Original Research Article

Research on Ordering and Transportation of Raw Materials Based on Gray Scale

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Abstract: In this paper,a scientific and reasonable production planning evaluation system is established based on the order quantity and supply quantity data of raw material suppliers related to a construction and decoration plate manufacturer.In order to conduct quantitative analysis on all supplier data,we first process the data,select five indicators that can reflect the supplier's ability,establish a grey correlation analysis and evaluation model,obtain the importance of each supplier,determine the top 50 most important suppliers,and finally draw a ranking box chart with SPSS software for visual inspection.

Keywords: Grey correlation analysis; Linear programming; Gray prediction

1. Introduction

A manufacturer of building and decorative plates hopes to establish a scientific and reasonable production planning evaluation system by analyzing the ordering quantity and supply quantity data of raw material suppliers,transportation loss rate data of transporters,procurement cost of raw materials and other factors,so as to determine the ordering scheme and transportation scheme of raw materials under various production conditions,So as to maximize the production efficiency of the enterprise.

The raw materials used in the production of the enterprise can be divided into three types:A,B and C.The production is arranged 48 weeks a year.It is necessary to formulate a 24 week raw material order and transfer plan in advance,that is,determine the suppliers to be ordered and the corresponding weekly order quantity according to the capacity requirements,determine the forwarder and entrust it to transfer the weekly supply quantity of the supplier to the enterprise warehouse.

The weekly production capacity of the enterprise is 28200 cubic meters,and 0.6 cubic meters of class a raw materials,0.66 cubic meters of class B raw materials,or 0.72 cubic meters of class C raw materials are consumed per cubic meter of products.Due to the particularity of raw materials,the supplier cannot guarantee to supply strictly according to the order quantity,and the actual supply quantity may be more or less than the order quantity.In order to ensure the needs of normal production,the enterprise should keep the inventory of raw materials that meet the production needs of two weeks as much as possible.Therefore,the enterprise always purchases all the raw materials actually provided by the supplier.

In the actual transportation process,there will be a certain loss of raw materials.The transportation capacity of each forwarder is 6000 m3/week.Generally,raw materials supplied by one supplier every week shall be transported by one forwarder as far as possible.

The purchase cost of raw materials directly affects the production efficiency of enterprises.In practice,the purchase unit price of class A and class B raw materials is 20%and 10%higher than that of class C raw materials respectively.The unit cost of transportation and storage of three types of raw materials is the same.

2. Grey Relational Model

2.1 Train of thought analysis

Annex 1 gives the order quantity and supply quantity data of 402 raw material suppliers in recent 5 years(240 weeks in total). For problem 1,we first process the data of all suppliers,calculate and compare the relevant data by establishing a specific index system,and quantify the supply characteristics of suppliers.Establish the importance evaluation model of individual suppliers to ensure the production of enterprises to reflect the importance of each supplier to ensure the production of enterprises.On this basis,rank and determine the 50 most important suppliers.

2.2 Determination of evaluation indicators

We record the digital code of all supplier IDS in the table as I(1 I 402,I z),the order quantity(240 weeks)from the enterprise to each supplier as M_i,and the supply quantity(240 weeks)from each supplier to the enterprise as N_i.

In addition to the original data known in the annex,we also use the above indicators to construct the following newly defined indicators:

(1)The total number of weeks with weekly order quantity of"0"from the enterprise to each supplier is recorded as X_1;

(2)Divide the supply quantity of each supplier to the enterprise by the number of effective supply weeks to obtain the effective

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mean value of each supplier's weekly supply quantity,which can intuitively reflect the centralized trend of supplier supply,which is recorded as X_2:

$$X_2 = \frac{1}{240 - \text{num}\,(M_i = N_i = 0)} \sum_{i=1}^{402} S_i \tag{1}$$

2.3 supplier to obtain the stability of the supply quantity of each supplier,which is recorded as X_3:

$$X_3 = \frac{1}{n}\left[\sum_{i=1}^{402} (X_i - X_2)^2\right] \tag{2}$$

4.Define the ratio of the supply quantity of each supplier to the order quantity of the enterprise in these 240 weeks as the fit between supply and demand,which is recorded as X_4:

$$X_4 = \frac{N_i}{M_i} \tag{3}$$

2.3.1 Establish the importance evaluation model of individual supplier to ensure enterprise production

We use the evaluation indexes proposed above to establish the evaluation model.We need to find out the relationship between each index and the importance of individual suppliers to ensure enterprise production.The grey system theory was first put forward by Professor Deng Julong,a famous scholar in China,in 1982,and grey correlation analysis came into being[1].Grey correlation analysis provides a quantitative measurement standard for the development and change trend of a system.Therefore,we think it is very suitable for the dynamic process analysis of each evaluation index and the importance of individual suppliers to ensure enterprise production.

2.3.2 Grey relational analysis principle

In the process of system development,if the change trend of the two factors is consistent,that is,the degree of synchronous change is high,it can be said that the degree of correlation between the two factors is high;On the contrary,the degree of correlation is low. Therefore,the grey correlation analysis method is a method to measure the correlation degree between various factors according to the similarity or dissimilarity of the development trend between various factors(called"grey correlation degree").The grey system theory puts forward the concept of grey correlation analysis of each subsystem,and tries to find the numerical relationship between the factors in the system through a certain method.

The specific calculation steps of grey system correlation analysis are as follows:

(1)Determine the reference sequence and comparison sequence:the data sequence reflecting the behavior characteristics of the system is called the reference sequence.The data series composed of factors affecting system behavior is called comparison series.

