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Research on Manufacturer Supply Model Based on Analytic Hierarchy Process

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Abstract:This paper studies the optimal solution model of manufacturer based on multivariate linear programming and analytic hierarchy process.Firstly,based on visual processing,the evaluation indexes are determined as supply quantity,full rate,stable rate and order times.Reasonably set the weight,evaluate 402suppliers and determine the 50 most important suppliers for the enterprise. Then,using the linear programming optimization method,the optimal solution of supplier selection without transportation loss is obtained.Finally,taking the full rate,loss variance and acceptance rate as the evaluation indexes,the transportation company with the lowest transportation loss is determined.Finally,the most economical material quantity actually needed by the production enterprise is calculated,and the supplier selection andtransportation company selection under the condition of loss are given.
Keywords: Multivariate linear function; Analytic hierarchy process

1. Introduction

The raw materials used by the production enterprises of building and decorative plates are mainly wood fiber and other vegetable fiber materials,which can be divided into three types:A,B and C.The enterprise arranges production 48 weeks a year.It needs to formulate a 24 week raw material ordering and transportation plan in advance,determine the suppliers to be ordered and the corresponding weekly ordering quantity according to the demand,and select the logistics company to transport to the enterprise warehouse.

2. Establishment and solution of model

2.1 Model of problem 1

2.1.1 Model establishment

Different suppliers intuitively indicate that the order quantity is different.At the same time,it reflects that the square difference and supply quantity are different for different material categories(A,B and C).The variance s reflects the full rate of supply and supply quantity,indicating the choice of enterprises for different suppliers.In order to better select the 50 most important businesses for the enterprise,the evaluation indicators are order times,supply quantity and full rate.The full rate is the times/total times with supply rate>=1,and supply rate=supply quantity/order quantity.The weights of evaluation indicators are shown in Table 1 below.The stable delivery rate is the supplier's ability to meet the enterprise's order.The smaller the variance,the stronger the supply capacity,the greater the variance,and the weaker the supply capacity.Therefore,it can be expressed by variance S.

$$S_1^2 = \sum_{i=1}^{240} \frac{(Q_1-Q)^2}{239}. \quad (1)$$

Tab1 Supplier weight value

Supply quantity	Full rate	Order times	Stable rate
0.15	0.3	0.1	0.45

Where q is the supply order ratio,that is,the ratio of weekly supply/weekly order.For the calculation of variance S_1^2,first eliminate the data with order quantity of 0,and then divide three intervals of{x|x=0},{x|0<x<1},and{x|x=1} according to the supply order ratio Q.among them,the case of{x|x>1}is classified as{x|x=1},which is the same as{x|x=1}because the supply ratio is considered to be 1 for the case of{x|x>1}.Finally,calculate the variance s.Forward the variance.

$$S_{forward}=max\text{-}S_i \quad (2)$$

Define the distance D_i+between the i(i=0,1,2..402)evaluation object and the maximum value.Define the distance D_i-between the i(i=0,1,2..402)evaluation object and the maximum value.

2.1.2 Model solution

Apply matlab to solve 402 suppliers.For the final 50 enterprises,the final results of the evaluation criteria are shown in the figure below.

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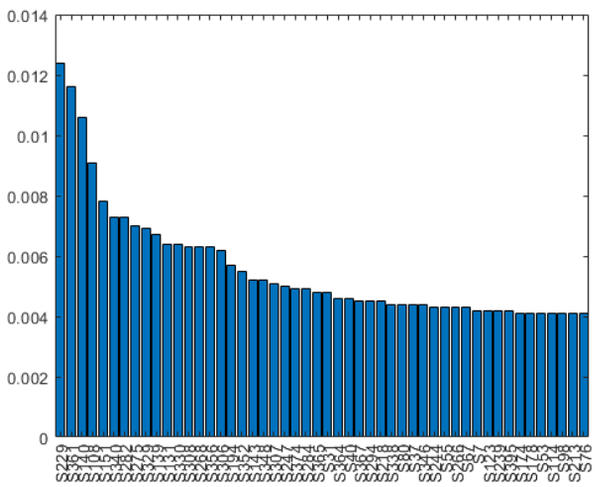

