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Evaluation Model of Enterprise Production Importance Based on Analytic Hierarchy Process and TOPSIS Entropy Method

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Abstract: The ordering of raw materials is an important link in the supply chain management of production enterprises. Using the order quantity and supply quantity data of 402 raw material suppliers, this paper first constructs an evaluation model reflecting the importance of ensuring enterprise production by using analytic hierarchy process, and gives weight 10 times on this basis, so as to increase the objectivity of weight giving in analytic hierarchy process. Then TOPSIS entropy method is used to process these 10 results to form an evaluation model reflecting the importance of ensuring enterprise production. Finally, 50 most important suppliers are selected according to the results.

1. Introduction

The supply of economic and high-quality raw materials has an important impact on the production cost and product quality of enterprises. Firstly, this paper makes a quantitative analysis on the supply characteristics of 402 suppliers. Combined with relevant data, the supply characteristics of suppliers are mainly determined by five influencing factors: supply reliability, supply stability, supply accuracy, type of raw materials and supply volume. The supply reliability is related to the difference between the order quantity and the supply quantity; Supply stability is related to average oversupply and average difference supply; The type of raw material is the type of raw material specially provided by the supplier; The supply is related to the average supply per week and the maximum supply per week.

Considering the influencing factors of the above seven categories, a supplier comprehensive selection model based on AHP can be established. Because the weighted subjectivity of AHP is too strong, in order to improve, we assign values for many times to obtain multiple analytic hierarchy process results, and process these results with TOPSIS entropy method to obtain the final model.

2. Model Establishment and Solution

2.1 Construction of Index System

(1) Supply reliability S: It can fully reflect the matching degree of supply and demand capacity

between suppliers and enterprises.

$$S = \sum_{i=1}^{402} (x_i - y_i)^2 \div N$$

Where x_i represents the order quantity in week i, y_i represents the supply quantity in week i, and N represents the effective order times.

(2) Average oversupply c_1: It represents the average value of the supplier's oversupply.

$$\begin{cases} k_{i+1} = k_i + (y_i - x_i) & (x_i < y_i) \\ k_{i+1} = k_i & (x_i > y_i) \end{cases}$$

$$C_1 = k_{240} \div T_1$$

(3) Average shortage supply quantity c_2: the average value of the supplier's shortage supply quantity.

$$\begin{cases} g_{i+1} = g_i + (x_i - y_i) & (x_i > y_i) \\ g_{i+1} = g_i & (x_i < y_i) \end{cases}$$

$$c_2 = g_{240} \div T_2$$

(4) Accurate delivery rate J

$$J = Z \div N$$

Where Z represents the number of accurate deliveries and N represents the number of effective orders.

(5) Supply stability f: the stability is determined by the average oversupply and average shortage.

$$f = 0.6 * c_1 + 0.4 * c_2$$

Where c_1 represents the average excess supply and c_2 represents the average shortage supply. Considering the need to ensure production, we make the impact of average oversupply larger, and the weight is set to 0.6.

(6) Advantages of raw material types

According to the known data, the volume of material A consumed per cubic meter of product is the smallest, so the transportation and storage cost is low. Therefore, it is considered that the material advantage of material A is larger, the material advantage of material B is in the middle, and the material advantage of material C is smaller.

2.2 Construction of Evaluation Model

2.2.1 Analytic Hierarchy Process

Analytic hierarchy process is a combination of qualitative and quantitative analytic hierarchy process, which is suitable for those problems that are difficult to be analyzed completely quantitatively. Therefore, we decided to use seven index data to construct the evaluation reflecting the importance of ensuring enterprise production based on analytic hierarchy process. The specific process is as follows:

① The hierarchical structure model of analytic hierarchy process is established

In order to achieve a structured and hierarchical structural model of decision-making problems, the complex problems are first decomposed into some factors, and then these factors form several levels according to their attributes and relationships. The factors at the upper level are used as criteria

to dominate the relevant factors at the lower level. These layers can be divided into target layer, criterion layer and scheme layer.

② Construct pairwise comparison matrix

Suppose to compare the influence of N factors $\{C_1, C_2, \ldots, Cn\}$ on a factor Z, take two factors C_i and C_j each time, and use a_{ij} to represent the ratio of the influence of C_i and C_j on Z. The result matrix is represented by $A = (a_{ij})_{n\times n}$, which is called the judgment matrix.

