Performance Evaluation of Third-party Cold Chain Logistics Enterprise Based on A Comprehensive Evaluation Method

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Abstract: Performance evaluation of third-party cold chain logistics (3PCCL) enterprise is a complex and difficult process requiring the consideration of various aspects. This paper set up a scientific index system including four aspects: finance, internal operation, customer as well as learning and growth. Meanwhile, it used a comprehensive evaluation method, which combines analytic hierarchy process (AHP) with grey theory and fuzzy comprehensive evaluation method, to implement performance evaluation. Then, a professional 3PCCL enterprise was chosen to be evaluated as a case study. The results show that the comprehensive evaluation method is efficient and reliable, and thereby it can be used for better logistics management and improvement.

Keywords: Third-party cold chain logistics, Performance evaluation, Analytic hierarchy process, Grey theory, Fuzzy comprehensive evaluation

1 Introduction

With the development of society and the change of consumption concepts, the requirement on product quality is heightened, especially for the fresh product. And transporting fresh products with cold chain logistics is an important way to ensure the quality. However, the comprehensive cold chain circulation rate is only 19% in china, while in the United States, Japan and other developed countries, the cold chain circulation rates are above 85%[1]. Moreover, in the process of logistics, the losses of agricultural products are up to 25%-30%, which is far higher than the 5% in developed countries [2]. On the one hand, the cold chain logistics in our country has large rooms for development. On the other hand, the third-party logistics will dominant in cold chain logistics in the next few decades[3]. Hence, it is vital to develop a new approach to evaluate the performance of the third-party cold chain logistics enterprises.

Performance evaluation is a multi-criteria decision problem, it involves a plethora attributes and factors. Some methods have been used to solve multiple criteria problems. AHP is a widely used method to handle multi-criteria problems. It divides the various factors into orderly hierarchies and is a simple, flexible and practical method for quantitative analysis of qualitative problems[4]. Grey theory, mainly through the extraction of some known or unknown information to realize the effective management [5]. Fuzzy comprehensive evaluation method is used to conduct an overall evaluation of objects that are constrained by a variety of factors and is also a widely used method for multi-criteria decision making[6]. Different methods have their own strengths, which complement rather than repel each other. This paper combines AHP with grey theory and fuzzy comprehensive evaluation method implement evaluation. It applies AHP to obtain the weight of each index; integrating grey theory and fuzzy comprehensive evaluation method to obtain the comprehensive evaluation results. Finally, the results of performance evaluation can assist in reasonable utilization of resources and formulating development plans.

2 Comprehensive Evaluation Method

2.1 Establish Evaluation Index system

In order to evaluate the 3PCCL enterprise performance, on must first of all, accord to the core mind of balanced scorecard (BSC)[9]and consider the enterprise's actual situation, this paper gathers a series of indexes from the four aspects: finance, internal operation, customer, learning and growth. Then through analysis of related literatures[6-8], as well as the discussion and inquiry of experts, the index system is established and shown in figure 1.

