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Supplier Selection of Manufacturers Based on Order Supply Data

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Abstract: *Supplier management is an indispensable part of production management. Facing a large number of suppliers in the market, manufacturers need to choose reliable and strong suppliers, to meet the needs of enterprise production, but also to overcome the number of suppliers too many, coordination and communication costs of the purpose. In this paper, using the raw material ordering and supply data produced by manufacturers in the past, Xi'an constructs the index system of supplier selection, then helps manufacturers objectively screen suppliers through grey correlation analysis, and finally achieves the goal of further streamlining the number of suppliers by constructing an integer planning model.*

Keywords: *Production enterprises Suppliers choose Grey correlation analysis integer planning*

1. Introduction

Production management is particularly important, especially for manufacturers. To produce good products, manufacturers have to rely on good management. The quality of production management directly affects the development of manufacturers. Supplier management is an indispensable part of production management. Manufacturers produce products, need to purchase a variety of raw materials, and raw materials from different suppliers. Facing a large number of suppliers in the market, how to make decisions, in order to choose reliable and strong suppliers, that is, to meet the needs of manufacturers production, but also to overcome the number of suppliers too many, coordination and communication costs. In view of this, this paper explores the use of raw material ordering and supply data generated by enterprises in the past, through data analysis and modeling methods, to help enterprises choose suppliers, improve the level of manufacturers supplier management, and thus improve the level of manufacturers production management.

2. Supplier selection metrics system

In order to objectively evaluate each supplier, assuming that the manufacturers has collected order and supply data for all suppliers in the past week, we build metrics in three ways.

(1) Performance capacity

Credit is the cornerstone of inter-enterprise cooperation; credit suppliers are worthy of trust and dependence. After the enterprise orders the raw materials from the supplier, the supplier delivers the ordered raw materials in full and on schedule in accordance with the promise to ensure the stability of the ordering enterprise's production. Therefore, the supplier's performance capacity is demonstrated by two indicators, the order quantity completion rate and the order delivery schedule rate.

Order Quantity Completion Rate (CR): Total supply is divided by total order to determine whether the supplier can deliver the goods in sufficient quantities

Order Delivery Schedule (SR): The number of weeks of availability is divided by the number of weeks of ordering to determine whether the supplier can deliver on time.

(2) Supply capacity

Suppliers who produce large quantities of raw materials each week and provide a stable and continuous supply of large quantities are the most important partners. The supplier's supply capacity is

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represented by three indicators: short-term average supply, long-term average supply and standard deviation in delivery.

Short-term average supply (SAS): Total supply is divided by the number of weeks of supply to determine whether suppliers can provide more raw materials in the short term Long-term average supply (LAS): The total supply is divided by the total number of weeks to determine whether the supplier can provide enough raw materials in the long term Standard deviation (SDS) for supply: Determine whether a supplier is able to provide raw materials consistently

(3) The value of raw materials

Enterprises produce the same number of products, consumption of different types of raw materials different quantities. For example, Class A raw materials can produce more products in the same amount as other raw materials, at lower transportation and storage costs, and are of higher value to the business. The value of raw materials is expressed here as an indicator of the quantity of finished products.

Quantity of finished products (NFP): The amount of finished product conversion of raw materials from each supplier, and the value of raw materials of each supplier.

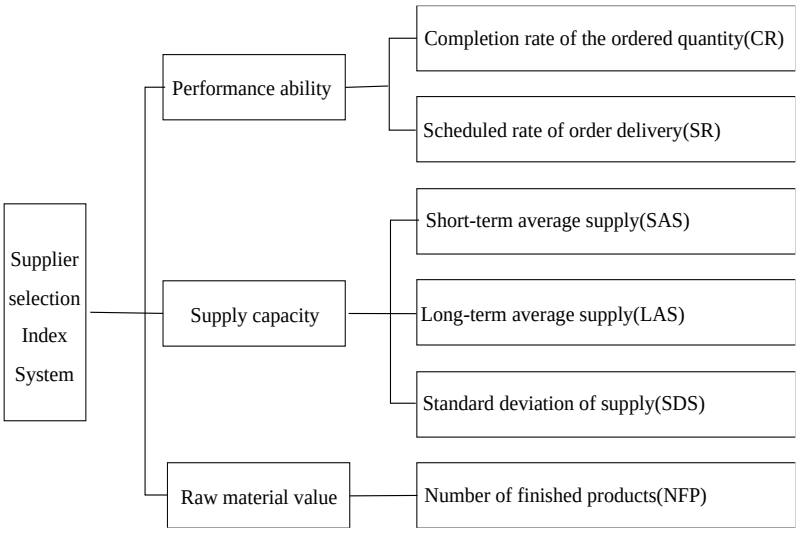

Figure 1 Supplier Selection Metrics System Chart

Figure 1 shows the metrics evaluation system constructed based on the ordering and supply data of raw material suppliers to evaluate and select suppliers.

3. Preliminary selection of suppliers based on grey relational analysis

Assuming that there are n raw material suppliers, there are 6 existing evaluation indicators, and the corresponding value of each indicator of each supplier is a_{ij} $(i = 1,2,\dots,n; j = 1,2,\dots,6)$.

Specific steps are as follows:

(1) Determine the comparison series (suppliers) and reference series (evaluation criteria).

The comparison sequence is:

$$b_i = \{b_{ij} | j = 1,2,\dots,6\}, i = 1,2,\dots,n$$

b_i is the standardized index vector value of the i-th supplier.

