ISSN: 2688-9323

# Order a Transport Model for Multi-objective Planning based on Gray Association Analysis

Rongzhi Li*, Rongxiang Li, Xu Yao, Kuntang Hao, Yuxin Liao

Qufu Normal University, Rizhao, Shandong 276827, China

## Abstract

**The choice of raw materials, suppliers, order quantities and transporters affects the interests of enterprises, this paper processes data, builds mathematical models and helps enterprises make decisions. Using MATLAB to quantify and visualized the data in Annex 1, obtain the three-dimensional visual map of supply quantity-supplier-240 weeks, and find the difference and ratio of the value of each supplier supply quantity and enterprise order quantity in each week respectively. After comprehensive analysis, the evaluation index of the supplier are four factors: total supply quantity, supply stability, supply rate and error rate. MATLAB was used to visuthe corresponding data map. Select the 50 most important suppliers.Using hierarchical analysis method, the weight of each index is 3,3,2,2; normalize the data of each index, calculate the correlation coefficient and gray correlation degree, obtain the correlation order, and conclude that the top 50 data are the suppliers to guarantee the production importance of enterprises. Firstly, construct a Multi-objective planning model based on type 0-1 integer planning. Firstly, whether the supplier choose as the target function and the minimum 127 suppliers and 127 suppliers as the lowest purchase cost and the weekly purchase supplier as the decision variable to obtain the most economical order scheme.ijMulti-objective planning model for type 0-1 integer programming established with compressed production cost. In the choice of raw materials, enterprises prefer A, so to raw materials A, B, C, the weight of A is 50, C weight is 30, B weight is 20. Based on a 0-1 integer planning dual-target optimization model, follow the production capacity standard for the next two weeks, weekly maximum transport capacity, A minus C criterion, to solve the target function with the lowest total procurement cost. The decision variables are integer aggregated by MATLAB's minimum deviation method to obtain the optimal ordering and transfer scheme.In the almost same scenario, the total purchase cost of raw materials A, B and C is saved by 9.23%. The gray prediction model is used to predict the data of the next 24 weeks based on the first 24 weeks of the previous five years, to find out the maximum weekly supply capacity of each supplier and the supply law (difference) of the adjacent weeks, and to find out the optimal weekly production capacity with MATLAB. Reset the weekly order volume of the enterprise raw materials according to the predicted weekly supply volume of each supplier.The type 0-1 integer programming model is applied to give the constraints and decision variables, and use MATLAB to find the ordering and transfer scheme.**

## Keywords

**Gray Correlation Degree; Comprehensive Evaluation Model; Type 0-1; Integer Planning; Multi-objective Planning Model; Gray Prediction Model; Minimum Deviation Method.**

## 1. Restatement of Problems

The ordering and transportation of raw materials have always been one of the problems that plague enterprise decision makers. In recent years, with the implementation of national policies, China's industry and commerce has achieved rapid development, and the economic level has