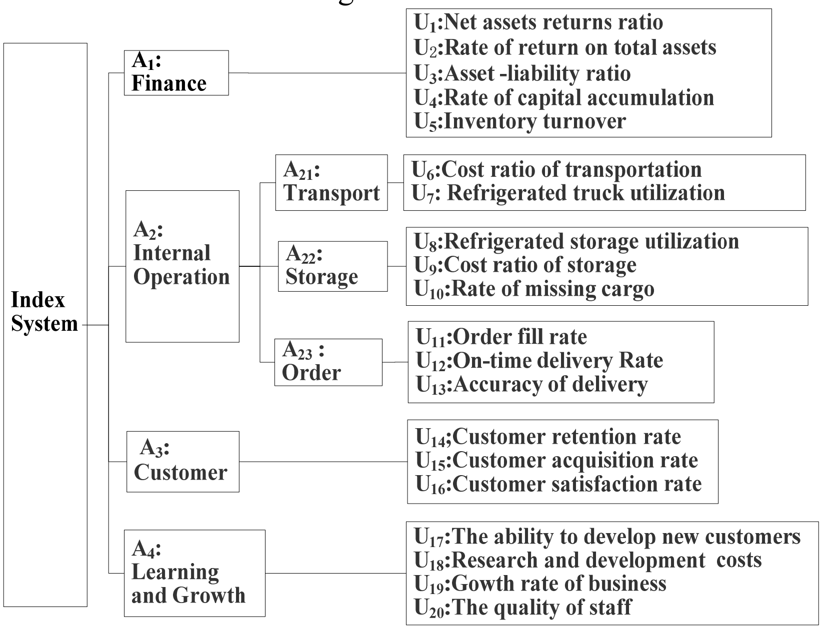

Figure 1 Index System

2.2 Use AHP to Determine the Weight of Index

Step 1: Construct the comparison matrix. Suppose there are n factors, $X_1, X_2, ..., X_n$. Then the experts give the relative importance scale a_{ij} by comparing any two factors. The term a_{ij} represents a quantified judgment on a pair of element X_i and X_j. And the value of a_{ij} is represented using a saaty scale[10], which is given in table 1. The results constitute the comparison matrix $A_{(n\times n)} = [a_{ij}]$.

Table 1 Saaty Scale

Importance Scale	Meaning
1	Two element are compared to be the same importance
3	The former is more importance than the latter
5	The former is obviously importance than the latter
7	The former is strongly importance than the latter
9	The former is extremely importance than the latter
2,4,6.8	Intermediate value above
Reciprocal	When the ratio of I and J is a_{ij} ,the ratio of J and I is $a_{ji} = 1/a_{ij}$, $a_{ii} = 1$

Step 2: Implement a consistency test for the comparison matrix. At first, calculate the largest eigenvalue $\lambda_{\max}$ of comparison matrix A. When the size of the matrix is n, the consistency index $C.I$ can be acquired through formula (1):

$$C.I = \frac{\lambda_{\max} - n}{n-1} \quad . \tag{1}$$

Step 3: Calculate the consistency ratio $C.R$ by the formula (2):

$$C.R = \frac{C.\mathrm{I}}{R.\mathrm{I}} \quad . \tag{2}$$

R.I is called the random index, and the corresponding values of R.I of different scales are provided in table 2.

Table 2 RI for Different Scale

The size of Matrix	1	2	3	4	5
$R.I.$	0	0	0.519	0.864	1.096

If $C.R \le 0.10$, the comparison matrix will pass the consistency test. Otherwise, the matrix needs to be revised until consistence can be accepted.

Step 4: Calculate the weight by formula (3), $W=[W_1,W_2,...,W_i,...,W_n], i=1,2,...,n$. W_i represents i-th index relative importance weight.

$$\bar{W_i}=\frac{1}{n}\sum_{j=1}^{n}\frac{a_{ij}}{\sum_{k=1}^{n}a_{kj}},1\le i,j\le n \quad ,\mathrm{W}_i=\frac{\bar{W_i}}{\sum_{i=1}^{n}\bar{W_i}} \ . \tag{3}$$

2.3 Grey Fuzzy Comprehensive Evaluation

Step 1: Confirm evaluation factor set. Suppose an evaluation factor set is $\mathrm{U}=\{\mathrm{U}_1,\mathrm{U}_2,...,\mathrm{U}_n\}$, u_i means the i-th index. This paper establishes five evaluation factor sets: $\mathrm{U}_F=\{\mathrm{U}_1,\mathrm{U}_2,\mathrm{U}_3,\mathrm{U}_4,\mathrm{U}_5\}$, $\mathrm{U}_{IO}=\{\mathrm{U}_6,\mathrm{U}_7,\mathrm{U}_8,\mathrm{U}_9,\mathrm{U}_{10},\mathrm{U}_{11},\mathrm{U}_{12},\mathrm{U}_{13}\}$, $\mathrm{U}_C=\{\mathrm{U}_{14},\mathrm{U}_{15},\mathrm{U}_{16}\}$, $\mathrm{U}_{LG}=\{\mathrm{U}_{17},\mathrm{U}_{18},\mathrm{U}_{19},\mathrm{U}_{20}\}$, $\mathrm{U}_A=\left\{\begin{matrix}\mathrm{U}_1,\mathrm{U}_2,\mathrm{U}_3,\mathrm{U}_4,\mathrm{U}_5,\mathrm{U}_6,\mathrm{U}_7,\mathrm{U}_8,\mathrm{U}_9,\mathrm{U}_{10},\mathrm{U}_{11}\\ \mathrm{U}_{12},\mathrm{U}_{13},\mathrm{U}_{14},\mathrm{U}_{15},\mathrm{U}_{16},\mathrm{U}_{17},\mathrm{U}_{18},\mathrm{U}_{19},\mathrm{U}_{20}\end{matrix}\right\}$. U_F means the set of financial indexes, U_{IO} represents the set of indexes that belong to internal operation. U_C implies the set of indexes that customer-related. U_{LG} denotes the set of indexes that can reflect the ability of leaning and growth. And the last U_A represents the set of all indexes that show the comprehensive performance. (The same suffixes appearing later, representing similar meanings)