Fig 1 evaluation of top 50 important businesses

So far,50 of the 402 enterprises have selected the most important businesses for the enterprise.The selection of the weight of businesses depends on the big data in literature[4~5],and the weight of enterprises for suppliers is obtained.Among them,s229,s361,S140,S108 and S151 are outstanding in terms of supply quantity,number of purchase orders,full rate and stable rate,and the other 45 are evaluated as average.

2.2 Model of problem 2

2.2.1 Model establishment

Firstly,when there is no transportation loss,the supply quantity can meet the order quantity,and there is 5.64×10^4,the weekly production capacity of the enterprise needs to be guaranteed to be 2.82×10^4.The definition requires Y_{min} to establish a linear differential[1]

$$\begin{cases} Y_{\min} = x_1 + x_2 + \ldots + x_{50} \\ \dfrac{A}{0.6} + \dfrac{B}{0.66} + \dfrac{C}{0.72} \geq 2.82\times10^4 \end{cases} . \quad (3)$$

Where Pr=”average supply order ratio”×”Total order quantity”/”order times”,for expressions A,B and C:

$$\begin{cases} A = \sum_{i=1}^{50} (p_{rAi} \times x_{Ai}) \\ B = \sum_{i=1}^{50} (p_{rBi} \times x_{Bi}) \\ C = \sum_{i=1}^{50} (p_{rCi} \times x_{Ci}) \end{cases} . \quad (4)$$

For the question,set the unit price of C as 1,add the constraint formula based on formula(3)and(4),and calculate the minimum cost w_{min} without transportation loss[2~3]. $W_{min}=1.2A+1.1B+C$. (5)

Then,under the condition of minimum cost,there is no dissipation minimum capacity.The minimum loss is obtained by adding the loss condition under the minimum capacity condition under the condition of no loss.Therefore,the constraint equation of the minimum production requirements of the enterprise under the condition of loss is:

$$\begin{cases} Y_{\min} = x_1 + x_2 + \ldots + x_{50} \\ \dfrac{A_1}{0.6} + \dfrac{B_1}{0.66} + \dfrac{C_1}{0.72} \geq 2.82\times10^4 + \left(\dfrac{\omega_A}{1.2\times0.6} + \dfrac{\omega_B}{1.1\times0.66} + \dfrac{\omega_C}{1\times0.72} \right)\beta \\ \omega_{\min} = \omega_A + \omega_B + \omega_C \\ \omega_A \leq \omega_{\min} \\ \omega_B \leq \omega_{\min} \\ \omega_C \leq \omega_{\min} \end{cases} . \quad (6) \qquad \begin{pmatrix} 2 & 1 & 7 \\ 0.25 & 0.1428 & 1 \end{pmatrix} . \quad (7)$$

AmongβIs the loss ratio,ω_A is the amount re spent on material A,ω_B the amount re spent on material B,ω_C the amount re spent on material C.In order to better formulate the scheme,select the freight forwarder with strong transportation capacity,and take the full rate,loss variance and acceptance rate as the evaluation indicators for visual processing.

The rough ranking of forwarder capability indicators can be preliminarily obtained in order to more intuitively express the selection needs of enterprises for transporters and better describe the evaluation of transporters.The evaluation indexes of variance,full law and acceptance rate are established,and the weight value of transporters is calculated by analytic hierarchy process.

The hierarchical structure model is established[4],the M-C judgment matrix is constructed,and the pairwise comparison matrix is obtained based on the pairwise comparison of the three elements of criterion layer C.

Tab 2 Weight calculation of evaluation layer

Evaluation criterion	Arithmetic average	Geometric average	Characteristic value
Reception rate	0.3151	0.3150	0.3150

Loss variance	0.6025	0.6026	0.6026
Full rate	0.0824	0.0823	0.0823

Finally,Cr=0.0019<0.1,and the consistency of the matrix is reasonable.

