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**Research on the Performance Evaluation of Logistics
Enterprise Based on the Analytic Hierarchy Process**

Jiansheng Zhang^{ab*}, Wei Tan^a^a*Chongqing Three Gorges University, Chongqing, China*^b*Southwest Jiaotong University, Chengdu, China*

Abstract

The performance evaluation plays a more and more important role in the modern enterprise management, and the method of evaluation system on enterprise performance is always an important question in the theory and practice. So this paper set up a scientific, reasonable performance evaluation index system which was especially suitable for the small and medium third party logistics enterprise from the four levels of financial, customers, business and innovation. Meanwhile, according to the index system, it gave a performance evaluation with the Chinese access logistics corporation. The results showed that the construction of the index system was reasonable, and the evaluation results also were reliable.

Keywords: Logistics enterprise; Performance evaluation; The Analytic Hierarchy Process

1. Introduction

With the rapid economy development in the world, the modern logistics is as an advanced organization and management technology which has been developing rapidly in the global scope, and it is highly valued by the governments and enterprises[1]. China's entry into WTO, the logistics enterprise has got a further developing, but it faces a more fierce market competition. This situation calls for establishing corresponding performance evaluation index system for logistics enterprise, and the determination of reasonable evaluation method which are in order to scientifically and objectively reflect the performance of logistics enterprise[2] [3]. But at present the researches on logistics enterprise's benefit evaluation are little, on the one hand, because the process of logistics enterprise is not long, and the enterprises with obvious characteristics and development model have not yet fully formed; on the other hand, the activity of logistics enterprise has particularity, it is difficult to copy the traditional enterprise performance evaluation method[4] [5].

* Corresponding author. Tel.: 15923400592;.
E-mail address: asheng0124@126.com.

Objectively measuring the economic benefit of enterprise logistics shows particularly important for promoting the development and improve the management level of logistics enterprise. Establish an objective, reasonable logistic enterprise performance evaluation index system, and adopt scientific performance evaluation method, its important significances lay in the following: First, promote the optimized allocation of logistics resources, improve the management level of enterprises and promote enterprise performance. Second, provide the references for the performance evaluation standard and national policy formulation. Therefore, this paper attempts to design a feasible and convenient performance evaluation system, in order to give a performance evaluation for the third party logistics enterprise[6].

2. The Establishment of Performance Evaluation Index System in the Third Party Logistics Enterprise

According to the characteristics of the third party logistics enterprise, based on the defects of current domestic and international evaluation index system, this paper this paper sets up a scientific, reasonable performance evaluation system which is especially suitable for the small and medium third party logistics enterprise from the four levels of financial, customers, business and innovation[7].

Table I The performance evaluation index system of the third party logistics enterprise

| The targets | The standards | The index |
|---------------------|-----------------------|--|
| The small targets A | The financial B1 | Profitability C11, Solvency C12, Development ability C13 |
| | The customers B2 | Enterprise image C21; Operation quality C22, Service level C23 Cost evaluation C24 |
| | The transportation B3 | Economy C31, safety C32 , Ability sex C33 |
| | The storage B4 | Economic benefits C41, Warehouse operation quality C42 Storage utilization degree C43, Research quantity C44 |
| | The technology B5 | Advanced management method C51, Transportation automation C52 Storage automation C53, Information technology , utilization rate C54 |

3. The Determination of Index Weight

3.1 The Analytic Hierarchy Process

The analytical hierarchy process (AHP) was put forward by the United States professor T.L.Satty in the early 1970s. The basic procedures are as follows:

Tectonic judgment matrix. After building the hierarchical analysis model, the subordinate relationships among each level are determined, and then gives comparison between two elements in different levels to construct more judgment matrix[8].

Judge scale. Expressing the relative importance of number scale of the element A to element B. Such as the table 2.