Step 2: Determine the evaluation appraisal-set $V=\{V_1,V_2...V_m\}$. V_i denotes the i-th grade , m represents the number of grade. This paper adopts four evaluation grades. Namely, m=4 and $V=\{V_1,V_2,V_3,V_4\}=(\text{excellent, good, ordinary, poor})$.

Step 3: Invite experts to evaluate the performance of each index. Suppose there are r experts, they give the evaluation value d_{li}, d_{li} represents l-th expert's evaluation value for i-th index. So, the evaluation matrix is obtained: $D=(d_{li})_{r\times n}$

Step 4: Determine the whitening function $f_p(d_{li})$. This paper adopts three types whitening function: (a) upper shape grey number $\otimes\in[d_1,\infty)$. (b) mid shape grey number $\otimes\in[0,d_1,2d_1]$. (c) lower shape grey number. $\otimes\in(0,d_1,d_2)$.

$$f_1(\mathrm{d}_{\mathrm{li}})=\begin{cases}\frac{\mathrm{d}_{\mathrm{li}}}{\mathrm{d}_1} & \mathrm{d}_{\mathrm{li}}\in[0,\mathrm{d}_1]\\ 1 & \mathrm{d}_{\mathrm{li}}\in[\mathrm{d}_1,\infty)\\ 0 & \mathrm{d}_{\mathrm{li}}\notin[0,\infty)\end{cases},\quad f_2(d_{li})=\begin{cases}\frac{d_{li}}{d_1} & d_{li}\in[0,d_1]\\ 2-\frac{d_{li}}{d_1} & d_{li}\in[d_1,2d_1]\\ 0 & d_{li}\notin[0,2d_1]\end{cases},\quad f_3(d_{li})=\begin{cases}1 & d_{li}\in[0,d_1]\\ \frac{d_2-d_{li}}{d_2-d_1} & d_{li}\in[\mathrm{d}_1,\mathrm{d}_2]\\ 0 & d_{li}\notin[0,d_2]\end{cases}$$

(a) (b) (c)

Step 5: Establish the fuzzy judgment matrix. First at all, calculate grey statistics n_{ip} and total grey statistics n_i by the formula (4) and formula (5) respectively, which are expressed as follows:

$$n_{ip}=\sum_{l=1}^{r}f_p(d_{li}) \ . \tag{4}$$

$$n_i=\sum_{p=1}^{m}n_{ip} \ . \tag{5}$$

Then, we can get r_{ip} by the formula (6).

$$r_{ip} = \frac{n_{ip}}{n_i} \quad . \tag{6}$$

r_{ip} represents the grey weight, and it means the possibility that the j-th index falls into i-th evaluation grade. Finally establish the fuzzy judgment matrix R.

$$R_{(n\times m)} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix}$$

Step 6: Obtain comprehensive evaluation vector by using the formula (7).

$$B = [b_1, b_{2,}, ..., \mathrm{b_j}, ...b_m] = W \circ R \text{ , } \sum_{j=1}^{m} b_j = 1 \quad . \tag{7}$$

Step 7: Comprehensive evaluation. In order to express the evaluation grade of the target and compare with the others more clearly, it supposes $V = \{V_1, V_2, V_3, V_4\} = [9, 7, 5, 2]$. So it can calculate the value of performance evaluation of the 3PCCL enterprise by formula (8).