(2)Dimensionless processing:due to the different physical meanings of various factors in the system,the dimensions of the data are not necessarily the same,which is not convenient for comparison,or it is difficult to get a correct conclusion during comparison. Therefore,dimensionless data processing is generally necessary in grey correlation analysis.

(3)Calculate the grey correlation coefficient between the reference series and the comparison series:the so-called correlation degree is essentially the difference degree of geometry between curves.Therefore,the difference between curves can be used as a measure of correlation degree.

(4)Calculation of correlation degree:because the correlation coefficient is the correlation degree value of the comparison series and the reference series at each time(i.e.each point in the curve),it has more than one number,and the information is too scattered to facilitate overall comparison.Therefore,it is necessary to concentrate the correlation coefficient of each time(i.e.each point in the curve)into one value,that is,calculate its average value as the quantitative expression of the correlation degree between the comparison series and the reference series.

2.3.3 Grey relational analysis principle

According to the above four basic steps of grey correlation analysis principle,the specific calculation steps of this problem are as follows:

Step 1.Determine the reference sequence and the comparison sequence.According to the practical significance of the five indicators in enterprise production,we take[1,1,1,0.1,0.001]as the reference sequence,Y={y(k),k=1,2. . . . . 5};Taking the total number of weeks X_1,effective mean X_2,variance X_3,fit between supply and demand X_4 and the sum of supply N_i with weekly order quantity of"0"from the enterprise to each supplier as the comparison sequence, $C_i = \{c_i(k), k = 1,2,\cdot,5$.

Step 2.Dimensionless treatment.Write a program in MATLAB to standardize each sequence.

Step 3.Find the difference sequence.The difference column $\Delta c_i(k)$ between the reference sequence y and the comparison sequence C_i is:

$$\Delta c_i(k) = |Y(k) - C_i(k)| \tag{4}$$

Step 4.Find the minimum difference and maximum difference of the difference sequence.

$$\Delta_{ik} min = \min_i \min_k \Delta c_i(k) \tag{5}$$

$$\Delta_{ik} max = \max_i \max_k \Delta c_i(k) \tag{6}$$

Step 5.Solve the correlation coefficient.Correlation coefficients of reference sequence Y and comparison sequence c_i is:

$$\gamma_i(k)\Delta_{ik} = \frac{\Delta_{ik}min + \rho\Delta_{ik}max}{\Delta_i(k) + \rho\Delta_{ik}max} \tag{7}$$

Step 6.Solve the correlation degree.

$$\xi_i = \frac{1}{n}\sum_{i=1}^{402} \gamma_i(k) \tag{8}$$

2.3.4 Solution of model

The correlation matrix can be obtained by programming with MATLAB $\Gamma = [\xi_1, \xi_2, \cdots, \xi_{402}]$ .The data in the matrix are arranged in descending order.The top 50 data correspond to the 50 most important raw material suppliers for the production of the enterprise.

Tab1 The 50 most important raw material suppliers for the production of the enterprise.

Num	ID	Num	ID	Num	ID	Num	ID	Num	ID
1	S275	11	S352	21	S364	31	S388	41	S114
2	S229	12	S282	22	S040	32	S397	42	S314
3	S329	13	S108	23	S367	33	S150	43	S291
4	S361	14	S194	24	S055	34	S007	44	S023
5	S268	15	S247	25	S395	35	S307	45	S189
6	S306	16	S330	26	S143	36	S074	46	S123
7	S340	17	S308	27	S294	37	S244	47	S003
8	S151	18	S365	28	S346	38	S245	48	S146
9	S131	19	S284	29	S218	39	S263	49	S138
10	S356	20	S031	30	S362	40	S129	50	S080

2.3.5 Model test

By observing the distribution of abnormal points on the box line diagram,the abnormal data of various indexes can be obtained intuitively.

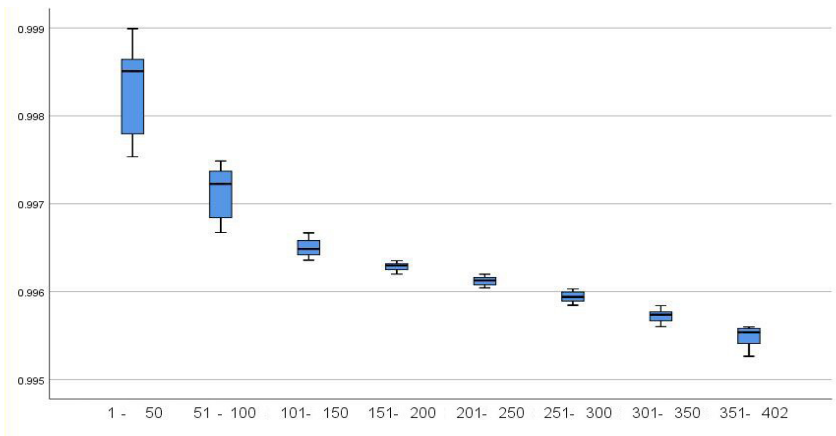

Fig2 Box diagram.

3. Model evaluation and generalization

3.1 Model evaluation

(1)In this paper,the simulation process is used many times to bring the theoretical value into the model for simulation solution,and the resulting data is more scientific and reliable;

(2)In this paper,the planning model is used to analyze the production planning scheme,and the planning process is optimized by many algorithm ideas,which makes the calculation simple and easy to solve;

3.2 Model generalization

After the mathematical programming model is established,genetic algorithm or particle swarm optimization algorithm can be used to assist in the solution of the programming model,which can greatly improve the speed of solution and ensure that the results will not fall into the local optimal solution.

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