Grey Fuzzy Comprehensive Judgment of Logistics Enterprise Based on Triangular Module

Limei Qi [1] Wei Xing [2]

[1]College of Information Engineering, Tarim University, Alar, Xinjiang,843300, lzqlm1224@163.com

[2]*College of Computer Science and Technology, Zhejiang University, Hangzhou, Zhejiang,310027, wxing@zju.edu.cn*

Abstract

On the basis of the judgment index system using balanced scorecard, we give grey fuzzy comprehensive judgment of logistics enterprise based on triangular module and give a case analysis.

Keywords: triangular module, grey fuzzy comprehensive, logistics enterprise

1. Introduction

Considering the performance judgments' information are both grey and fuzzy in logistics enterprise. This paper uses the triangular module to evaluate the logistics enterprises.

2. Triangular module

Definition 2.1[1] A map $T:[0,1]^2 \to [0,1]$ is called a triangular module or triangular module operator if T satisfies following conditions, for each $a,b,c,d \in [0,1]$.

(i) $T(0,0)=0$, $T(1,1)=1$;

(ii) If $a \le c$, $b \le d$, then $T(a,b) \le T(c,d)$;

(iii) $T(a,b)=T(b,a)$;

(iv) $T(T(a,b),c)=T(a,T(b,c))$.

Sometimes $T(a,b)$ is denoted by aTb.

Definition 2.2[2] Let $\tilde{R}_{\otimes}$ be a grey fuzzy relation in direct product space $x \times y$. $\tilde{R}_{\otimes}=\left[\left((u_{ij},v_{ij})\right)\right]_{mn}$ is called a single factor grey fuzzy judgment matrix. u_{ij} denotes a membership degree $u_R(x_i,y_j)$ for element (x_i,y_j). v_{ij} denotes point grey of element u_{ij}.

3. Grey fuzzy comprehensive judgment of logistics enterprise based on triangular module

Fuzzy comprehensive judgments of logistics enterprise are divided into first-level model and multilevel model. Study on application of triangular module in logistics enterprise' judgment, steps are as follows [3-6].

3.1. Establish judgment object factor set

Factor set is an assembly of every factor affecting objects. For first-level model, factor set $X=\{x_1,x_2,\cdots,x_r\}$; For

multilevel, factor set $X=\{x_1,x_2,\cdots,x_n\}$. According to the property, X is divided into several factor subsets $X_i=\{x_{i1},x_{i2},\cdots,x_{in_i}\}$, $i=1,2,\cdots,s$.

3.2. Establish judgment set $Y=\{y_1, y_2,\cdots,y_n\}$

Judgment set is a group of all judgment results that evaluator evaluate the object.

3.3. Judgment

As the judgment index information may be incomplete, it is hard to measure in number. We match descriptive measure to the gray level range. Information is divided into five categories, such as very complete, complete, general, poor, and very poor. The corresponding point grey values are 0~0.2, 0.2~0.4, 0.4~0.6, 0.6~0.8, 0.8~1.

(1) First-level judgment

According to every indexes' information and them completeness, establish grey fuzzy judgment matrix $\underset{\otimes}{\tilde{R}_i}=[(u_{ij},v_{ij})]_{n_i\times m}$, $i=1,2,\cdots,s$.

In practical applications, evaluator should determine weight of every factor $\underset{\otimes}{\tilde{A}}=\{(a_{i1},v_{i1}),(a_{i2},v_{i2}),\cdots,(a_{in_i},v_{in_i})\}$, $i=1,2,\cdots,s$. Here a_{it} $(t=1,2,\cdots,n_i)$ is factor weight and v_{it} is corresponding point grey. According to judgment matrix and weight set, we do first-level judgment using triangular module. There are several usual grey fuzzy comprehensive judgment models due to different operators. Such as $\underset{\otimes}{\tilde{A}}=(a_1,a_2,\cdots,a_n)$, $\underset{\otimes}{\tilde{R}}=\left[u_{ij}\right]_{n\times m}$, there are following six models.

Model Ⅰ Let $\underset{\otimes}{\tilde{B}}=\underset{\otimes}{\tilde{A}}\circ\underset{\otimes}{\tilde{R}}$, in which $(b_j,v_j)=(\overset{n}{\underset{i=1}{\vee}}(a_i\wedge u_{ij}),\overset{n}{\underset{i=1}{\wedge}}(v_i\vee v_{ij}))$. This model use zadeh operator. It can emphasize the main judgment factors.