$$Z = B \circ V^T \; . \tag{8}$$

3 Case Study

3.1 Data Sources

This paper selects a professional 3PCCL enterprise in Shenzhen (enterprise S) for case study. Case data is mainly from two aspects: Firstly, the daily operation data of enterprise S. We collect the data by internal department of enterprise S. Such as distribution centers, operation department, finance department and various other departments. The second aspects derive from the logistics experts' judgments. We invite five experts to participate in an evaluation. They are the president, the manager of research, the manager of the distribution center with the warehouse supervisor and logistics professor. Therefore, the results of evaluation will be more feasible and reasonable with their help.

3.2 Calculate the Weight

Construct pairwise comparison matrix. We take the first layer indexes that contain finance, internal operation, customer, learning and growth as an example. Invite five logistics experts and executives to determine the relative importance between each pair of indexes. The result is displayed as table 3. (Other judgment matrixes are given in appendix A)

Table 3 Judgment Matrix

	A_1	A_2	A_3	A_4
A_1	1	1/3	5	7
A_2	3	1	5	7
A_3	1/5	1/5	1	3
A_4	1/7	1/7	1/3	1

Appendix A: Judgment Matrix

	A_{21}	A_{22}	A_{23}
A_{21}	1	3	1/3
A_{22}	1/3	1	1/5
A_{23}	3	5	1

	U_1	U_2	U_3	U_4	U_5
U_1	1	1	3	3	3
U_2	1	1	3	3	3
U_3	1/3	1/3	1	1	1
U_4	1/3	1/3	1	1	1
U_5	1/3	1/3	1	1	1

	U_6	U_7
U_6	1	3
U_7	1/3	1

	U_8	U_9	U_{10}
U_8	1	1/5	1/3
U_9	5	1	1
U_1	3	1	1

	U_{11}	U_{12}	U_{13}
U_{11}	1	3	3
U_{12}	1/3	1	1
U_{13}	1/3	1	1

	U_{14}	U_{15}	U_{16}
U_{14}	1	1	3
U_{15}	1	1	3
U_{16}	1/3	1/3	1

	U_{17}	U_{18}	U_{19}	U_{20}
U_{17}	1	5	1	5
U_{18}	1/5	1	1/5	3
U_{19}	1	5	1	5
U_{20}	1/5	1/3	1/5	1

Use MATLAB 7.0 to obtain $\lambda_{\max} = 4.2281$ and get $C.I = 0.076$ by formula (1). And when the matrix size is 4, $R.I = 0.864$. Reuse formula (2) to get $C.R = 0.088 < 0.1$. This means the matrix built in table 3 meets the consistence requirement.

Calculate the weight for each index. Utilize the formula (3), and we obtain the weight for each index. The weight of the finance factor is 0.315, and the weight of the internal operation element is 0.529. The weight of customer factor and the learning and growth factors are 0.105 and 0.051 respectively. These weights indicate that the finance and internal operation factors are dominant in the index system. The weight of the other layer index can be obtained as the same way. Hence, all weights can be obtained and shown in table 4.

Table 4 The Weight of Index

The Target	Four Aspect		Index	Weight	Combined Weight
Performance Evaluation	A_1 0.315		U_1	0.334	0.105
			U_2	0.333	0.105
			U_3	0.111	0.035
			U_4	0.111	0.035
			U_5	0.111	0.035
	A_2 0.529	A_{21} 0.26	U_6	0.750	0.103
			U_7	0.250	0.034
		A_{22} 0.107	U_8	0.115	0.007
			U_9	0.480	0.027
			U_{10}	0.405	0.023
		A_{23} 0.633	U_{11}	0.600	0.201
			U_{12}	0.200	0.067
			U_{13}	0.200	0.067
	A_3 0.105		U_{14}	0.429	0.045
			U_{15}	0.429	0.045
			U_{16}	0.142	0.015
	A_4 0.051		U_{17}	0.408	0.021
			U_{18}	0.117	0.006
			U_{19}	0.408	0.021
			U^{20}	0.067	0.003

Finally, we get W_F=[0.334,0.333,0.111,0.111,0.111], W_{IO}=[0.195,0.065,0.012,0.051,0.043, 0,380,0.127,0.127], W_C=[0.429,0.429,0.142],W_{LG}=[0.408,0.117,0.408,0.067].W_A=[0.105,0.105,0.035, 0.035,0.035,0.103 ,0.034 ,0.007,0.027 ,0.023,0.201,0.067,0.067,0.045,0.045,0.015,0.021,0.006,0.021,0.003].

