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Research on Raw Material Ordering and Transportation Scheme based on 0-1 Programming Model

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Abstract

This article in view of the enterprise production efficiency, reduce the cost of transportation and storage, at the same time hope to transport: business research, the problems of the attrition rate as far as possible through supply characteristics of 402 suppliers and transport the eight transport supplier attrition rate data for quantitative analysis, using the analytic hierarchy process (ahp), and establish the model, get the optimal solutions and transfer of the order. First order to Excel data and supply data preprocessing, by using effective order data and supply data to evaluate suppliers, we selected the four important indexes constitute a collection, using the analytic hierarchy process (ahp) to analyze the four indicators, establish evaluation model, to analyze the 402 suppliers, The top 50 most important suppliers were selected. Then we by setting up multiple index to A, B, C to evaluate three kinds of raw materials, through the analytic hierarchy process (ahp) weight analysis for three kinds of raw materials, in order to reduce the production cost, more moderate less C class raw materials and procurement category A, thus to empowerment, A, C to scale up again after A kind of raw material weight is 90, take A class C raw material weight of 1. Taking the maximum sum after weighting and the transport loss rate of the transporter as the objective function as small as possible, and taking the weekly average supply quantity of the supplier to meet the weekly production as the constraint condition, the 0-1 programming model is established, so as to obtain the optimal ordering scheme and transport scheme for the enterprise.

Keywords

Excel Preprocessing; Analytic Hierarchy Process; 0-1 Planning Model.

1. Introduction

The raw materials used by H decorative plate manufacturer can be divided into three types: A, B and C. The company arranges production for 48 weeks every year, so it needs to make raw material ordering and transfer plan for 24 weeks in advance. In order to ensure normal production, the company should prepare raw material inventory as much as possible. And it is assumed that the initial raw materials of the production enterprise in the first week just meet the production demand of the first week.

We normalized and comprehensively processed the order quantity and supply quantity data of 402 raw material suppliers in the past five years, and identified 50 most important suppliers on the basis of guaranteeing production. Secondly, based on the actual situation above and in order to reduce costs, The objectives to be achieved are (1) reducing transshipment and warehousing costs (2) reducing transshipment attrition rates (3) meeting weekly production requirements. Therefore, this paper uses multi-objective programming model and analytic hierarchy process to analyze the selection of suppliers and transporters, so as to obtain the optimal scheme.

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2. Establish and Solve the Model of 50 Suppliers

2.1 Establishment of Factor Set

Select four main factors affecting the selection of the final 50 suppliers.

1) Total order D

The total order quantity D represents the sum of the order quantity D from 402 suppliers within 240 weeks, denoted as D. The larger the value is, the greater the enterprise's credit to the supplier, that is, the stronger the supplier's ability, and the higher the importance of ensuring the production of the enterprise.

The specific calculation formula is as follows:

$$D = \sum d \tag{1}$$

2) Total supply G

Total supply G represents the sum of G supplied by 402 suppliers to the enterprise within 240 weeks, denoted as G. The larger the value is, the stronger the supply capacity of the supplier is.

The specific calculation formula is as follows:

$$G = \sum g \tag{2}$$

3) Supply and demand ratio λ

The supply-demand ratio λ represents the ratio of the average supply quantity of the supplier within 240 weeks to the average order quantity of the enterprise to the supplier within 240 weeks. The smaller the value, the more stable the supply capacity of the supplier and the higher the reliability of the supplier.

The specific calculation formula is as follows:

$$\lambda = \frac{G/240 - T_{(g=0)}}{D/240 - \ _{(g=0)}} \tag{3}$$

4) Large order rate η

Large order rate η represents the ratio of large order days T_(G≥400)96% to the number of supply weeks (minus the number of weeks in which the supply is zero). The higher the value is, the stronger the supply of the supplier is, and the more important it is to the production of the enterprise in case of emergencies.

The specific calculation formula is as follows:

$$\eta = \frac{T_{G\geq 400}}{240 - T_{(g=0)}} \tag{4}$$

2.2 Determine the Factor Weight Vector

In the evaluation of 402 suppliers, the analytic hierarchy process (AHP) was used to determine the weight of four different factors below. The judgment of different weights has strong practicability and effectiveness in dealing with this problem. The weight set of each factor is N= (N_1, N_2... N_m)

The consistent matrix method is used to construct the judgment matrix.

By analyzing data and survey data, and taking "optimal scheme" as an example, the judgment matrix is artificially constructed, as shown in Table 1.

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Table 1. data sheet

	Total order D	Total supply G	Supply and demand ratio λ	Large order rate η
The total order D	1.0000	3.0000	4.0000	5.0000
Total supply G	0.3333	1.0000	2.0000	3.0000
Supply and demand ratio λ	0.2500	0.5000	1.0000	2.0000
Large order rate η	0.2000	0.3333	0.5000	1.0000

Weight distribution is obtained by calculation for N = (0.5462, 0.2323, 0.1377, 0.0838). Figure 1 shows the results of running MATLAB software.

```
A =

    1.0000    3.0000    4.0000    5.0000
    0.3333    1.0000    2.0000    3.0000
    0.2500    0.5000    1.0000    2.0000
    0.2000    0.3333    0.5000    1.0000

weight w=
    0.5462
    0.2323
    0.1377
    0.0838

The largest feature root t=
    4.0511

The consistency of this matrix is acceptable!
CI=
    0.0170

CR=
    0.0191
```

Figure 1. Running results

It can be seen that the first influencing factor is the total order D, the second is the total supply G, the third is the ratio of supply and demand λ, and the fourth is the large order rate η, among which the total order D factor accounts for more than half of the weight.