It is easy to see that if the influence ratio of C_i and C_j on Z is a_{ij}, the influence ratio of C_i and C_j on Z should be $a_{ji} = \frac{1}{a_{ij}}$

③ Consistency inspection processing

The calculation formula for calculating the consistency index (recorded as CI) is

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

④ Calculation of combined weight vector

⑤ Combination consistency inspection processing

2.2.2 TOPSIS Entropy Method

In the analytic hierarchy process, the influence weight of the criterion layer is given subjectively. Because the subjectivity is too strong, we will try to give multiple weights and get multiple scores. We think that when the weight changes slightly, the score of good suppliers will still be very high and the trend will remain unchanged. Finally, when there are many scores, we use TOPSIS entropy method to find the optimal solution, so as to increase the scientificity.

① In order to eliminate the influence of different data index dimensions, it is also necessary to standardize the forward matrix. Note that the standardized matrix is Z, where

$$z_{ij} = \frac{x_{ij}}{\sqrt{\Sigma_{i=1}^{n} x_{ij}^2}}$$

② Calculate the optimal and worst vectors composed of the maximum and minimum of each column as follows:

$$z^{+} = \left(z_{i1\,max}, z_{i2\,max}, z_{i3\,max}, \ldots\ldots z_{in\,max}\right)$$

$$z^{-} = \left(z_{i1\,min}, z_{i2\,min}, z_{i3\,min}, \ldots\ldots z_{in\,min}\right)$$

③ Calculate the distance between each year and the best and worst vector

$$D_m{}^{+} = \sqrt{\left(z_{m1} - z_{i1max}\right) + \cdots + \left(z_{mn} - z_{inmax}\right)}$$

$$D_m{}^{-} = \sqrt{\left(z_{m1} - z_{i1min}\right) + \cdots + \left(z_{mn} - z_{inmin}\right)}$$

④ Calculate proximity

$$C_m = \frac{D_m{}^{-}}{D_m{}^{-} + D_m{}^{+}}$$

2.3 Model Solution

(1) The ordering quantity and supply quantity data of 402 raw material suppliers of the enterprise in recent 5 years are read with Python programming, and the data are visualized. According to the visualization results and the principle of operations research, the index system to ensure the production importance of the enterprise is obtained, and the data of each factor of the criterion layer is obtained by programming, and the data of each factor of the criterion layer is preprocessed, When the larger the data is, the more unfavorable it is, the data is inverted.

(2) Establish hierarchical model.

(3) Assign weight ratio to criterion layer $\boldsymbol{h_i}$ $(\boldsymbol{i = 1, 2, 3, 4, 5})$. The comparison matrix $\boldsymbol{A}$ is calculated according to the weight ratio, and then the weight vector $\boldsymbol{w^{(2)}}$ is obtained according to the comparison matrix.

(4) Calculate the pairwise comparison matrix of each criterion of the third layer to the second layer $\boldsymbol{A_i}$ $(\boldsymbol{i = 1, 2, 3, 4, 5})$. Then a one-time test is carried out, and the normalized eigenvector $\boldsymbol{w_i}$ $(\boldsymbol{i = 1, 2, 3, 4, 5})$ corresponding to the maximum eigenvalue is obtained.

(5) Weight matrix of the third layer:

$$\boldsymbol{W^{(3)} = (w_1, w_2, w_3)}$$

(6) The combined weight vector of the third layer to the first layer is:

$$\boldsymbol{w^{(3)} = W^{(3)} w^{(2)}}$$

(7) Because the weighting in (3) is subjective, we will randomly assign the weight 10 times, and keep $\boldsymbol{h_4}$ minimum when assigning the weight of random symbols. Ten analysis results were obtained $\boldsymbol{w_i}^{(3)}(\boldsymbol{i = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10})$.

(8) According to the above calculation method of TOPSIS entropy, write a program to calculate it, record the results in the file title 1 TOPSIS results. CSV, sort the results, and get 50 suppliers according to this result.

3. Model Evaluation

We summarize various influencing factors into five aspects: supply reliability, supply stability, supply accuracy, types of raw materials and supply volume, and give reasonable strategies to reflect the importance of ensuring enterprise production, which has a strong guiding role in practice. The random weighting mechanism is introduced to improve the result deviation caused by too strong subjectivity in weighting in analytic hierarchy process. The combination of simple model is adopted to give consideration to efficiency and accuracy.

References

[1] Wang BINGTUAN. Concise course of mathematical modeling. Beijing: Tsinghua University Press; Beijing Jiaotong University Press, 2012-2.

[2] Zhao Dejin, Li Dongyang, Pu Chengdao, Wang Dechao. Research on reliability evaluation of machining center based on AHP entropy weight extension theory [J]. Manufacturing technology and machine tools, 2021 (11): 114-119 + 126.

[3] Li Feiya, Zhang Yubi, Wang Shengjiao. Construction of budget performance evaluation index system of technical universities based on analytic hierarchy process [J]. China Agricultural Accounting, 2021 (11): 22-24.