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Raw Material Ordering and Transportation Problems in Production Enterprises

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Abstract: *This paper analyzes from the perspective of the enterprise, establishes the corresponding objective function based on the requirements of different problems, and solves the optimal solution through the stochastic optimization algorithm combined with the corresponding constraints. Taking suppliers as the research object, this paper constructs the unordered rate index for suppliers from the perspective of enterprises. The average difference between supply and demand and the stability of the difference between supply and demand are adjusted. Finally, an evaluation model is constructed based on the grey comprehensive evaluation method to obtain the ranking of the importance of each supplier in ensuring the production of enterprises. Based on this ranking, the 50 most important suppliers are determined.*

Keywords: *Potential factor; Grey comprehensive evaluation method; Raw material ordering and transportation*

1. Introduction

Maximizing benefits is the core goal of every enterprise, that is, obtaining greater benefits with less cost. For production-oriented enterprises [1], the procurement cost of raw materials directly affects the production efficiency of the enterprise. Reasonable planning of raw material ordering and transportation costs will help companies maximize benefits. At the same time, the sufficient supply of raw materials is another source of power to support the enterprise. Therefore, ensuring sufficient supply of raw materials and controlling the cost of raw materials are crucial for production enterprises.

It is known that the company needs to make an ordering and transshipment plan for the required materials 24 weeks in advance every year. It is known that the weekly production capacity of the company is 28,200 cubic meters, and each cubic meter of product needs to consume 0.6 cubic meters of A material. Or B material 0.66 cubic meters, or C material 0.72 cubic meters. In real life, it takes 1.2 times and 1.1 times the cost to order one cubic meter of Class A and Class B materials, respectively, than Class C materials. The cost of transporting and storing the same unit of three types of raw materials is the same. The capacity of each forwarder to transport cargo is the same and is 6000 m^3/week.

In this paper, the supply characteristics of the given suppliers are analyzed, the 50 most important suppliers to the enterprise are selected, and the results are given.

2. Model construction and analysis

Whether an enterprise can carry out production normally is often related to the company's own situation and the situation of its suppliers. This question requires suppliers to be the research object, and an important model to ensure the production of enterprises is constructed according to their corresponding characteristics. For enterprises, find their unordered rate, and from the supplier's point of view, find their average supply and demand difference, the stability of supply and demand difference, and the lack of order rate, a total of four characteristics, establish a model to ensure the importance of normal production of the enterprise, and analyze based on this, and rank the corresponding supplier importance.

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2.1. Corresponding basic characteristic values of suppliers

(1) Enterprise unordered rate

In daily life, people's choice of a certain thing represents the preference of the thing to a certain extent, and also reflects the importance of the thing to people. When an enterprise selects a supplier, the selection of the supplier for supply reflects the importance of the supplier to the enterprise to a certain extent. Therefore, from the above analysis, from the enterprise aspect, the supplier is taken as the research object to define the enterprise's impact on a certain supplier. The unordered rate of the merchant x_{w}, the specific expression is as follows:

$$x_{\mathrm{w}} = \frac{W_{\mathrm{wd}}}{W_{\mathrm{z}}} \tag{1}$$

Here, five years are used as the research time period, which W_{wd} is the number of weeks in which the company did not order the supplier's raw materials in the W_{z} five-year time period, and the total number of production weeks in the five-year period. The x_{w} larger the number, the less important the company considers the supplier. The frequency of most of the suppliers being ordered by the enterprise is less than 0.5, and only a few are greater than 0.5. This is because the enterprise has a few fixed suppliers and tends to trade with these fixed suppliers, which is in line with reality.