Select the best index value in each evaluation index to form a reference series and record it as:

$$b_0 = \{b_{0j} | j = 1,2,\dots m\}$$

$b_{0j} = \max_{1 \le i \le n} b_{ij}, j = 1,2,\dots,m$, which is the optimal value of each supplier's metrics.

(2) The evaluation indicators are unified (that is, all are converted into extremely large metrics) and dimensionless, and an evaluation matrix $B = (b_{ij})_{n \times m}$is constructed.

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(3) Calculate the gray correlation coefficient

The formula of gray correlation coefficient is shown in (1).

$$\xi_{ij} = \frac{\min\limits_{1\le s\le n}\min\limits_{1\le k\le m}|b_{0k}-b_{sk}|+\rho\max\limits_{1\le s\le n}\max\limits_{1\le k\le m}|b_{0k}-b_{sk}|}{|b_{0j}-b_{ij}|+\rho\max\limits_{1\le s\le n}\max\limits_{1\le k\le m}|b_{0k}-b_{sk}|} \quad (1)$$

$$i = 1,2,\ldots,n; j = 1,2,\ldots,6$$

Where ξ_{ij} is the correlation coefficient of the comparison series b_{ij} to the reference series b_0 on the j-th metric, $\rho \in [0,1]$ is the resolution coefficient (ρ value is 0.5), $\min\limits_{1\le s\le n}\min\limits_{1\le k\le m}|b_{0k}-b_{sk}|$ is the two-level minimum difference and $\max\limits_{1\le s\le n}\max\limits_{1\le k\le m}|b_{0k}-b_{sk}|$ is the maximum difference between the two levels

(4) Calculate the degree of gray correlation

The calculation formula of gray correlation degree is shown in formula (2), Where w_j is the weight of the j-th metric variable x_j and r_i is the gray correlation degree of the i-th evaluation object to the ideal object.

$$r_i = \sum_{j=1}^{m} w_j \xi_{ij}, \quad i = 1,2,\ldots,n \quad (2)$$

(5) Evaluation and analysis

Sort according to the degree of gray relevance of suppliers. The greater the degree of relevance, the more reliable and powerful the supplier. Use the gray correlation degree of suppliers to conduct a preliminary screening of suppliers, and give priority to the top-ranked suppliers, such as retaining the top 30-40% of the suppliers and complete the preliminary selection.

4. Supplier streamlining based on 0-1 integer programming

After the primary election, sometimes the number of suppliers is still large, which is not conducive to the maintenance of the company's daily relationship, and the coordination of suppliers is also more difficult. Therefore, it is necessary to further streamline the number of suppliers on the basis of screening. This paper constructs a 0-1 integer plan to select suppliers and achieves the goal of streamlining the number of suppliers.

Assuming that the raw materials supplied by suppliers are divided into three categories: A, B, and C, the suppliers are classified first when constructing a simplified model of the number of suppliers. The number of suppliers of A, B, and C raw material suppliers are represented by r, s and t respectively.

4.1 Decision variables

Suppose ax_i only takes two values of 0 or 1. When ax_i is 1, it means that the company chooses the i-th supplier of type A raw materials, otherwise it does not choose. bx_i and cx_i have similar meanings

4.2 Objective function

Our goal is not only to meet the needs of the raw materials learned in production, but also to minimize the number of selected suppliers. Therefore, the objective function is to minimize the total number of three types of suppliers.

l_A represents the number of A-type suppliers finally selected, and the formula is shown in (3).

$$l_A = \sum_{i=1}^{r} ax_i \quad (3)$$

l_B represents the number of B-type suppliers finally selected, and the formula is shown in (4).

$$l_B = \sum_{i=1}^{s} bx_i \quad (4)$$

l_C represents the number of C-type suppliers finally selected, and the formula is shown in (1).

$$l_C = \sum_{i=1}^{t} cx_i \quad (5)$$

The final selection of the number of raw material suppliers is shown in the following formula (11)

$$\min(l_A + l_B + l_C) \quad (6)$$

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4.3 Constraints

Since the weekly raw material supply quantity of each supplier fluctuates, it is related to the company's order quantity and the supplier's supply capacity. Here we believe that each supplier's short-term average supply SAS_i is each supplier The minimum quantity that can be supplied each week, that is, the minimum quantity that the supplier can guarantee to provide raw materials each week is s_i. In order to distinguish the types of raw materials, here are respectively marked as aSAS_i, bSAS_i, and cSAS_i. Therefore:

The number of products produced by the raw materials that can be supplied by all A-type raw material suppliers each week:

R_A represents the number of products produced by all raw material suppliers of A-type that can supply each week.

$$R_A = \frac{\sum_{i=1}^{r} aSAS_i \cdot ax_i}{q_A}$$

R_B represents the number of products produced by all raw material suppliers of B-type that can supply each week.

$$R_B = \frac{\sum_{i=1}^{s} bSAS_i \cdot bx_i}{q_B}$$

R_C represents the number of products produced by all raw material suppliers of C-type that can supply each week.

$$R_C = \frac{\sum_{i=1}^{t} cSAS_i \cdot cx_i}{q_C}$$

Among them, q_A, q_B, q_C respectively represent the quantity of raw materials that need to be consumed to produce a unit of enterprise products。

According to requirements, the raw materials provided by suppliers must meet the weekly production capacity of the company, so the sum of the number of suppliers must satisfy the following inequality (7).

$$R_A + R_B + R_C \geq R \quad (7)$$

Where R is the number of products required by the production enterprise per week.

3. Conclusions

This paper uses existing data, through data analysis and model methods, to help manufacturers objectively select reliable and powerful suppliers, provides a quantitative method for the evaluation and management of suppliers, and helps manufacturers improve their management capabilities.

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