

Research on Enterprise Raw Material Ordering and Transportation Based on Index Analysis and Entropy Method

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Abstract: Aiming at the raw material ordering and transportation process of production enterprises, this paper first selects the supply index and obtains 56 suppliers with large supply volume. Then, with the help of entropy method, 56 suppliers are ranked by supply variance, order quantity, payment rate and supply frequency as decision variables. In order to obtain the most economical ordering plan, the data of order quantity and supply quantity are mined, and the categories of suppliers are further divided into stable suppliers, potential emergency suppliers and general emergency suppliers. By accumulating the production capacity from high to low among 50 suppliers one by one, the threshold larger than the historical average production capacity of 670397m is found. Finally, it is determined that only 39 suppliers can meet the production conditions.

Keywords: Data mining, Planning problem, BP neural network, Entropy weight method

1. Introduction

For the production company, the production and ordering of raw materials is a vital link. Therefore, collect the relevant data of a construction and decoration enterprise, and explore this process [1]. The enterprise allocates the order to the selected supplier, and then the supplier provides the raw material, but due to the limitation of production capacity, the supplier may not be able to meet the order. Therefore, for the sake of production continuity, the enterprise will store the stored raw materials that meet the 2-week production and receive all the raw materials provided by the supplier. It is then handed over to the transporter for transshipment, but the raw materials will be consumed in the process.

2. Entropy weight index system

2.1. Data sorting

Sort the supply quantity from high to low [2], taking the demand tendency of different suppliers as the preliminary screening condition, the fault between important suppliers and retailers is determined as the 56th supplier, S123.

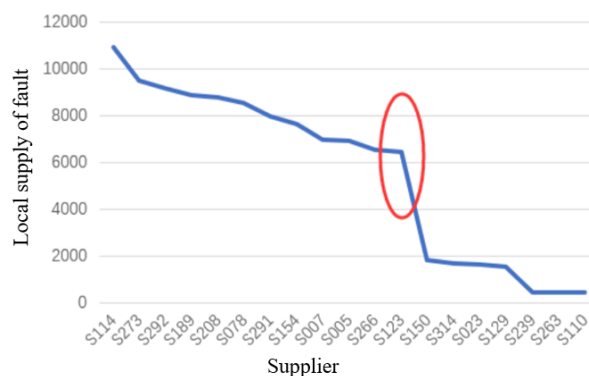


Figure 1: Partial drawing of supply fault

Establish multidimensional indicators to quantify suppliers: supplier supply variance, enterprise order quantity [3], supplier delivery rate, and supply frequency. The remaining 56 suppliers are ranked by entropy weight method.

2.2. Entropy weight method

Step1: Construct the decision matrix $A=(a_{ij})$, where a_{i1} - a_{i4} is the supplier's supply variance, total enterprise order quantity, supplier delivery rate and supply frequency are respectively corresponding. And normalize it into $R=(r_{ij})$.

Step2: Supply variance Var

$$G(S_i) = \sum_i^n G(S_i) \tag{1}$$

$$Var = \frac{1}{n-1} \sum_{i=1}^n (G(S_i) - G(S_i)) \tag{2}$$

Supplier payment rate J:

$$J = \frac{1}{m} \sum_{i=1}^m J_i \tag{3}$$

Total order quantity of the enterprise D: the total order quantity of the supplier in 240 weeks

Supply frequency P of suppliers: Number of times supplied by supplier within 240.

Step3: The column normalization matrix is obtained

$$r_{ij} = \frac{r_{ij}}{\sum_{i=1}^n r_{ij}} \tag{4}$$

Step4: Calculate the information entropy of attribute output

$$E_j = -\frac{1}{\ln n} \sum_{i=1}^n \bar{r}_{ij} \ln \bar{r}_{ij} \tag{5}$$

When $\bar{r}_{ij} = 0$, set $\bar{r}_{ij} \ln \bar{r}_{ij} = 0$

Step5: Calculate attribute weight vector

$$w_j = \frac{1 - E_j}{\sum_{k=1}^m 1 - E_k} \tag{6}$$

Step6: Calculate $z_i(w)$

$$z_i(w) = \sum_{j=1}^n r_{ij} w_j \tag{7}$$

Sort the of 56 suppliers and count the 50 most important suppliers from top to bottom.

