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Reputation Scoring Model based on AHM-CRITIC Combination Weighting Method

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Abstract

In this paper, based on the order and supply data of this enterprise in the past 5 years, the basic principles of selection and evaluation of suppliers are analyzed. And a reputation scoring model to select the 50 most important suppliers for the company has been established. Six indicators were selected to measure the reputation of suppliers, and the AHM-CRITIC combination weighting method was used to assign different weights to the indicators. The total score of each supplier was finally obtained, and the top 50 suppliers were selected as the most important 50 suppliers.

Keywords

Reputation Scoring Model; AHM-CRITIC; The Combined Weighting Method.

1. Introduction

Determining the ordering and transportation of raw materials for a manufacturing enterprise is a problem with a wide range of applications and a high degree of practicality. In practice, developing more economical ordering and transportation solutions for an enterprise can help it control costs and gain more profit. This problem is a typical supply chain management problem, which refers to the various activities and processes of planning, coordinating, operating, and optimizing the entire supply chain system, to deliver the right products in the right quantity and quality to the right place, and optimize the total cost.

2. Reputation Scoring Model

2.1. Selection and Acquisition of Evaluation Indicators

For every production enterprise, the selection of suppliers is a very important task in the procurement process, and the selection of suitable suppliers is of great significance to ensure the normal production of the enterprise. The type and quantity of raw materials supplied by the supplier, the time of continuous supply, the punctuality of delivery, and the quality of the goods will influence the choice of the production enterprise. To reflect the degree of dependence of this producer on different suppliers and the degree of trustworthiness of each supplier, I have selected six indicators as follows.

The total number of orders placed by the manufacturer with suppliers over five years (hereinafter referred to as the "total number of orders"). "Total order quantity" can reflect to a certain extent the trust of a manufacturer in its suppliers.

The supplier's total volume of supply for 5 years (hereinafter referred to as "total volume of supply"). After excluding the influence of abnormal data, "total supply" can reflect the supplier's supply strength to a certain extent, the larger the total supply, the more raw materials the supplier can provide, which is an important reference value for the normal operation of the production enterprise, so choose "total supply" as one of the indicators. Total supply" is one of the indicators.

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Supplier on-time delivery scores (hereinafter referred to as "on-time performance"). The credibility of the supplier is largely reflected in whether the raw materials can be delivered to the warehouse of the manufacturing enterprise on time, "punctuality" can not only measure the trustworthiness of the supplier but also is one of the important factors affecting whether the enterprise can put into production on time and in quantity. Therefore, "on-time performance" as one of the indicators is chosen. I operate with the table obtained through data pre-processing, subtracting the corresponding position of the two tables for each data, i.e. (supply minus order quantity). If the value obtained is non-negative, it means that the supplier has delivered the specified quantity of raw materials to the production company on time for that week, and vice versa, it means that the supplier has "broken the trust" for that week.

Supplier supply stability score (hereinafter referred to as "stability rate"). To ensure the normal production of enterprises, I certainly prefer to find suppliers who can provide stable supply to enterprises, so the "stability rate" of supply in history should also be used as one of the indicators to measure the credibility of suppliers. I calculate the variance of each supplier's supply data for each of the 10 data as the stability of supply data.

Supplier supply continuity score (hereinafter referred to as "continuity"). For the selection of suppliers, it is also necessary to consider the level of operation of the suppliers. In real life, there is great uncertainty in the operation of enterprises, and whether the continuous supply of raw materials for the production enterprise can reflect a certain extent the internal operation level of the supplier and the health level of the enterprise, which is one of the important factors whether the supplier can continue to supply in the future, and is also an important factor to ensure the normal operation of the production enterprise, so "continuity" should also be used as one of the measurement indicators. I process the 10 data separately and the textual formula is Continuity = maximum number of weeks of continuous supply per 24 weeks for each supplier/ 24 weeks to get the "continuity" indicator data for each supplier.

Continuity score of supplier deliveries meeting order quantity standards (hereinafter referred to as "continuous compliance rate"). To consider the supplier supply level, in addition to the continuity of supply, it is also necessary to consider whether the supplier can meet the order requirements of the production enterprise and the level of continuity to meet the order requirements if a supplier has completed the order requirements of the enterprise in sufficient quantity for some time, it is obvious that the supplier is excellent in terms of supply capacity or credibility. More importantly, it should be included in the "50 most important suppliers". Therefore, I introduced the supplier's "continuous rate of compliance" as one of the measurement indicators.

