The Enterprises Performance Evaluation Based on Analytic Hierarchy Process (AHP) and Entropy Value Mode

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Abstract: With the development of the social productivity and the open economy, in China, industrial enterprises have already faced with more and more challenges from home and abroad. In the intensive competition, in order to strengthen the internal incentive mechanism to improve the corporate efficiency, enterprises must choose a set of suitable performance evaluation methods. As for the characteristics of industrial enterprises performance evaluation systems, this paper puts forward a new comprehensive evaluation system — Analytic Hierarchy Process (AHP) and entropy value mode. This method uses APH mode and entropy value mode to analyze industrial enterprises' performance generally, and combined with weight to estimate. This paper offers discussion of this mode in the usage process of industrial enterprises performance evaluation with cases, so as to provide a more objective estimation method of enterprises performance evaluation.

Keywords: Analytic Hierarchy Process (AHP); entropy value; weight; performance evaluation

1. Introduction

In China, industrial enterprises have already faced with more and more domestic and foreign challenges. Under the market competition environment, it has become a problem that calls for immediate solution to scientifically analyze the industrial enterprises' performance evaluation in order to clear the advantages and weaknesses of enterprises and pertinently take measures to improve enterprise competitiveness. Enterprises' performance evaluation is to use the following ways: depending on the factors of enterprises' performance, using the system project method and certain indexes system, compared with unified assessment criteria, carrying out a contrast certain quantitative and qualitative analysis in a specified sequence, make a objective, fair, accurate and comprehensive estimation about the enterprises' organizing, finance, economy during a certain period. The performance appraisal of most industrial enterprises in China is still based on experiencing judgment that is lack of objective criteria, without normalized, fix quantifying estimation system. Therefore, we need to use the system estimation theory, combined with the characteristics of the industrial enterprises' performance evaluation, to build the indexes system of the industrial enterprises' performance evaluation and estimation model, and to provide the suitable performance estimation method of our industrial enterprises, in order to improve the rationality and effectiveness of industrial enterprises performance estimation.

2. The problems of industrial enterprises performance estimation

The evaluation of the industrial enterprises performance involves two major issues: estimation indexes system and appraisal method. Because industrial enterprises performance is a result of different factors, its descriptive indexes must be made up of a series of mutual related and mutual restraint estimation indexes; Thus, we should adopt appropriate, objective and comprehensive appraisal method to enhance the accuracy and precision. At present, there are two main problems of the building construction enterprises performance:

(1)Estimation indexes become more and more clarifying

At present estimation indexes of the building construction enterprises performance is more and more clarified, some even achieves more than 100 indexes. This will lead to a series of problems. First, it is difficult to find the main problem of the enterprise management from the evaluate results; Secondly, there exists a high degree of dependency among the indexes, which causes the repeated and irrational estimation, and it also increases the complexity of the problem analysis.

(2)The subjectivity of determining the indexes weight

At present, the more comprehensive evaluation methods, such as the weighted synthesis method, vague and comprehensive evaluation, etc, are the methods to subjectively determine the weight of indexes. The meth-

ods to subjectively determine the weight of indexes influenced by the knowledge structure and personal preference greatly, which easily leads to too high or underestimated estimation of the importance of some indexes, and it is difficult to reflect the fact. To solve these two problems, this paper attempts to use Analytic Hierarchy Process (AHP) and entropy value mode to carry out a comprehensive estimation of the industrial enterprises performance.

3. The Principle of Analytic Hierarchy Process (AHP) and Entropy Value Mode

3.1. According to selected evaluation indexes, carry on the determination of the index weight Subsection

There are a lot of methods to confirm indexes weight, for instance expert's investigation method, Analytic Hierarchy Process (AHP), statistical method, entropy technology, etc. AHP method is widely used in practice, the usage steps of this method are clear, the calculation is simple, the calculative thinking is explicit and methodical; But this is a subjective evaluation method, the judging matrix the experts make a pairwise comparison of the importance of every index. Though this method demands to carry on the test of consistency to guarantee the transitivity between the estimation values, the estimation still isn't clear, the inherent relations such as competitiveness between every index, etc. are not well reflected. In order to dispel this influence, this paper introduces the entropy weight method, entropy weight can be used as a weight value, but it has its special meaning: after objects of evaluation are given and all kinds of evaluation indexes are determined, under such circumstances, entropy weight is the relatively fierce intensity in the competition of every index. The mode modifies the AHP weight on the basis of entropy weight, to get associative entropy weight of index, and to improve the objectivity of index entropy weight.