Model Ⅱ Let $\underset{\otimes}{\tilde{B}}=\underset{\otimes}{\tilde{A}}\square\underset{\otimes}{\tilde{R}}$, in which $(b_j,v_j)=(\overset{n}{\underset{i=1}{\vee}}a_iu_{ij},\overset{n}{\underset{i=1}{\wedge}}(v_i\vee v_{ij}))$. In some extent, this model also emphasizes the main judgment factors.

Model Ⅲ Let $\underset{\otimes}{\tilde{B}}=\underset{\otimes}{\tilde{A}}*\underset{\otimes}{\tilde{R}}$, in which $(b_j,v_j)=(\sum_{i=1}^{n}a_iu_{ij},\overset{n}{\underset{i=1}{\wedge}}(v_i\vee v_{ij}))$. This model gives a balanced consideration according to weight and every factor affect the judgment result.

Model Ⅳ Let $\underset{\otimes}{\tilde{B}}=\underset{\otimes}{\tilde{A}}\otimes\underset{\otimes}{\tilde{R}}$, in which $(b_j,v_j)=(\overset{n}{\underset{i=1}{\vee}}u_{ij}^{a_i},\overset{n}{\underset{i=1}{\wedge}}(v_i\vee v_{ij}))$. This model emphasizes the less important factors.

Model Ⅴ Let $\underset{\otimes}{\tilde{B}}=\underset{\otimes}{\tilde{A}}\vec{\otimes}\underset{\otimes}{\tilde{R}}$, in which $(b_j,v_j)=(\sum_{i=1}^{n}(a_i\wedge\frac{u_{ij}}{\sum_{k=1}^{n}u_{kj}}),\overset{n}{\underset{i=1}{\wedge}}(v_i\vee v_{ij}))$.

This model also gives a balanced judgment.

Model Ⅵ Let $\underset{\otimes}{\tilde{B}}=\underset{\otimes}{\tilde{A}}\otimes\underset{\otimes}{\tilde{R}}$, in which $(b_j,v_j)=(\sum_{i=1}^{n}(a_i\wedge u_{ij}),\overset{n}{\underset{i=1}{\wedge}}(v_i\vee v_{ij}))$.

This model especially emphasizes the main factors.

(2) Second-level judgment

Let subset X_i $(i=1,2,\cdots,s)$ be elements of factor set X, donates as $X=\{X_1,X_2,\cdots,X_s\}$.So the judgment

matrix $\underset{\otimes}{\tilde{R}} = [\underset{\otimes}{\tilde{B}_1}\ \underset{\otimes}{\tilde{B}_2} \cdots \underset{\otimes}{\tilde{B}_S}]^T$. Similarly to the first-level, we can get judgment vector $\underset{\otimes}{\tilde{B}}$.

3.4. Process judgment results

Every vector above all has two parts that are fuzzy judgment for different planes and description for judgment information completeness. In order to reflect the principle of maximum degree membership, let sorted vector $\beta = (\beta_1, \beta_2, \cdots, \beta_m)$, in which $\beta_j = b_j + (1 - v_j)$, $j = 1, 2, \cdots, m$.

4. Case analysis

First, establish following logistics enterprise performance judgment index system based on balanced scorecard (BCS).

Table 1. Logistics enterprise performance judgment index system based on BCS

Research plane	Research index
Finance X_1	Profit growth rate x_{11}, asset turnover rate x_{12}, net asset profit rate x_{13}, asset debt ratio x_{14}, current ratio, logistics cost rate
Customer X_2	Customer satisfaction x_{21}, customer retention x_{22}, customer acquisition rate x_{23}, accuracy delivery rate x_{24}, market share x_{25}, customer profitability x_{26}
Interior business X_3	Product failure rate x_{31}, inventory accuracy x_{32}, vehicle (ship) load factor x_{33}, R&D input rate x_{34}, system error correction processing time
Learn and develop X_4	Employee satisfaction x_{41}, employee retention x_{42}, employee productivity rate x_{43}, employee continue learning ability x_{44}
Others	Total asset of tax rate, social contribution rate, creation job rate, network level, information system capability, environmental governance rate

