The domain of this problem = \{A, B, C, D, E, F, G\}.

The software level of carriers like basic information, management level, technical strength directly affect the level of production quality and supply chain operation, while transport capacity (vehicles, car parks) and transport networks is the hardware basis for carriers carrying out transportation. Accordingly, choose the following seven index, each index and its score is shown in Table 2.

<table>
<thead>
<tr>
<th>Basic information (10)</th>
<th>Management level (15)</th>
<th>Technical strength (15)</th>
<th>Transport capacity (20)</th>
<th>Informatization level (10)</th>
<th>Market competition (15)</th>
<th>Customer service (15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company size (3)</td>
<td>The proportion of managers (4)</td>
<td>The proportion of technical personnel (3)</td>
<td>Condition of the vehicles (8)</td>
<td>Information standardization (4)</td>
<td>Market share (5)</td>
<td>Order fulfillment rates (4)</td>
</tr>
<tr>
<td>Credibility (3)</td>
<td>Inventory turnover (4)</td>
<td>Development and innovation capacity (4)</td>
<td>Drivers’ quality (3)</td>
<td>Information security (3)</td>
<td>Anti-risk capability (3)</td>
<td>On time delivery (3)</td>
</tr>
<tr>
<td>Business (2)</td>
<td>Assessment (3)</td>
<td>Patented proportion (3)</td>
<td>Network (4)</td>
<td>Resilience (3)</td>
<td></td>
<td>Rates (4)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 2 The score of each evaluation index</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
</tr>
<tr>
<td>-----------------------</td>
</tr>
<tr>
<td>Basic information (10)</td>
</tr>
<tr>
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</tr>
<tr>
<td>Informatization level (10)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 3 The scoring data of each carrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
</tr>
<tr>
<td>-----------------------</td>
</tr>
<tr>
<td>Basic information (10)</td>
</tr>
<tr>
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</tr>
<tr>
<td>Transport capacity (20)</td>
</tr>
<tr>
<td>Informatization level (10)</td>
</tr>
</tbody>
</table>
After collecting relevant information through various channels, the manufacturer evaluated and graded for each carrier, as shown in Table 3.

As the measured values between the sample is close, so we use the formula 

\[ d(x_i, x_j) = \sum_{k=1}^{m} |x_{ik} - x_{jk}| \]

to calculate Hamming distance, and get distance matrix \( D \)

\[
D = \begin{bmatrix}
0 & 27 & 10 & 6 & 20 & 29 & 24 \\
27 & 0 & 33 & 23 & 7 & 6 & 5 \\
10 & 33 & 0 & 10 & 26 & 31 & 26 \\
6 & 23 & 10 & 0 & 18 & 25 & 22 \\
20 & 7 & 26 & 18 & 0 & 11 & 4 \\
29 & 6 & 31 & 25 & 11 & 0 & 7 \\
24 & 5 & 26 & 22 & 4 & 7 & 0 \\
\end{bmatrix}
\]

And then Calibrate by Absolute value subtraction method,

\[ r_{ij} = 1 - c \sum_{k=1}^{m} |x_{ik} - x_{jk}| \]

Choose \( C = 0.03 \), we can get fuzzy similar matrix

\[
R = \begin{bmatrix}
1 & 0.19 & 0.7 & 0.82 & 0.4 & 0.13 & 0.28 & \\
0.19 & 1 & 0.01 & 0.31 & 0.79 & 0.82 & 0.85 & \\
0.7 & 0.01 & 1 & 0.7 & 0.22 & 0.07 & 0.22 & \\
0.82 & 0.31 & 0.7 & 1 & 0.46 & 0.25 & 0.34 & \\
0.4 & 0.79 & 0.22 & 0.46 & 1 & 0.67 & 0.88 & \\
0.13 & 0.82 & 0.07 & 0.25 & 0.67 & 1 & 0.79 & \\
0.28 & 0.85 & 0.22 & 0.34 & 0.88 & 0.79 & 1 & \\
\end{bmatrix}
\]

As calculating the data is very complex, so use MATLAB as a computing platform [5], and use least square method to get transitive closure \( t(R) \) of the matrix \( R \):

\[
R^4 = R^2 \circ R^2 = \begin{bmatrix}
1 & 0.46 & 0.7 & 0.82 & 0.46 & 0.46 & 0.46 \\
0.46 & 1 & 0.46 & 0.46 & 0.85 & 0.82 & 0.85 \\
0.7 & 0.46 & 1 & 0.7 & 0.46 & 0.46 & 0.46 \\
0.46 & 0.46 & 0.7 & 1 & 0.46 & 0.46 & 0.46 \\
0.82 & 0.46 & 0.7 & 1 & 0.46 & 0.46 & 0.46 \\
0.46 & 0.85 & 0.46 & 0.46 & 1 & 0.82 & 0.88 \\
0.46 & 0.82 & 0.46 & 0.46 & 0.82 & 1 & 0.82 \\
0.46 & 0.85 & 0.46 & 0.46 & 0.88 & 0.82 & 1 \end{bmatrix}
\]

So fuzzy equivalence matrix \( R^* = t(R) = R^4 \).

While we choose \( \lambda \) as \((0.88, 0.85, 0.82, 0.7, 0.46)\) respectively, and we can get clustering result, as shown in figure 1.
By fuzzy clustering, the A, B, C, D, E, F, G seven carriers were divided into two categories, in which carriers A, C, D have stronger comprehensive power, higher management level, while rates are also higher; carriers B, E, F, G relatively have weaker comprehensive power, lower management level, while rates are low. Accordingly, the manufacturer can choose a carrier from A, C, D according to their needs to outsource its transport business.

5. Conclusion

This paper applied clustering analysis in logistics enterprise evaluation system, through the use of seven index including basic information, management level, technical strength, transport capacity, informatization level, market competition and customer service, grade the weight of each index, according to this to assess enterprise's comprehensive strength, and then do fuzzy clustering analysis. The paper analyzed the system of expert score module, design and implementation of clustering analysis module, system operation results show that the model can efficiently make logistics enterprises classified results shown in front of managers clearly.

With the diversification of production and the accumulation of market competition, logistics has become the core element of enterprises to improve market competitiveness, effective logistics performance measurement has become urgent for logistics enterprises. In this paper, we proposed the index system of logistics performance measurement, using a fuzzy clustering method of fuzzy mathematics as its evaluation tool, using a quantitative method to assess the logistics business, allowing managers to more clearly learn the advantages and inadequate of logistics enterprises.

References