ISSN: 2688-9323

been greatly improved. However, in this glorious background, some problems also arise, and more and more suppliers and logistics companies have joined the competition, which makes the raw material market uneven. Therefore, it becomes more important to choose appropriate suppliers and transporters for enterprises, and this group has launched a study on this issue. Through further analysis of the problem, the factors affecting the production of the enterprise include four factors: total supply volume, supply stability, five-year supply rate and error rate. Therefore, this question needs to be developed around these four factors for the description of the evaluation indicators). This group adopts a comprehensive evaluation model of gray correlation to establish a mathematical model reflecting the importance of production of enterprises. By observing quantitative data diagram and using hierarchical analysis to calculate the weight of the evaluation index, based on gray association evaluation method to determine the supplier index and the highest index, then according to the degree of correlation, select the top 50 suppliers as an important supplier. The first part requires the finding of the minimum number of suppliers to meet the plant production and the most economical weekly raw material ordering program for the next 24 weeks; the second part is the least loss raw material transfer and storage plan based on the first part. In general, these two parts are progressive optimization solution problems. For this problem, this group first establishes a multi-target planning model based on type 0-1 integer planning. When the weekly raw material procurement cost is at least as the target function, the decision variable represents 50 suppliers with different choices (whether to choose), 1 is the choice, 0 is no choice; and the lowest raw material loss as the target function. The decision variable refers to whether the first supplier will choose the first porter, 1 is the choice and 0 does not. The constraints of both are the supply capacity limit of the supplier, the supply rate of each supplier, etc. The production capacity can be reserved for at least two weeks. The transportation capacity of each transporter should be less than or equal to 6,000, and the raw materials of one supplier can only be transported by one transporter. The results were calculated using MATLAB's fminimin function, and the data were analyzed for the selection of ordering schemes and transport schemes for the next 24 weeks.$X_1, X_2 \ldots X_{50} Y_{ij}$ijIf the original purchase category A as much as possible and reduce the category C purchase amount, also require the loss rate of the transporter as low as possible, and then formulate new orders and transfer based on the plan. It is not difficult to see that the problem three is the two-objective planning problem optimized on the basis of problem 2, but the objective function, decision variables and constraints have changed. This group first transforms the two-target model into a single-target model. On the basis of problem 2, the first target function is the lowest total procurement cost of raw materials A, B and C, and the decision variables are the total procurement amount of A, B and C. The constraints increase on the basis of problem 2: increase the actual purchase amount of A and reduce the actual purchase amount of C when the original purchase amount remains unchanged. The second objective function is the least loss rate, and the decision variable refers to whether the first supplier will choose the first transporter, 1 as the choice and 0 as not. The results are calculated by MATLAB and new ordering and transport schemes are developed.$Y_{ij}$ijBased on the analysis of the supply capacity of the existing 402 raw material suppliers, how much the enterprise production capacity can be increased. Without considering the raw material cost of the enterprise, the higher the production capacity is closely related to the supplier and transporter transport capacity, so this group establishes the gray prediction model (GM (1,1) model), first identify the weekly maximum supply capacity of each supplier and the supply rules (difference) of adjacent weeks, and use the optimal weekly supply capacity of each supplier. Limited weekly transport capacity ($6000m^3$ per week) and one supplier supplies weekly raw materials by one transporter. Based on this, the maximum production capacity of enterprises is found through the gray prediction model. The second small question is to use a multi-target planning model of type 0-1 integer planning of Question 2 to find out the order and transfer plan for the next 24 weeks without

ISSN: 2688-9323

considering the raw material cost and reaching the maximum weekly production capacity of the enterprise.

## 2. Symbol Description

**Table 1.** Symbol Description

| symbol | explain | unit |
|---|---|---|
| D | order amount | $m^3$ |
| G | Supply quantity | $m^3$ |
| $R_1$ | Supply rate | / |
| A | Receive | $m^3$ |
| $R_2$ | acceptance rate | / |
| X′ | Refer to the data column | / |
| L | Weekly average loss rate | / |
| $P_2$ | Unit expenses for transportation and storage of three types of raw materials (A, B, C,) | century |
| $P_1$ | Purchase unit price | century |

## 3. Establishment and Solution of the Model

### 3.1. Model Establishment and Solution of Problem 1

Using MATLAB visualized the supply volume of 402 suppliers for 240 weeks, and obtained the three-dimensional diagram of Figure 1, and found that the data distribution was uneven and quite different. Therefore, this paper determines the variance of the supplier in five years to indicate the stability of the supply, and the supply stability is taken as one of the evaluation indicators.

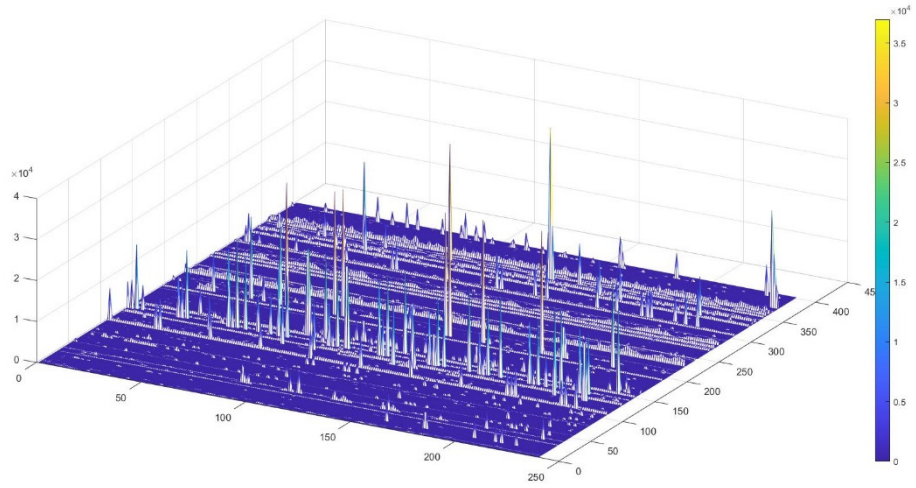

**Figure 1.** 3D stereo

$R_{iC_j}R_{iC_j}R_iC_j$Use the Excel formula = 'supplier supplier ($m^3$)'!- 'Enterprise order volume ($m^3$)'! (Column j, line i) respectively find the difference between the supply quantity of each supplier and the order quantity of the enterprise in each week, which is called the completion quantity. According to the data, the supply quantity is more or less than the order quantity, so the error rate is introduced to describe the difference between the supply quantity and the actual order quantity. Figure 2 shows the data visualization analysis diagram of the difference between supply quantity and order quantity.