2.3. Solution of model

56 suppliers are ranked by entropy weight method [4-6], and the 10 most important suppliers are as follows:

Table 1: 10 Most important supplier

Supplier	Material	Supplier	Material
S229	A	S284	C
S308	B	S151	C
S140	B	S201	A
S275	A	S361	C
S340	B	S108	B

3. Supplier Division

Establish an emergency supplier selection model with triple standard deviation. In normal distribution, σ stands for standard deviation [7] and μ for mean. In order to better select emergency suppliers, the principle of double standard deviation is adopted.

The probability that the variable value is between the interval $(\mu - \sigma, \mu + \sigma)$:
 $P(\mu - \sigma \leq \xi \leq \mu + \sigma) = 0.6826$.

The probability that the variable value is between the interval $(\mu - 2\sigma, \mu + 2\sigma)$:
 $P(\mu - 2\sigma \leq \xi \leq \mu + 2\sigma) = 0.9545$.

The probability that the variable value is between the interval $(\mu - 3\sigma, \mu + 3\sigma)$:
 $P(\mu - 3\sigma \leq \xi \leq \mu + 3\sigma) = 0.9973$.

Then, according to the continuous supply of emergency suppliers through Excel, if the supplier has supply for 24 consecutive weeks, it will be regarded as a potential emergency supplier, otherwise it will be regarded as a general supplier. The specific supplier classification is as follows:

Table 2: Emergency supplier

Supplier	Material	Supplier	Material	Supplier	Material
S078	A	S003	C	S139	B
S154	A	S037	C	S140	B
S201	A	S074	C	S338	B
S208	A	S086	C		
S273	A	S126	C		
S291	A	S210	C		
S307	A	S374	C		
S348	A				
S395	A				

Table 3: Potential emergency supplier

Supplier	Material	Supplier	Material	Supplier	Material
S078	A	S037	C	S139	B
S201	A	S086	C	S140	B
S208	A	S126	C	S338	B
S273	A	S210	C		
S291	A				
S307	A				
S348	A				

4. Establishment of model

For the convenience of calculation, the following provisions are made: 1) The loss rate of each transporter in the next 24 weeks is predicted as the average loss rate of the past five years; 2) The payment rate of each supplier in the next 24 weeks is the average payment rate in the past 5 years; 3) Stabilize the supply capacity forecast of suppliers in the next 24 weeks, and take the average value of supply in the previous 5 years; 4) Forecast the supply capacity of emergency suppliers in the next 24 weeks, taking the

average value that has not fallen into $(\mu - 2\sigma, \mu + 2\sigma)$ in the previous 5 years;

4.1. Establishment of model

Step 1: Determine the minimum number of suppliers to meet the demand

Step 2: Formulate the linear planning of the most economical raw material ordering scheme every week in the next 24 weeks.

The supply capacity corresponding to the supply volume of stable suppliers A, B and C per week is calculated respectively. Make a difference and get the weekly supply gap. In order to make the scheme the most economical, all these gaps should be supplemented by the emergency supplier of A. at the same time, theoretically, the supply should be equal to the consumption, so as to achieve a balance of revenue and expenditure, reduce the cost of material storage and achieve the most economical purpose. Set:

1/ F: total cost;

2/ $G(i)$: materials supplied by the i th supplier;

3/ $G'(i)$: the capacity corresponding to the materials supplied by the i th supplier;

4/ $Y(i)$ emergency materials of the supplier;

5/ $Y'(i)$: the capacity corresponding to the material of the i th emergency supplier;

6/ α, β : unit cost of transporting materials and unit cost of storing materials;

7/ P_{Ti} : Loss rate of the T_i th forwarder

8/ a,b,c is the unit cost corresponding to A, B and C

Get weekly orders for the next 24 weeks:

$$D' = \frac{\bar{G}(i)}{\bar{P}(I)} \tag{8}$$

Consider the best allocation scheme, goods A and C shall be transported by the transporter with low damage rate as far as possible, and goods B shall be transported by the transporter with the second damage rate.

4.2. Supply data prediction-BP neural network

The contents and steps of the standard BP neural network algorithm are described as follows, and the following variables and independent variables are defined:

Vector of input layer: $X = (x_1, x_2, \dots, x_n)$;

Hidden layer input vector: $H = (h_1, h_2, \dots, h_m)$;

Output layer output vector: $Y = (y_1, y_2, \dots, y_n)$;

Expected value output vector: $D = (d_1, d_2, \dots, d_n)$;

Weight connection matrix between input layer and hidden layer: $V = (v_1, v_2, \dots, v_m)$;

Weight connection matrix from hidden layer to output layer: $W = (w_1, w_2, \dots, w_n)$;