3.3 Grey Fuzzy Comprehensive Evaluation

Invite five experts to evaluate the annual performance. Evaluation values range from 0 to 10, the higher value indicates that the index is more in line with the requirements. Given the limited space, we will only take performance in 2013 as an example. Table 5 is the evaluation sample matrix of 2013. (Evaluation matrix of other years are manifested in appendix B)

Table 5 Evaluation Matrix of 2013

	U_1	U_2	U_3	U_4	U_5	U_6	U_7	U_8	U_9	U_{10}	U_{11}	U_{12}	U_3	U_{14}	U_{15}	U_{16}	U_{17}	U_{18}	U_{19}	U_{20}
E_1	8	2	2	6	6	6	4	7	5	6	7	6	8	6	5	8	7	5	6	6
E_2	8	3	3	7	7	7	5	7	4	6	8	7	8	7	5	8	7	4	7	5
E_3	8	3	2	6	7	7	4	8	4	5	7	7	8	7	6	8	8	4	7	5
E_4	7	2	1	5	7	6	3	7	4	5	6	6	8	7	6	8	7	5	7	5
E_5	8	1	2	6	6	7	4	7	4	5	6	6	9	7	7	8	6	3	7	5

Appendix B: Evaluation Matrix

Evaluation matrix of 2014

	U_1	U_2	U_3	U_4	U_5	U_6	U_7	U_8	U_9	U_{10}	U_{11}	U_{12}	U_{13}	U_{14}	U_{15}	U_{16}	U_{17}	U_{18}	U_{19}	U_{20}
E_1	8	8	6	6	6	6	7	8	7	6	7	7	8	7	5	8	6	5	5	6
E_2	9	9	7	7	7	7	8	8	8	7	8	7	8	7	6	7	7	4	6	7
E_3	8	8	7	7	6	6	7	9	8	7	8	8	8	7	5	7	6	4	7	7
E_4	8	9	8	8	7	5	7	8	8	5	8	7	8	8	5	8	6	4	6	6
E_5	9	8	7	7	6	7	6	8	7	6	7	7	8	7	6	8	6	3	5	6

Evaluation matrix of 2015

	U_1	U_2	U_3	U_4	U_5	U_6	U_7	U_8	U_9	U_{10}	U_{11}	U_{12}	U_{13}	U_{14}	U_{15}	U_{16}	U_{17}	U_{18}	U_{19}	U_{20}
E_1	8	8	6	6	6	6	7	8	6	7	8	7	6	5	5	6	6	5	6	6
E_2	9	8	7	7	5	7	8	9	7	8	9	6	7	4	5	7	7	6	7	7
E_3	8	9	7	7	5	7	8	8	7	8	8	7	7	5	4	6	7	6	6	8
E_4	8	9	8	6	5	6	8	7	7	7	9	7	6	4	6	6	5	7	6	7
E_5	9	8	7	7	6	6	7	8	7	8	9	7	6	6	4	6	5	6	7	7

Referring to the relevant literatures and experts' opinions, this paper adopts the whiten weight function expressions as follows.

$$f_1(d_{li})=\begin{cases}\dfrac{d_{li}}{9} & ,d_{li}\in[0,9]\\ 1 & ,d_{li}\in[9,\infty)\\ 0 & ,d_{li}\in(-\infty,0]\end{cases},\quad f_2(d_{li})=\begin{cases}\dfrac{d_{li}}{7} & ,\mathrm{d_{li}}\in[0,7]\\ 2-\dfrac{d_{li}}{7} & ,d_{li}\in[7,14]\\ 0 & ,d_{li}\notin[0,14]\end{cases},\quad f_3(d_{li})=\begin{cases}\dfrac{d_{li}}{5} & ,d_{li}\in[0,5]\\ 2-\dfrac{d_{li}}{5} & ,d_{li}\in[5,10]\\ 0 & ,d_{li}\notin[0,10]\end{cases},\quad f_4(d_{li})=\begin{cases}1 & ,d_{li}\in[0,2]\\ \dfrac{4-d_{li}}{2} & ,d_{li}\in[2,4]\\ 0 & ,d_{li}\notin[0,4]\end{cases}$$