ISSN: 2688-9323

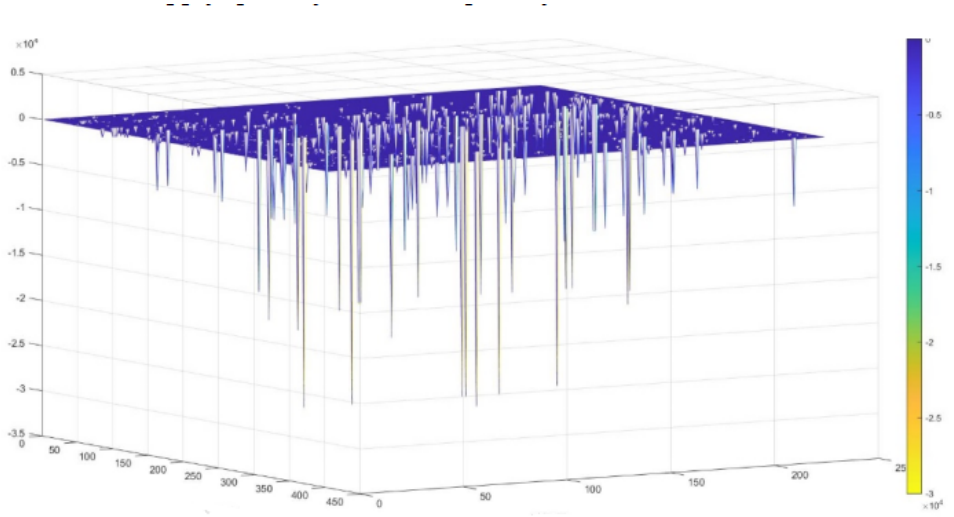

**Figure 2.** Data visualization and analysis diagram of the difference between supply quantity and order quantity

$R_{iC_j}R_{iC_j}R_{iC_j}R_iC_j$Use the formula =IF ('Order quantity of the enterprise ($m^3$)'!- =0,0, 'Supplier Supply Quantity ($m^3$)'!-/ 'Enterprise Order Quantity ($m^3$)'!) (It indicates column j of line i) and finds the ratio of each supplier's weekly supply quantity to the weekly order quantity of each enterprise, which is called the supply rate.

After the quantitative and visual analysis of the data, this paper determines that the evaluation indicators of the selected suppliers are mainly the total supply quantity, the supply stability, the five-year supply rate and the error rate.

## 3.2. Establishment and Description of the Evaluation Indicators

**Table 2.** Supplier evaluation index system

| evaluating indicator / supplier ID | Total supply (stere) | Supply stability | Supply rate | error rate |
|---|---|---|---|---|
| S001 | 49 | 4.559780392 | 0.212121212 | 0.787878788 |
| S002 | 273 | 4.04279194 | 0.883495146 | 0.116504854 |
| ... | | | | |
| S401 | 67 | 6.459907066 | 0.335 | 0.665 |
| S402 | 35 | 18.26167387 | 0.036534447 | 0.963465553 |

**Table 3.** Description of the evaluation indicators

| evaluating indicator | Index description |
|---|---|
| Total supply | Quantity of raw materials supplied by the supplier in the past five years |
| Supply stability | The variance of the supplier is used to indicate the stability of the supply |
| Supply rate | Supply rate = Supply quantity / Order quantity |
| error rate | Error rate = \| Supply quantity-Order quantity \| / Order quantity |

ISSN: 2688-9323

The four evaluation indicators were visualized with MATLAB, and the difference between each supplier was more intuitive according to the ordinate value size and data fluctuation situation, so as to conduct gray correlation analysis.

### 3.3. Gray Association Analysis was Performed

1. The weight of each evaluation index is determined by hierarchical analysis method.$n = [n_1, n_2, n_3, n_4]n_1, n_2, n_3, n_4$. Among them, the total supply quantity, supply stability, supply rate and error rate are weighted successively, and the value is 3,3,2,2. $Z_{ij}$iZ.