As shown in the table 1, we select 18 indexes to evaluate logistics enterprise performance. Establish factor sets $X_1 = \{x_{11}, x_{12}, x_{13}, x_{14}\}$, $X_2 = \{x_{21}, x_{22}, \cdots, x_{26}\}$, $X_3 = \{x_{31}, x_{32}, x_{33}, x_{34}\}$, $X_4 = \{x_{41}, x_{42}, x_{43}, x_{44}\}$. Establish judgment set $Y = \{y_1, y_2, y_3\}$, in which y_1 denotes positive comment, y_2 denotes moderate comment and y_3 denotes negative comment.

Then we get following four single factor grey fuzzy judgment matrixes.

$$\underset{\otimes}{\tilde{R}_1} = \begin{bmatrix} (0.5,0.2) & (0.6,0.1) & (0.3,0.1) \\ (0.7,0.2) & (0.5,0.2) & (0.2,0.2) \\ (0.7,0.1) & (0.6,0.2) & (0.2,0.1) \\ (0.8,0.1) & (0.4,0.4) & (0.2,0.2) \end{bmatrix}$$

$$\underset{\otimes}{\tilde{R}_2} = \begin{bmatrix} (0.5,0.2) & (0.8,0.1) & (0.2,0.2) \\ (0.8,0.2) & (0.5,0.4) & (0.2,0.1) \\ (0.7,0.2) & (0.5,0.2) & (0.1,0.2) \\ (0.7,0.2) & (0.6,0.1) & (0.2,0.2) \\ (0.5,0.1) & (0.7,0.2) & (0.1,0.2) \\ (0.4,0.2) & (0.8,0.1) & (0.1,0.1) \end{bmatrix}$$

$$\tilde{R}_{3\otimes}=\begin{bmatrix}(0.8,0.3) & (0.3,0.4) & (0.1,0.3)\\ (0.7,0.2) & (0.6,0.1) & (0.2,0.2)\\ (0.9,0.1) & (0.4,0.2) & (0.1,0.1)\\ (0.8,0.1) & (0.6,0.2) & (0.1,0.2)\end{bmatrix}$$

$$\tilde{R}_{4\otimes}=\begin{bmatrix}(0.7,0.3) & (0.4,0.4) & (0.2,0.2)\\ (0.9,0.2) & (0.3,0.1) & (0.1,0.1)\\ (0.8,0.1) & (0.5,0.2) & (0.2,0.1)\\ (0.6,0.1) & (0.6,0.2) & (0.1,0.1)\end{bmatrix}$$

Establish weight set $\tilde{A}_{i\otimes}\ (i=1,2,3,4)$ and point grey degree $\tilde{A}_{\otimes}$.

$\tilde{A}_{1\otimes}=[(0.5,0.3),(0.2,0.1),(0.2,0.1),(0.1,0.3)]$,

$\tilde{A}_{2\otimes}=[(0.15,0.2),(0.15,0.2),(0.2,0.4),(0.18,0.2),(0.17,0.2),(0.15,0.2)]$,

$\tilde{A}_{3\otimes}=[(0.4,0.3),(0.3,0.1),(0.15,0.1),(0.15,0.3)]$,

$\tilde{A}_{4\otimes}=[(0.35,0.3),(0.3,0.1),(0.2,0.3),(0.15,0.1)]$,

$\tilde{A}_{\otimes}=[(0.35,0.3),(0.3,0.1),(0.2,0.3),(0.15,0.1)]$.

We chose model Ⅲ to evaluate this logistics enterprise performance. Then $\tilde{B}_{\otimes}=[(0.64405,0.1),(0.5431,0.1),(0.1799,0.1)]$ and sorted vectors $\beta_1=1.54405$, $\beta_2=1.4431$, $\beta_3=1.0799$. So this logistics enterprise performance judgment is well.

5. Conclusion

In this paper, the traditional information aggregation operators are extended to triangular module operator in the comprehensive judgment of logistics enterprise. And establish grey fuzzy comprehensive judgment model, in which selection of the triangular module operator should combine with the actual situation.

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7. References

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Brief introduction of the first author: Limei Qi (1980-), female, associate professor at Tarim University, research on applied mathematics.