3.2 The Determination of AHP Weight Sub-subsection[1]

The steps of the AHP is as follows:

①The AHP hierarchical structure mode should be set up according to the certain estimation object and estimation criterion. Hierarchical structure model is divided into scheme layer, criterion layer and object layer, they are confirmed specifically based on the practical conditions.

②Construct pairwise compared judge matrix

$$A = (a_{ij})_{k \times k} \quad (k = l, m, ..., n) \qquad (1)$$

③The hierarchy are arranged in an individual order and carried on the test of consistency.

④The hierarchy are arranged in a total order and car-

ried on the test of consistency.

3.3. Entropy weight determination[2]~[4]

An estimation question which has m estimation indexes and n estimation objects (shortened form is (m, n) estimation question), the calculation of entropy weight has the following several steps:

① The program analytic estimation matrix (or estimation table) can get according to the methods such as Delphi method, questionnaire survey and so on.

This program estimation matrix is only used for initial calculation of initial weight, therefore the accuracy request is not very high.

According to the following equation to get matrix R after standardized $R^{'}$:

$$R = (r_{ij})_{m \times n} \qquad (2)$$

$$r_{ij} = \frac{\max r_{ij}^{'} - r_{ij}^{'}}{\max r_{ij}^{'} - \min r_{ij}^{'}} \qquad (3)$$

②Calculate entropy H_i of ith evaluation index

$$H_i = -k \sum_{j=1}^{n} f_{ij} \ln f_{ij} \qquad (4)$$

(i=1, 2, ⋯, m)

 Assuming for

$$f_{ij} = \frac{r_{ij}}{\sum_{j=1}^{n} r_{ij}} \qquad (5)$$

when $f_{ij} = 0$, $f_{ij} \ln f_{ij} = 0$. Choosing k, make $0 \leq H_i \leq 1$, this kind of standardization is very essential while comparing.

③Calculate of entropy weight $\omega_i^{'}$ of ith index

$$\omega_i^{'} = \frac{1 - H_i}{m - \sum_{i=1}^{m} H_i} \qquad (6)$$

The entropy of the index is greater, its entropy weight is smaller, and it satisfies $0 \leq \omega_i^{'} \leq 1$ and $\sum_{i=1}^{m} \omega_i^{'} = 1$.

Vector quantities $\omega^{'}$ is the vector quantities of index entropy weight.

3.4. The selection of neural network hierarchy weight

After calculating the weight $\omega_i^{''}$ of the index by Analytic Hierarchy Process (AHP), to make these two a scientific association with the entropy weight $\omega_i^{'}$ of the index. It

can let index value be more objective, and get the assembled weight vector quantities W of the index, therefore, the responsibilities what each side of the project accident should be responsible for can be divide according to the assembled weight of each index.

The weight of the neural network is calculated as follows:

$$\omega_i = \frac{\omega_i^{'}\omega_i^{''}}{\sum_{i=1}^{m}\omega_i^{'}\omega_i^{''}} \qquad (7)$$

4. The usage case of the industrial enterprises performance estimation based on Analytic Hierarchy Process (AHP) and entropy value mode

4.1. Application background

A group includes six industrial enterprises and every enterprise need performance evaluation yearly. The indexes estimation system is a pyramid-shaped structure, containing 3 indexes layers, coming to 49 indexes. The former estimation used the weighted synthesis method and vague and comprehensive evaluation, the evaluation work was complex and evaluation results are often influenced by the individual factors greatly.