2. According to the question stem, there are 402 suppliers and set up 4 evaluation indicators. The initial matrix is obtained by representing the evaluation value of the j-th index of the first supplier accordingly. The original matrix was normalized using the vector normalization. Get:

$$Z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{k=1}^{4} x_{ki}^2}}, (i = 1,2,3,4; j = 1,2,\cdots,402) \quad (1)$$

$$\text{in: } Z = \left(z_{ij}\right)_{4\times 402} (i = 1,2,3,4; j = 1,2,\cdots,402)$$

The above formula can obtain the standard value of each evaluation standard in the original matrix. The so-called standard value is the data with significant attribute differences to transform, so that the attribute's obtained attributes are close to unity and convenient for calculation.

3. Determine the reference number of columns

Analysis was performed using MATLAB, and the optimal values of the four evaluation indicators were selected to constitute the reference data column.

As follows:$X' = (1,1,1,1)$

4. Calculate the gray correlation coefficient

The association coefficients of the corresponding elements of each comparison data column and the reference data column were calculated separately.

$$\xi_i(k) = \frac{\min_s \min_t |x_0(t) - x_s(t)| + \rho \max_s \max_t |x_0(t) - x_s(t)|}{|x_0(k) - x_i(k)| + \rho \max_s \max_t |x_0(t) - x_s(t)|} \quad (2)$$

$x_i x_0 k\rho$. 5 The above formula is the correlation coefficient of the comparative column to the pair reference number on the first index, and take the resolution coefficient in the formula is 0. The gray correlation coefficients for each evaluation index were calculated by the calculation.

5. Calculate gray weighted correlation; gray weighted correlation, as follows:$r_i$ .

$$r_i = \sum_{k=1}^{n} n_i \xi_i(k) \quad (3)$$

$r_i$iWhere: it is the gray-weighted correlation degree of the first evaluation object to the ideal object. $n_i \xi_i(k)$i For the corresponding weight of each evaluation index, for the correlation coefficient of each supplier on the first evaluation index. Sort the calculation results, and take the top 50 suppliers as the 50 most important suppliers.

ISSN: 2688-9323

# 4. Establishment and Solution of Model II

## 4.1. Data Quantification and Visualization Analysis

The data in Annex 2 were processed using MATLAB to obtain a three-dimensional area map of the weekly loss rate of each transporter (Figure 3), which visually shows that the transport capacity of each transporter is clearly different.

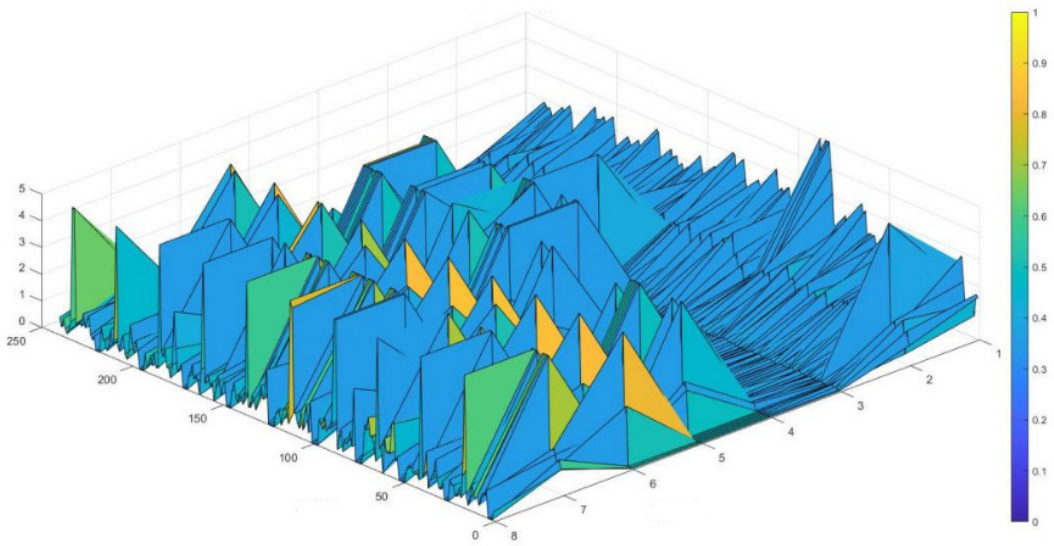

**Figure 3.** 3 D area plot of the weekly loss rate for each transporter

The average weekly loss rate, loss variance and minimum loss rate of the 8 transporters are visually analyzed in Figure 4, which shows that the average weekly loss rate is the lowest, and the loss variance is also the smallest, which provides ideas for solving the problem.