2.3 Establishing Evaluation Model

After determining the weight N of each factor, the data was analyzed and sorted out:

We first add all the order quantities and then rank them. The total order quantity of 402 suppliers is displayed in Excel in the order from large to small. Since the weight of total order quantity is 0.5462, which accounts for the largest proportion, we select the top 100 suppliers, whose order quantity accounts for 96.37% of the total order quantity. So let's start with the top 100.

Among the 100 selected suppliers, we add the supply quantity and show 100 suppliers in a new table in the order of total supply quantity from large to small, and select the top 60 suppliers.

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In the selection of the top 60 suppliers, we calculate the ratio of supply and demand to λ, show the 60 suppliers in the new table in the order of λ from large to small, and select the first 54 suppliers.

54 before selecting suppliers, we make large order rate calculation, eta through calculation, we found that in the subsequent 38-54 of the supplier, their eta is zero, because D factor weights of the supreme, we will (1) the first 50, and (4) the first compare the 54, remove the D value is low and the eta is zero four, Finally, the optimal top 50 suppliers are obtained.

According to our enterprise production evaluation model, the 50 plus the most important suppliers that reflect the importance of enterprise production support are shown in Table 2 (from left to right and from top to bottom, the importance tends to decrease):

Table 2. Top 50 suppliers

1	S229	2	S361	3	S108	4	S268	5	S275
6	S329	7	S340	8	S151	9	S131	10	S306
11	S282	12	S308	13	S194	14	S330	15	S356
16	S395	17	S143	18	S352	19	S037	20	S348
21	S208	22	S338	23	S086	24	S139	25	S140
26	S307	27	S114	28	S055	29	S284	30	S364
31	S040	32	S291	33	S273	34	S374	35	S078
36	S367	37	S123	38	S218	39	S007	40	S294
41	S189	42	S080	43	S365	44	S031	45	S247
46	S244	47	S346	48	S003	49	S292	50	S154

3. Model Establishment and Solution of Cost Compression

3.1 Establishment of Decision Variables

Due to the large data set due to the need to purchase class C raw materials in an appropriate amount or less and class A raw materials in an appropriate amount or more, it is necessary to conduct screening from all 402 enterprises with data. Among them, there are 146 suppliers of material A and 122 suppliers of material C. We assume that for raw material A, the supply quantity of each family in the NTH week constitutes A matrix of 146 rows and 1 column G_{AN}.The same definition G_{BN}, G_{CN}. Meanwhile, a variable matrix with 402 rows and 8 columns was established.

3.2 Determination of Objective Function

We satisfy the business enterprise under the premise of normal production, first of all, in order to reduce transport and storage costs, will try to make less quantity of materials, according to the consumption of all kinds of raw materials for products per cubic meter of analysis can be concluded that to produce products per cubic meter, required minimum class A, class C needed most, so the establishment of the objective function for A moderate amount of less purchasing class C and A moderate amount of raw materials purchasing A class, Then weight A and C according to the analytic

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hierarchy process, and then expand the proportion by 100 times, the weight of A raw materials is 90, the weight of C raw materials is 1.

That is, the specific expression is:

$$Max_Y = 1 \times \sum_{i=1}^{122}(G_{CN}) + 90 \times \sum_{i=1}^{146}(G_{AN}) \tag{5}$$

3.3 Determination of Constraint Conditions

According to the specific situation analysis, we obtain the following constraints for ordering and transshipment, and express them as mathematical expressions:

1) Meet normal production requirements

The enterprise should prepare as much stock of raw materials as possible. The sum of suppliers' weekly average capacity is required to be no less than 3.74*10^4 m3. The specific mathematical expression is:

$$98\% \times D \times Y \geq 3.74 \times 10^4 \tag{6}$$

2) The transshipment capacity of each transporter

We know that the transshipment capacity of each transporter is not higher than 7000, so the mathematical expression can be obtained as follows:

$$\begin{pmatrix} A \\ B \\ C \end{pmatrix} \cdot p_m \leq \begin{pmatrix} 7000 \\ 7000 \\ 7000 \end{pmatrix} \tag{7}$$

3.4 Results of the Programming Model

According to the 0-1 planning model, the optimal selection of suppliers and transporters can be worked out in order to reduce production costs.

4. Conclusion

1) Based on the correct and clear analysis of enterprise demand, this paper establishes a scientific and reasonable evaluation model, which provides the conditions for finding the minimum supplier, the optimal ordering scheme and the transport scheme with the least loss.

2) In this paper, analytic hierarchy Process (AHP) and 0-1 planning model are used to analyze and determine the 50 most important suppliers, providing direction for strategic cooperation of enterprises, based on three objectives: Reduce the cost of transport and storage, reduce transport loss rate, meet the weekly production demand, establish the optimal ordering scheme and transport scheme for the enterprise, so as to make the enterprise obtain the maximum income as far as possible, at the same time, we can also apply the idea of modeling in more fields, will drive the sustainable development of society.

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