(2) Average supply and demand gap

After the supplier accepts the order, the number of raw materials issued represents the supplier's supply capacity. The difference between the supplier's supply quantity and the company's order quantity is called the supply-demand gap. The larger the supply-demand gap, the stronger the supplier's supply capacity. more reliable. Based on the above analysis, this paper takes the difference between the actual supply number of suppliers and the number of enterprises scheduled within two weeks as a set of data, five years as the total research time period, and 120 sets of data corresponding to each supplier as the research data to find The average value of 120 sets of data in the five-year period of the supplier is defined as the average supply and demand difference S_{c} to measure the reliability of the supplier. The specific expression is as follows:

$$S_{\mathrm{c}} = \frac{\sum_{\mathrm{i=1}}^{120} S_i}{120} \tag{2}$$

S_i and demand of each group of data. The S_{c} larger the value, the stronger and more reliable the supplier's supply strength is. During this research period (within five years), most suppliers supply less raw materials than the company's order quantity, in a state where supply is less than demand, and a small number of positive values, that is, a state where supply exceeds demand.

(3) Supply and demand stability

Stability represents the degree of fluctuation of the data. The better the stability, the smaller the fluctuation of the data. Whether it is the number of shipments or the number of unshipped data, companies all hope that the value will be stable, and they do not want to bear the burden of instability due to its instability. Therefore, the variance in the σ 120 sets of data of each supplier in (2) represents the stability of its data. The σ larger the data, the more unstable the set of data, and the less reliable the supplier. The importance of the enterprise has also declined, and the σ specific expression is as follows:

$$\sigma^2 = \sum_{\mathrm{i=1}}^{120} (S_i - S_{\mathrm{d}})^2 / 120 \tag{3}$$

Table 1: Enterprise variance

Company Name	S003	S011	S012	S019
variance	4386.86	0.29	129.78	53.02

The variance data of some companies are in Table 1.

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The above values are the data selected by the members of this group to display (not a single case). It can be seen from this that the variance of different suppliers is quite different.

(4) Supplier shortage rate

Lack of order refers to the fact that the company submits an order to the supplier, but due to various reasons, the supplier has not paid any goods to the enterprise. This situation is called lack of order. The lack of orders or not represents the credibility of the supplier. If there is a long-term lack of orders, the supplier's importance to the company will become increasingly weakened and will be in a marginalized position. The stronger the production capacity of the enterprise, the five-year research period is used here, and the shortage rate is used as a measure to study the shortage of orders of the enterprise. The specific expression is as follows: x_q

$$x_q = \frac{S_q}{S_z} \tag{4}$$

S_z is the total number of orders from the company to suppliers, and is the number S_q of missing orders from suppliers. The results of some companies are as follows:

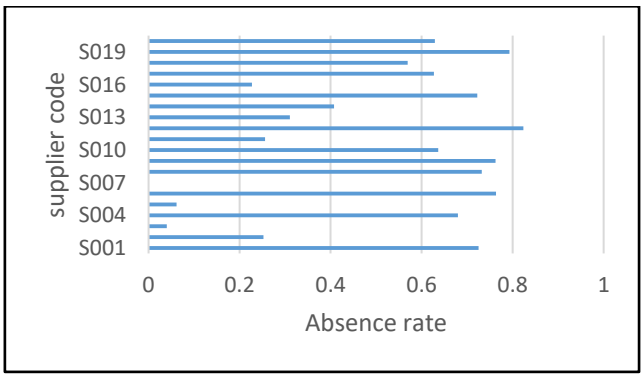

Figure 1: Information about supplier shortage rate

2.2. Adjustment of some basic eigenvalues by potential factor

The above characteristic values are calculated based on five years as the research object, and can reflect the average level of suppliers. However, there may be suppliers who have just established unfamiliar processes in the past few years. As time goes by, they become more familiar with the market and start well at this time, it is biased to measure the supplier with the average level, so the potential factor is introduced here α to modify some of the above eigenvalues.

Potential factor α represents the development potential of the supplier, and the potential factor is classified according to the following discriminant:

Table 2: Potential factor grading table

Restrictions	rating	Potential factor α
$X_1 < X_2 < X_3$	potential	1.1
$X_1 < X_2$ and $X_2 > X_3$	general	1.0
$X_1 > X_2$ and $X_2 < X_3$	general	1.0
$X_1 > X_2 > X_3$	recessionary	0.9

X_1 is the average of the supplier's supply in the first and second years, the average of the supplier's supply in the X_2 third and fourth years, and the fifth year's X_3 supplier's supply.