Network initialization, matrix, assignment period is determined by the value range of the activation function. Data preprocessing, select sample data input:

$$\begin{aligned} h_j &= f(T_j^T X^T) \quad j = 1, 2, 3, \dots, m \\ y_k &= f(W_k^T H^T) \quad k = 1, 2, 3, \dots, n \end{aligned} \tag{9}$$

The actual output value y_k and the expected output value d_k of the network are used to calculate the error

$$E = 1/2 \sum_{k=1}^l (d_k - y_k)^2 \quad (10)$$

The partial derivatives of the error function to the neurons in the hidden layer and the output layer are calculated respectively

$$\delta_j^h = \left(\sum_{k=1}^{k=l} \delta_k^y w_{jk} \right)^* h_j * (1 - h_j), j = 1, 2, 3, \dots \quad (11)$$

$$\delta_k^y = (d_k - y_k) * (1 - y_k), k = 1, 2, 3, \dots$$

The connection weight of each layer is adjusted by error signal; the weight from hidden layer to output layer and from input layer to hidden layer

$$W_{jk}^{N+1} = W_{jk}^N + \varphi \delta_k^y h_j \quad k = 1, 2, 3, \dots \quad j = 0.1, \dots, m$$

$$V_{ij}^{N+1} = V_{ij}^N + \varphi \delta_j^h x_i \quad j = 1, 2, 3, \dots m \quad i = 0.1, \dots, n \quad (12)$$

Calculate global error:

$$E = 1/2 \sum_{p=1}^p \sum_{k=1}^l (d_k - y_k)^2 \quad (13)$$

At the same time, according to the best transportation strategy, M is the total transportation cost. On this basis, the additional expenses are equal:

$$\alpha G(i) + \beta G(i) + aG_A(i) + bG_B(i) + cG_C(i) \approx 28200 \quad (14)$$

Constructing linear programming model:

$$F_{\min} = \alpha G(i) + M_A + M_B + M_C$$

$$G(i) = G_A(i) + G_B(i) + G_C(i) \quad (15)$$

$$G'(i) = G'_A(i) + G'_B(i) + G'_C(i)$$

Then the constraint is:

$$\left\{ \begin{array}{l} F_{\min} \geq 0 \\ G(i) \geq 0 \\ G'(i) \geq 0 \\ P_{Ti} \geq 0 \\ T_{G_A(i)+G_B(i)+G_C(i)} \leq 6000 \\ G'_A(i) + G'_B(i) + G'_C(i) \geq 28200 \\ [S(i_1) + S(i_2) + \dots + S(i_j)] \leq 13 \\ \max\{G(i_1) + G(i_2) + \dots + G(i_j)\} \leq 6000 \end{array} \right. \quad (16)$$

Then, in addition to the basic demand, the additional capacity storage cost is approximately 0.

4.3. Solution of model

Confirm the minimum number of suppliers through Excel sorting, as shown in the table below

Table 4: 39 suppliers

Supplier	Material	Supplier	Material	Supplier	Material
S361	C	S356	C	S308	B
S229	A	S126	C	S210	C
S031	B	S140	B	S074	C
S040	B	S268	C	S340	B
S151	C	S306	C	S338	B
S201	A	S037	C	S330	B
S282	A	S194	C	S273	A
S395	A	S348	A	S364	B
S329	A	S307	A	S346	B
S055	B	S352	A	S143	A
S275	A	S208	A	S367	B
S131	B	S247	C	S154	A
S108	B	S284	C	S003	C
S139	B	S365	C		

The calculated weekly order quantity is 25723.96 m^3

5. Conclusion

First of all, this paper selects the supply index, looks for the obvious supply difference fault, and obtains 56 suppliers with large supply volume. After that, we get the top 50 suppliers with the help of entropy method. In order to obtain the most economical ordering scheme, the balance of income and expenditure should be achieved in theory, so that the storage cost is approximately zero. The data of order quantity and supply quantity are mined, and the categories of suppliers are further classified with the help of the principle of normal distribution. Treat potential emergency suppliers as stable suppliers to provide stable distribution. By accumulating the production capacity of 50 suppliers from high to low one by one, looking for a threshold larger than the historical average capacity of 670397 m^3 , and finally determining that only 39 suppliers can meet the production conditions. The linear programming of the remaining 39 suppliers is carried out to get the optimal solution in the range, and the result of the scheme is transformed into production capacity. At this time, the production capacity is 697427 m^3 , the capacity increase rate is 4.03%, and the capacity surplus rate is 1.5%. Achieve the "balance of payments"

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