Table II The relative importance of the element A to element B

| The scale | The meaning |
|-----------|---|
| 1 | Two factors have the same importance |
| 3 | A factor is slightly important than the other factor |
| 5 | A factor is obviously important than the other factor |
| 7 | A factor is strongly important than the other factor |
| 9 | A factor is extremely important than the other factor |
| 2,4,6,8 | The average value of the above judge |

The steps of calculating weight:

Calculate the product of the element in each line of the judgment matrix,

$$M_i = \prod_j a_{ij} \tag{1}$$

Calculate the nth root of M,

$$V = \sqrt[n]{M_i} \tag{2}$$

Standardize the vectors of $V = (W_1, W_2, \dots, W_n)^T$, that is $W_i = \frac{V_i}{\sum V_i}$ ($i = 1, 2, \dots, n$) (3)

Calculate the biggest characteristic root of judgment matrix,

$$\lambda_{max} = \frac{1}{n} \sum_i \left[\frac{(AW)_i}{W_i} \right] \tag{4}$$

The above calculated characteristics value is corresponding to the relative importance weights between various factors from the former level to the next level. Because people give the judgment matrix, there is always not accurate, at the same time, as the increasing dimension of the judgment matrix, it will also produce errors[9]. Therefore, in order to eliminate the error and improve reliability, we especially introduce the two experience indexes:

The judgment matrix deviates the consistency index C.I, $C.I = \frac{\lambda_{max} - n}{n - 1}$, and the index can check the consistency degree of the judgment matrix.

The judgment matrix divides the random consistency index R.I. The index could eliminate the error brought by the increasing dimension. For the 3-12th order judgment matrix, the R.I value respectively is in table 3:

Table III The R.I value corresponding to different order number

| | | | | | |
|---------------|------|------|------|------|------|
| The order | 3 | 4 | 5 | 6 | 7 |
| The R.I value | 0.52 | 0.89 | 1.12 | 1.26 | 1.36 |
| The order | 8 | 9 | 10 | 11 | 12 |
| The R.I value | 1.41 | 1.46 | 1.49 | 1.52 | 1.54 |

In the actual process, it usually gives the inspection with the ratio of C.I to R.I, that is $C.R = \frac{C.I}{R.I}$, Generally speaking, when $C.R < 0.1$, we think the judgment matrix has the consistency.

3.2 The Index Weights Analysis on the Performance Evaluation with the AHP

The Establishment of Weight in the Level 1 Structure. First, establish the judgment matrix for the financial B1, customers B2, transportation B3, warehousing B4, technology B5, and the results are seen in table 4:

Table IV The judgment matrix of B1, B2, B3, B4 and B5

| | | | | | |
|----|-----|-----|-----|-----|-----|
| A | B1 | B2 | B3 | B4 | B5 |
| B1 | 1 | 5 | 7 | 3 | 1/5 |
| B2 | 1/5 | 1 | 3 | 1/3 | 1/3 |
| B3 | 1/7 | 1/3 | 1 | 1/5 | 3 |
| B4 | 1/3 | 3 | 5 | 3 | 1/7 |
| B5 | 5 | 3 | 1/3 | 7 | 1 |

Table V The calculation of combined weight

| The targets | The standards | The weights of standard | The indexes | The weights of index | combined weights |
|---|------------------------|-------------------------|-------------|----------------------|------------------|
| The total goals of Performance evaluation In Logistics Enterprise A | Financial B1 | 0.319 | C11 | 0.442 | 0.141 |
| | | | C12 | 0.322 | 0.103 |
| | | | C13 | 0.236 | 0.075 |
| | Customers B2 | 0.101 | C21 | 0.205 | 0.021 |
| | | | C22 | 0.315 | 0.032 |
| | | | C23 | 0.34 | 0.034 |
| | | | C24 | 0.14 | 0.014 |
| | Transportation B3 | 0.025 | C31 | 0.45 | 0.011 |
| | | | C32 | 0.325 | 0.008 |
| | | | C33 | 0.225 | 0.006 |
| | Storage B4 | 0.202 | C41 | 0.422 | 0.085 |
| | | | C42 | 0.255 | 0.051 |
| | | | C43 | 0.215 | 0.043 |
| | | | C44 | 0.108 | 0.022 |
| | Advanced Technology B5 | 0.353 | C51 | 0.332 | 0.117 |
| | | | C52 | 0.225 | 0.079 |
| C53 | | | 0.255 | 0.09 | |
| C54 | | | 0.188 | 0.066 | |

Calculate the approximate values for the characteristics value with the root method. According to the formula (1), (2), (3) and (4), we can draw the following results:

$$V = [1.838, 0.582, 0.143, 1.165, 2.036]^T, W = [0.319, 0.101, 0.025, 0.202, 0.353]^T$$

$$AW = [1.127, 0.425, 1.206, 1.190, 0.683]^T, \lambda_{\max} = 5.224 \quad C.I = 0.056 \quad C.R = 0.05 < 0.1,$$