Adjustment object: the mean and variance of each supplier's supply within five years.

Adjustment rule: The potential factor is multiplied by the corresponding mean and variance. Establishment and solution of comprehensive evaluation model based on grey relational analysis [3,4]

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(1) Forward processing of matrices

Construct the corresponding matrix A. The elements in A are x_{ij}, which $(0 < i \le 402, 0 < j \le 4)$ represent x_{ij} the 1st i eigenvalue of the th supplier. Some indicators of this matrix are inverse indicators. The smaller the value, the better the result. When constructing the model, it needs to be positive. j Directionalization, where the reciprocal method is used for forwardization, that is

$$x_{ij_1} = \frac{1}{x_{ij}} \tag{5}$$

x_{ij} It is the original data, x_{ij_1} and it is the index after forwarding (when some positive sign data takes the reciprocal, because its value is 0, the reciprocal cannot be taken, so according to its data other than 0, set 0 to be smaller than the minimum value in these data. Smaller 0.01, do the reciprocal processing).

(2) Normalization of Matrix

The normalized matrix is re-normalized, and the elements after the processing are set to be x_{ij_2}, and the data initialization processing method is adopted, and the normalization formula is as follows:

$$x_{ij_2} = \frac{x_{ij_1}}{x_{1j_1}} \tag{6}$$

x_{1j_1} Represents the first value of each column.

(3) Selected reference sequence

Take the maximum value of each row element in the above matrix to form a sequence γ, which is the reference sequence.

(4) Grey correlation coefficient r_j

Taking each column of the standardized matrix as a group of research objects, there are 4 groups in total, and the degree of correlation between each element and the corresponding element of the reference sequence is expressed by the correlation coefficient r_{ij}, and the specific expression is as follows:

$$r_{ij} = \frac{\min\limits_i \min\limits_j |x_{0j_2} - x_{ij_2}| + \mu \max\limits_i \max\limits_j |x_{0j_2} - x_{ij_2}|}{|x_{0j_2} - x_{ij_2}| + \mu \max\limits_i \max\limits_j |x_{0j_2} - x_{ij_2}|} \tag{7}$$

μ 0.5 here.

The evaluation matrix is constructed according to the above-mentioned correlation coefficient.

(5) Weight calculation of each indicator

The index weight calculation formula is as follows:

$$W_j = \frac{r_j}{\sum_{j=1}^{4} r_j} \tag{8}$$

$W_j$is the index weight, and is $r_j$the mean value of the first column of the elements of the evaluation matrix j.

(6) The grey relational degree of each supplier

The i grey relational degree of the th object is D_i as follows:

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$$D_i = \sum_{j=1}^{4} W_j * r_{ij}^{T} \tag{9}$$

(7) 50 suppliers

The greater the grey correlation degree, the closer the corresponding evaluation object is to the optimal index, and the higher the ranking of its suppliers. According to this principle, the suppliers are sorted and the top 50 suppliers are selected. The details are as follows:

Table 3: Top 50 Suppliers

ranking	Enterprise number	ranking	Enterprise number
1	S284	26	S356
2	S282	27	S150
3	S266	28	S229
4	S031	29	S361
5	S374	30	S055
6	S365	31	S314
7	S218	32	S174
8	S247	33	S114
9	S294	34	S053
10	S275	35	S178
11	S268	36	S239
12	S306	37	S143
13	S123	38	S362
14	S080	39	S098
15	S007	40	S237
16	S329	41	S213
17	S194	42	S076
18	S364	43	S175
19	S352	44	S221
20	S040	45	S342
21	S244	46	S379
22	S340	47	S291
23	S367	48	S092
24	S346	49	S351
25	S131	50	S338

3. Model evaluation and improvement

It is reasonable to construct evaluation indicators from multiple perspectives of enterprises and suppliers. When quantifying the evaluation index of problem analysis, it is not quantified according to the superficial situation, but considering its growth potential, the potential factor is introduced for correction, and its value is more accurate. However, the selection of evaluation indicators is less, which cannot fully reflect the characteristics of the evaluation object.

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