The model is simplified.It can be seen from radar figure that the loss variance of T4 and T5 transportation companies is large,indicating that there are large fluctuations in the transportation process of T4 and T5,and other parameters are slightly lower than those of other transportation companies.The loss variance of T7 transportation company is higher than T4 and T5,and the acceptance rate is lower than T4 and T5.Therefore,T4,T5 and T7 transportation companies are not considered in the scoring model(transportation capacity T7>T4>T5).Establish the comparison matrix of C_1-P,C_2-P and C_3-P.

$$\begin{pmatrix} 1 & \frac{1}{3} & \frac{1}{3} & 2 & 3 \\ 3 & 1 & 1 & 3 & 3 \\ 3 & 1 & 1 & 4 & 4 \\ \frac{1}{2} & \frac{1}{3} & \frac{1}{4} & 1 & 1 \\ \frac{1}{3} & \frac{1}{3} & \frac{1}{4} & 1 & 1 \end{pmatrix} \begin{pmatrix} 1 & 2 & 3 & 2 & 1 \\ \frac{1}{2} & 1 & 2 & 1 & \frac{1}{2} \\ \frac{1}{3} & \frac{1}{2} & 1 & \frac{1}{2} & \frac{1}{3} \\ \frac{1}{2} & 1 & 2 & 1 & \frac{1}{2} \\ 1 & 2 & 3 & 2 & 1 \end{pmatrix} \begin{pmatrix} 1 & 1 & 2 & 5 & 7 \\ 1 & 1 & 3 & 5 & 7 \\ \frac{1}{2} & \frac{1}{3} & 1 & 3 & 4 \\ \frac{1}{5} & \frac{1}{5} & \frac{1}{3} & 1 & 1 \\ \frac{1}{7} & \frac{1}{7} & \frac{1}{4} & 1 & 1 \end{pmatrix} \quad (7)$$

2.2.2 Model solution

Based on formula(3)and(4),at least 20 companies s229,s361,S140,S108,S151,S340,s282,s275,s329,S139,s131,S330,S308,S268,S356,S306,s348,S307,S37 and s395 can meet the first question.For the second question,under the condition of no transportation loss,since the optimal solution is exactly equal to 28200m3,the ordering scheme in the next 24 weeks can be recycled,that is,it is the same as the scheme in the first week:suppliers of S140 s131 s364 S367 s346 S53 S213 are excluded,and all other suppliers are selected.

Select the transportation merchant capacity result based on formula(5)~(7).

Tab3 Transporter T1~T8 ranking

ID	Full rate	Reception rate	Loss variance	Score
T3	0.4875	0.9908	4.4256	0.256684
T2	1.0000	0.9946	4.3503	0.227384
T6	0.9000	0.9810	0.5504	0.209238
T1	1.0000	0.9981	2.3243	0.179207
T8	0.8458	0.9711	0.8079	0.127385
T7	1.0000	0.9792	0.4874	0.101548
T4	0.4250	0.9899	0.2690	0.714235
T5	0.3458	0.9843	0.2608	0.512621

3. Model Evaluation

3.1 Advantages of the model

(1)For model 1,TOPSIS analysis is adopted to greatly improve the accuracy of the model under the condition of giving the weight through investigation,and give the selection of reasonable suppliers.At the same time,the visualization more intuitively expresses the situation of each ordering and supplier.

(2)For model 2,the analytic hierarchy process is used to analyze the actual situation of suppliers and shippers,as well as the establishment of matrix,which greatly improves the accuracy of model parameters,improves the application ability of the model,and makes the final goal well quantified.At the same time,based on lingo's method and regression formula,the results under the condition of loss are finally calculated.

3.2 Disadvantages of the model

For model 2,the prediction is based on 240 weeks,and every 4 weeks is a change cycle,without considering the change of each week.At the same time,the matrix establishment of analytic hierarchy process is subjective and has certain limitations.

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