2.2. AHM-CRITIC Combined Assignment Method

Based on the above method, I obtained the scores of 6 indicators for each supplier. Considering the objective variation among the indicators, if the traditional and single weighting method is used, there are defects such as too much subjectivity, easy ignoring the influence of the size of the variation of the indicators and their conflict on the weights, I use the method of coupling the AHM subjective weights and CRITIC objective weights and establish the AHM-CRITIC combined weighting model to get the weights of different indicators.

2.2.1. AHM Empowerment

AHM (Attribute Hierarchical Model), by comparing each metric one by one. In turn, the ranking of all indicators is obtained, which is a better subjective assignment model based on hierarchical analysis (AHP). The specific steps are as follows.

(1) Weighting analysis

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The n-order AHP discriminant matrix $K=(k_{ij})_{n*n}$ is obtained by scoring the indicators based on the Satie 9-level scale method, and the value of k_{ij} indicates the relative importance between the measurement elements i and j.

(2) Construction of the attribute discriminant matrix

Unlike the hierarchical analysis (AHP), in the attribute hierarchy model (AHM) the relative attributes l_{ij} constitute a n order attribute discriminant matrix $L=(l_{ij})_{n*n}$, and there is the following transformation relationship between the relative attribute l_{ij} and the scale k_{ij}.

$$l_{ij}=\begin{cases}\frac{\beta m}{\beta m+1} & k_{ij}=m(i\neq j)\\ \frac{1}{\beta m+1} & k_{ij}=\frac{1}{k}(i\neq j)\\ 0.5 & k_{ij}=1(i\neq j)\\ 0 & k_{ij}=1(i=j)\end{cases} \tag{1}$$

where β is the attribute measure conversion parameter, usually β=1 or 2; k is a positive integer greater than 2; m is a positive integer greater than or equal to 2.

(3) Computation of relative attribute weights of indicators

The relative attribute weights W_{AHM} for each indicator were calculated according to the following equation.

$$W_{AHM}=\frac{2}{n(n-1)}\sum_{j=1}^{n}l_{ij} \tag{2}$$

where i=1,2, ..., n, n is the number of indicators. $\sum_{j=1}^{n}W_{AHM}=1$.

The final W_{AHM} obtained is shown in Table 1.

Table 1. The relative attribute weights

Indicator	Total supply	Total order quantity	Punctuality	Stability rate	Continuity	Continuous compliance rate
Weight	0.2617	0.2111	0.1611	0.1467	0.1167	0.1028

2.2.2. CRITIC Weight Assignment Method

Compared with other methods, the CRITIC weighting method is more objective and takes into account the influence of the variability and conflict between indicators on the weights. The CRITIC weighting method and the AHM attribute hierarchy model are both subjective and objective, and the weights of the indicators are more realistic and scientific than other weighting methods.

(1) The standard deviation of the calculated data σ

(2) The correlation coefficient matrix r_{ij} is constructed for each indicator. r_{ij} represents the correlation coefficients of (X_i, X_j) in the 2 indicator systems.

(3) The weight value of each indicator W_{CRI} is given by the following formula.

$$\begin{cases}W_{CRI}=\frac{C_j}{\sum_j^n C_j}\\ C_j=\sigma_j\sum_{j=1}^{n}(1-r_{ij})\end{cases} \tag{3}$$

The final WCRI determined is shown in Table 2.

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Table 2. The final WCRI

Indicator	Total supply	Total order quantity	Punctuality	Stability rate	Continuity	Continuous compliance rate
Weight	0.125	0.1106	0.3938	0.0807	0.1467	0.1431

2.2.3. Determination of Weights

The multiplier synthesis normalization method can effectively reflect the relative weight relationship of each index and its weight overall, so after determining the subjective weight W_{AHM} and objective weight W_{CRI} by the above method, the multiplier synthesis normalization method is used to obtain the comprehensive weight with the following formula. [4]