4.2. The analysis of hierarchy factors weight

According to 3 indexes layers and original 49 indexes, using the software to calculate 5 pairwise comparison matrix factors F1-F5. According to pairwise comparison matrix factors, we can draw the following analysis: 15 indexes such as plan complement rate, labor productivity rate, work eligible rate, labor and cost management, planning cost complement rate, reflect the basic instance of production and operation, etc, have great load of F1, which are defined as production and operation factors; Similarly, 13 indexes such as the major accident rate, maintenance quality eligible rate, safety production, security management, security facilities intactness rate and security management system, etc, have great load of F2, they are defined as security quality factors; the indexes such as information files management, resources management, technical management and financial management, etc, have great load of F3, they are defined as logistics management factors; the indexes such as posts-changing complementary capacity and honest in

performing their duties, etc, have great load of F4, they are defined as leadership development factors; cost reducing prices and cost reducing rate, etc, have great load of F5, they are defined as costs control factors.

4.3. The enterprises performance estimation based on entropy value mode

(1) data processing of indexes

According to the expert's estimation and the related laws' and regulations' criterion, responsibilities analysis estimation matrix can be get as follows (The full marks is 10, i.e. the highest score of each responsible side in each kind of accident cause is 10 points, and the lowest score is 0 points):

$$R' = \begin{bmatrix} 8 & 9 & 7 & 4 & 6 & 8 \\ 5 & 6 & 8 & 8 & 9 & 6 \\ 5 & 7 & 8 & 5 & 9 & 7 \\ 6 & 4 & 5 & 7 & 8 & 4 \\ 4 & 5 & 7 & 4 & 8 & 4 \end{bmatrix} \qquad (8)$$

(2) The process of calculation

According to the data of table 2, we can use the entropy value mode to calculate the weight of each index Fj, weight value Hj and differentiated parameter gj, and determine the weight $\omega_i^{'}$ of each index.

With the entropy of analytic hierarchy, the combined weight W can be calculated, see table 1 and 2.

4.4. The conclusion of estimation

The 6 industrial enterprises of this group pay attention to the production and operation, security management, from factors weight analysis. But they pay a little attention to logistics management, leadership development, cost control, etc, which express each enterprises should improve enterprise management and leadership of its construction; the estimation based on Analytic Hierarchy Process (AHP) and entropy value mode shows the performance of industrial enterprise E is No. 1 ranking. The group headquarters should apply appropriate incentives awards to this enterprise in order to encourage the initiative of the managers and staff, and should encourage other enterprises to learn the experiences of this enterprise. This estimation conclusion is praised by the group headquarters, they think it is suited to realities of this group, and pointed out the direction of the enterprises' development and construction.

Table 1. The calculation of each indexes economic benefit.

The enterprises	F1:production and operation factors	F2:security quality factors	F3: logistics management factors	F4: leadership development factors	F5: costs control factors

e	0.9958	0.9956	0.9978	0.9879	0.9948
g	0.0075	0.0078	0.0068	0.0085	0.0086
a	0.1919	0.2058	0.1859	0.2197	0.2002

Table 2. The weight of 6 enterprises.

The enterprises	A	B	C	D	E	F
Weight	0.1589	0.1520	0.1598	0.1789	0.1858	0.1720
Ranking	5	6	4	2	1	3

5. Conclusion

Through the implementation of standard performance estimation, the feasibility and rationality of performance estimation can be improved. This paper focuses on industrial enterprises performance estimation has the characteristic of complex indexes, considers the factors of objective weight, and defines a new method: Analytic Hierarchy Process (AHP) and entropy value mode combined with these two modes. The application of theory and practice has proved that this mode is a more objective method to estimate the industrial enterprises performance. This mode can overcome the limitations of subjective assessment on the basis of the quantification description and related analysis of estimation indexes, it uses the software to calculate, the enterprises performance estimation is accurate, objective and convenient. This mode also can improve and enhance the quality of enterprises performance, and it is a better effective way to be used in enterprises performance.

References

[1] Qiu Wanhua. *Management Decision-making and the Practical Application of Entropy Weight* [M]. Beijing:China Machine Press, 2001, 223-227.

[2] Yang Shiwen,Zhangyan, *The Principle of management*[M]. Beijing: China Renmin University Press, 1994, 189-193.

[3] Renhong,Lan Dingyun. The Safety Management of Project Construction[M].Beijing:China Architecture & Building Press, 2005, 184-190.

[4] Hu Yonghong, He Sihui. *The Integrated Estimation Methods* [M]. Beijing: Sciences Press, 2000, 10-11.