Next, according to formula (4), we continue to calculate the grey statistics in 2013:

$$n_{11}=\sum_{l=1}^{5} f_1(\mathrm{d_{1i}})=0.889+0.889+0.889+0.778+0.889=4.334$$

$$n_{12}=\sum_{l=1}^{5} f_2(\mathrm{d_{1i}})=0.857+0.857+0.857+1+0.857=4.428$$

$$n_{13}=\sum_{l=1}^{5} f_3(\mathrm{d_{1i}})=0.4+0.4+0.4+0.6+0.4=2.2,\quad n_{14}=\sum_{L=1}^{5} f_4(d_{1i})=0$$

Then for U1, total grey statistic $n_1 = n_{11} + n_{12} + n_{13} + n_{14} = 10.962$.

So, for U1, the grey statistic belongs to each grey category is:

$$r_{11} = \frac{n_{11}}{n_1} = 0.395,\ r_{12} = \frac{n_{12}}{n_1} = 0.404,\ r_{13} = \frac{n_{13}}{n_1} = 0.201,\ r_{14} = \frac{n_{14}}{n_1} = 0$$

The other grey statistic and total grey statistic can be gained in the same way. Therefore, the fuzzy judgment matrix of finance, internal operation, customer, learning and growth, and comprehension in 2013 can be established respectively.

$$R_F = \begin{bmatrix} 0.395 & 0.135 & 0.123 & 0.287 & 0.311 \\ 0.404 & 0.175 & 0.158 & 0.369 & 0.400 \\ 0.201 & 0.245 & 0.221 & 0.344 & 0.289 \\ 0 & 0.445 & 0.498 & 0 & 0 \end{bmatrix}^T, R_{LG} = \begin{bmatrix} 0.335 & 0.232 & 0.319 & 0.253 \\ 0.406 & 0.299 & 0.411 & 0.326 \\ 0.259 & 0.419 & 0.270 & 0.421 \\ 0 & 0.050 & 0 & 0 \end{bmatrix}^T$$

$$R_{IO} = \begin{bmatrix} 0.311 & 0.232 & 0.343 & 0.245 & 0.262 & 0.327 & 0.303 & 0.434 \\ 0.400 & 0.298 & 0.417 & 0.315 & 0.337 & 0.396 & 0.390 & 0.395 \\ 0.289 & 0.418 & 0.240 & 0.440 & 0.401 & 0.277 & 0.307 & 0.171 \\ 0 & 0.052 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}^T, R_C = \begin{bmatrix} 0.319 & 0.279 & 0.414 \\ 0.411 & 0.358 & 0.399 \\ 0.270 & 0.363 & 0.187 \\ 0 & 0 & 0 \end{bmatrix}^T$$

$$R_A = \left[\begin{array}{cccccccccc} 0.395 & 0.135 & 0.123 & 0.287 & 0.311 & 0.311 & 0.232 & 0.343 & 0.245 & 0.262 \\ 0.404 & 0.175 & 0.158 & 0.369 & 0.400 & 0.400 & 0.298 & 0.417 & 0.315 & 0.337 \\ 0.201 & 0.245 & 0.221 & 0.344 & 0.289 & 0.289 & 0.418 & 0.240 & 0.440 & 0.401 \\ 0 & 0.445 & 0.498 & 0 & 0 & 0 & 0.052 & 0 & 0 & 0 \end{array}\right.$$
$$\left.\begin{array}{cccccccccc} 0.327 & 0.303 & 0.434 & 0.319 & 0.279 & 0.414 & 0.335 & 0.232 & 0.319 & 0.253 \\ 0.396 & 0.390 & 0.395 & 0.411 & 0.358 & 0.399 & 0.406 & 0.299 & 0.411 & 0.326 \\ 0.277 & 0.307 & 0.171 & 0.270 & 0.363 & 0.187 & 0.259 & 0.419 & 0.270 & 0.421 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.050 & 0 & 0 \end{array}\right]^T$$

On the basis of formula (7), we obtain the fuzzy comprehensive evaluation vectors.