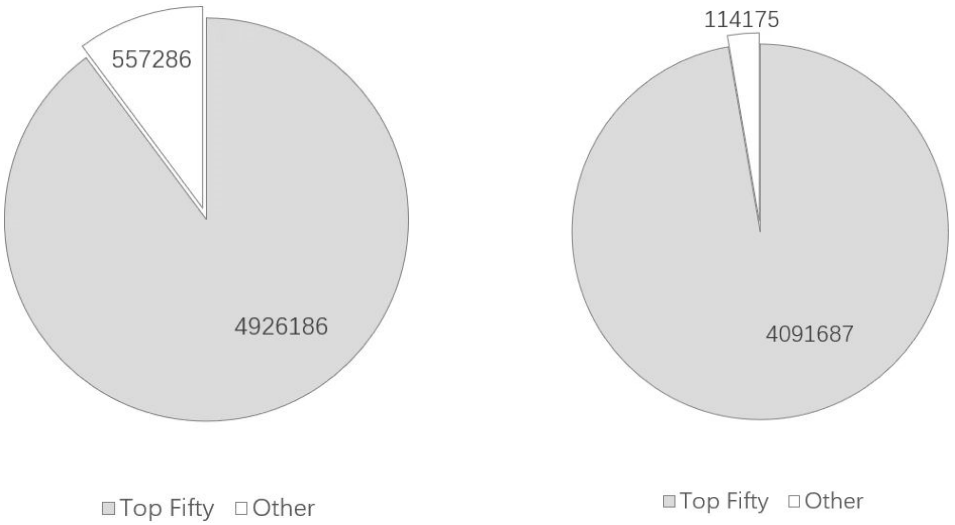
$$W_{AHM-CRI} = \frac{W_{AHM}W_{CRI}}{\sum_{j=1}^{n} W_{AHM}W_{CRI}} \tag{4}$$

After completing the AHM-CRITIC combined weighting method, I obtained the weights for each indicator, presented.

Table 3. The AHM-CRITIC combined weight

Indicator	Total supply	Total order quantity	Punctuality	Stability rate	Continuity	Continuous compliance rate
Weight	0.200466	0.143103	0.388852	0.072542	0.104896	0.090141

2.3. Analysis of Results



Order comparation Supply comparation

Figure 1. Order and supply comparation

In order to test the feasibility and reliability of the model, I collected data from 402 suppliers in an industry over the past five years. Then I quantified and analyzed the supply characteristics of suppliers, mined the limited data in-depth. And then substituted it into the above scoring-reputation model reflecting the importance of guaranteeing enterprise production, and scored 385 suppliers in addition to some suppliers with "potential". The top 50 suppliers were selected as the most important suppliers based on their scores. I compared their supply volume with the remaining suppliers who were not selected as "most important suppliers", and found that 12 of the top 50 suppliers with the highest scores had poor performance. After analysis, I believe that the problem is that the influence of "total supply" and "total order" has been reduced in the

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process of normalization, while in real life, the size of supply and order quantity often play a decisive role in choosing suppliers. To meet the actual situation, I selected 12 companies from the ranks of the "most important suppliers" that were not selected in terms of the volume of supplies and orders.

The results of the final solution were examined. The pie charts of the order and supply comparison were drawn in Figure 1.

It is easy to see that the 50 most important suppliers selected have accounted for the majority of both orders and deliveries over the past 5 years, with the 50 suppliers selected accounting for 89.83% of orders and 97.29% of deliveries, which shows that the selection of suppliers is scientific and correct.

3. Conclusion

To help manufacturing companies select the most important suppliers among many, a scoring-reputation model was developed. It was first necessary to select indicators that reflect the supplier's delivery capacity and reputation level, so six indicators such as the total number of supplier orders and supply stability were selected. Subsequently, subjective and objective factors were taken into account. A single subjective or objective weighting method for assigning indicators was abandoned, instead, they were coupled and the AHM-CRITIC combined weighting method was used to determined the weights of the six indicators. After that, the scores of each supplier were obtained after linear weighting with the calculated indicator values, while their rankings could be known. Finally, the ranking list is adjusted according to the actual situation, and the most important suppliers are selected. After the actual values were calculated and examined, the method was reliable and effective.

References

[1] Wang Mao-Ping,Pan Dazhi. Solving the set-valued discount {0-1} knapsack problem using a dynamic programming algorithm[J]. Practice and understanding of mathematics,2021,51(08):107-115.

[2] Qiu Xue,Wang Yongzhong,Zhao Zhi,Yang Chuanjun,Li Jiajun. Rational configuration of UAV combinations in fires based on multi-objective algorithm [J/OL]. Computerized Measurement and Control:1-12 [2021-09-12].

[3] Cheng Yang, Hu Bing. Improved AHM-CRITIC empowered gray comprehensive assessment of radar equipment assurance[J]. Telecommunications Technology,2019,59(02):229-236.

[4] Zhang Xiaobin, Fu Yuliang, Wang Shunsheng, Zhao Qingqing. Research on the evaluation of the comprehensive water-saving level of cities based on AHM-CRITIC empowerment[J]. People's Yangtze River,2021,52(08):113-119.

[5] Liang Shuang. Computer applications for solving linear programming models in operations research[J]. Popular Standardization,2021(11):104-106.

[6] Xu Chang, Li Yongshu. Application of gray prediction and 0-1 planning to water supply problems[J]. Scientific Consulting (Science and Technology - Management), 2020(08):59-60.