The consistency test results are acceptable. Therefore, the weight of level 1 is:
 $W = [0.319, 0.101, 0.025, 0.202, 0.353]^T$

The Establishment of Weight in the Level 2 Structure with AHP Method. The calculation method of evaluation index on the level 2 weight is same as that of level 1, the results are in table 5:

4. The Case Analysis

Table VI The comprehensive evaluation calculation on Chinese access logistics company

| The indexes | The grades | | | | scores | Compre-hensive scores |
|-------------|------------|------|--------|------|--------|-----------------------|
| | optimal | good | medium | poor | | |
| C11 | 2 | 3 | 5 | 0 | 27 | 3.807 |
| C12 | 6 | 4 | 0 | 0 | 36 | 3.708 |
| C13 | 3 | 4 | 3 | 0 | 30 | 2.25 |
| C21 | 2 | 4 | 4 | 0 | 28 | 0.588 |
| C22 | 4 | 4 | 2 | 0 | 32 | 1.024 |
| C23 | 2 | 3 | 5 | 0 | 27 | 0.18 |
| C24 | 2 | 4 | 3 | 1 | 27 | 0.378 |
| C31 | 4 | 3 | 2 | 1 | 30 | 0.33 |
| C32 | 3 | 4 | 2 | 1 | 29 | 0.232 |
| C33 | 2 | 3 | 3 | 1 | 24 | 0.144 |
| C41 | 4 | 3 | 2 | 1 | 30 | 2.55 |
| C42 | 3 | 4 | 3 | 0 | 30 | 1.53 |
| C43 | 4 | 3 | 3 | 0 | 31 | 1.333 |
| C44 | 3 | 4 | 3 | 0 | 30 | 0.66 |
| C51 | 3 | 4 | 2 | 1 | 29 | 3.393 |
| C52 | 1 | 3 | 4 | 2 | 23 | 1.817 |
| C53 | 3 | 4 | 3 | 0 | 30 | 2.7 |
| C54 | 2 | 4 | 3 | 1 | 27 | 1.782 |

The Chinese access logistics company is a large enterprise that is engaged in the logistics industry. Through the survey, we found that the logistics corporation was lack of a set of scientific and comprehensive performance evaluation system which caused the company didn't know much about their own advantages and disadvantages. In this paper, we did the performance evaluation for this logistics enterprise based on the analytic hierarchy process[10].

Giving the score for the specific index with expert scoring method. On the basis of each index score is divided into four grades: optimal (4 points), good (3 points), medium (2 points) and poor (1 point), according to level for the points test. Based on the 18 secondary indexes in the performance evaluation

index system for the third party logistics enterprise, we invited 10 experts and asked them to give the score with the actual operating conditions of the Chinese access logistics company. The specific results are seen in table 6.

From the above calculation, we can see the comprehensive performance score of Chinese logistics company is 28.4, and it takes 71% to the total score 40. That is to say, when the total score is 100 points, the comprehensive performance of Chinese logistics company is 71 points. Combined with performance evaluation index system, it can be found that the reasons of low performance score are the low profitability C11, logistics enterprise image C21, logistics service level C23, cost evaluation C24, safety and reliability C32, ability C33, management method C51, transportation automation C52, the use of information technology C54, the scores of the above are all no more than 30 points.

Conclusions

The performance evaluation accounts for an important position in the modern enterprise management, and the method of evaluation system on enterprise performance is always an important question in the theory and practice. The enterprise performance evaluation can make the enterprise to recognize their advantages and disadvantages and find that there is unreasonable phenomenon, so as to further improve their management level. From the present theory literatures, it can be seen majority of papers for selecting evaluation indicators and evaluation method, but few establish performance evaluation system for practice. So this paper set up a scientific, reasonable performance evaluation index system which was especially suitable for the small and medium third party logistics enterprise from the four levels of financial, customers, business and innovation. Meanwhile, according to the index system, it gave a performance evaluation with the Chinese access logistics corporation. The results showed that the construction of the index system was reasonable, and the evaluation results also were reliable.

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