2013: B_F=[0.257,0.296,0.244,0.203], B_{IO}=[0.322,0.383,0.292,0.003], B_C=[0.315,0.387,0.298,0], B_{LG}=[0.311,0.390,0.293,0.006], B_A=[0.3,0.357,0.277,0.066]

2014: B_F=[0.411,0.393,0.196,0], B_{IO}=[0.356,0.401,0.243,0], B_C=[0.313,0.381,0.306,0], B_{LG}=[0.282,0.362,0.350,0.006], B_A=[0.365,0,395,0.24,0]

2015: B_F=[0.404,0.387,0.209,0], B_{IO}=[0.381,0.394,0.225,0], B_C=[0.26,0.334,0.406,0], B_{LG}=[0.297,0.38,0.323,0], B_A=[0.371,0.385,0.244,0]

Calculate the fuzzy comprehensive evaluation results by the formula (8), and the final results are displayed in table 6. Meanwhile, we draw the line graph in figure 2 according to table 6.

Table 6 Evaluation Results

	Z_F	Z_{IO}	Z_C	Z_{LG}	Z_A
2013	6.011	7.045	7.034	7.006	6.716
2014	7.430	7.226	7.014	6.834	7.251
2015	7.390	7.312	6.708	6.948	7.254

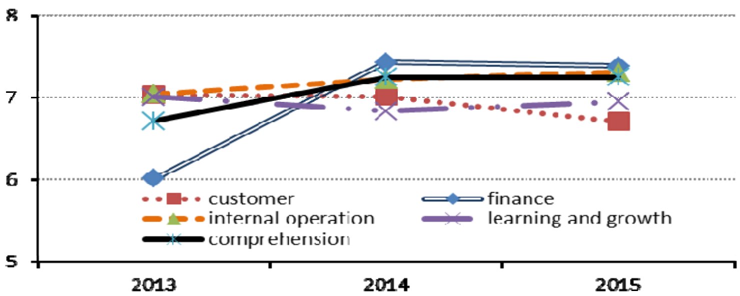

Figure 2 Evaluation Results

The results show that comprehensive performance has gradually increased in the past three years. The comprehensive performance in 2013 only reached the ordinary grade. However, due to the rapid growth and relative importance of financial performance, the comprehensive performance had climbed to the good grade in 2014 and 2015.

As visualized in Fig.2, a sharp increase occurred in 2014 in terms of finance. Compared with 2013, the financial performance in 2014 increased by 23.6%. While in 2015, it still remained in good grade. That means that enterprise S paid more attention to the financial management, subsequently the performance improved in the past two years.

On the one hand, the performance of internal operation held minute change between 2013 and 2015. The operation was steady for three consecutive years. Even so, the performance grades were still in good condition, enterprise S could be raised to a higher grade by enhancing operational efficiency in the future.

There was a slow decline in the performance of customer, this is particularly illuminated in the performance of 2015 which only received 6.708. We can conclude that enterprise S overlooked customer management in the latter two years. The enterprise should focus on customer needs, and maintain effective interactions with customers.

The learning and growth ability of enterprise S reveals a relative stability. It can essentially achieve good grade. With market competition becoming fiercer and the change of the surrounding environment growing in complexity, the enterprise must increase the flexibility and adaptability by learning and innovation.

4. Conclusion

A comprehensive evaluation method, which combines AHP with Grey theory and fuzzy comprehensive method, was proposed and applied to a performance evaluation for the third-party cold chain logistics enterprises. The results demonstrate that integrated framework is suitable for evaluation performance. Amidst the past three years, the comprehensive performances of enterprise S have gradually improved. And all aspects are in stable condition except finance. Additionally, the evaluation results are accepted by enterprise S. However, we have not claimed that the comprehensive evaluation method is conclusive or exhaustive. With the development of 3PCCL enterprise, further research should be conducted in the future.

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