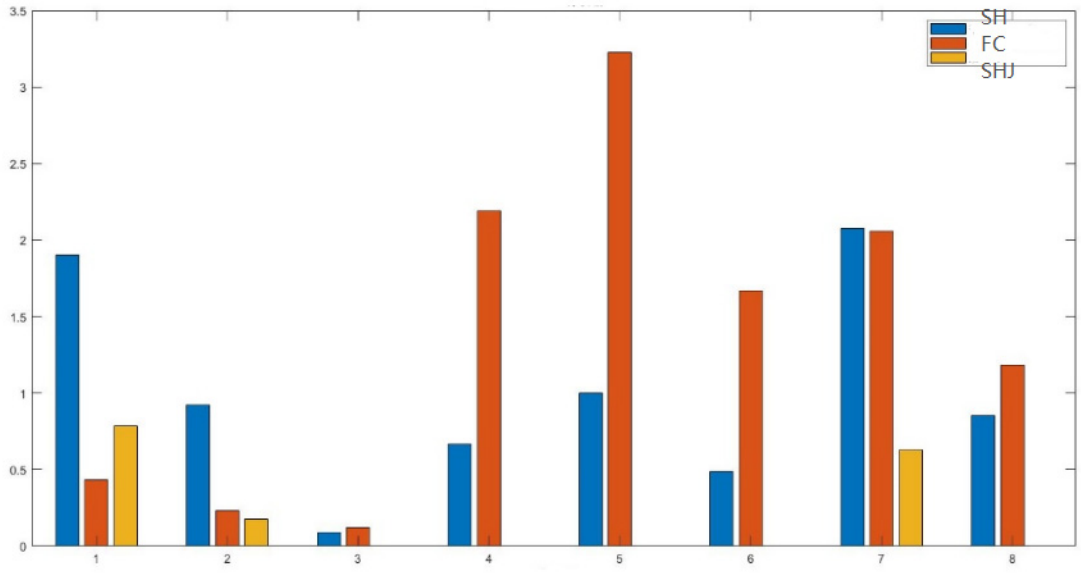


**Figure 4.** Mean weekly loss rate, loss variance, and minimum loss rate for visual analysis

For A, B, C raw materials ordered 240 weeks visual analysis, through the following chart, A, B, C three raw materials ordering periodic changes every 24 weeks, to each year through the first

ISSN: 2688-9323

24 weeks of the next 24 weeks, according to A, B, C three raw materials to determine the next 24 weeks of the most economical raw material ordering plan.

## 4.2. Supplier Problems --A Multi-objective Planning Model based on Type 0-1 Integer Planning

1. objective function

α, β, γFirstly, find the average weekly supply of A, B and C, and then select the suppliers to be selected according to the integer 0-1 planning model and calculate the total number as q. in order to meet the purpose of two weeks of output consumption of raw materials, A type suppliers to select m home, class B suppliers to choose n home, and C type suppliers to choose p home, then according to the above conditions, this paper can conduct multi-target linear planning.

As the weekly production capacity has been determined, the target function is the minimum (weekly) raw material procurement cost, and the formula is as follows:

$$\text{MinAverage weekly purchasing cost} = (\alpha * 1.2 * 0.6 + \beta * 1.1 * 0.66 + \gamma * 1 * 0.72) \quad (4)$$

2. Decision variables

$X_1, X_2 \ldots X_{50}$Whether to choose the 50 suppliers and suppliers' weekly supply capacity, 1 is choice, 0 is not choice.

3. Constraints

Constraints 1: the company should reserve at least the production capacity of the next two weeks, and because the enterprise's weekly production capacity of 28,200 cubic meters, each cubic meter of product needs to consume class A raw materials, or 0.66 cubic meters of class B raw materials, or class C raw materials 0.72 cubic meters, you can get the first constraint:

$$\alpha/0.6 * m + \beta/0.66 * n + \gamma/0.72 * p \geq 5.64 * 10^4 \quad (5)$$

Constraints 2:

$$q = m+n+p \quad (6)$$

A Multi-objective planning model based on type 0-1 integer planning.

1. objective function

α, β, γFirst, find the corresponding weekly receiving amount of A raw materials, B and C; select the suppliers selected to provide them according to the integer 0-1 plan and calculate the total number as q. In order to meet the purpose of two weeks of production consumption of raw materials, class A suppliers to select m home, class B suppliers to choose n home, and class C suppliers to choose p home, then according to the above conditions, this paper can conduct multi-target linear planning.

According to the loss rate = (supply amount-received amount) / supply amount to get the supply amount = (received amount / 1-loss rate), so the target function is the least (weekly) raw material purchase cost and transfer cost total, the formula is as follows:

$$\begin{gathered}\text{MinAverage weekly purchasing cost}=(\alpha*1.2*0.6+\beta*1.1*0.66+\gamma*1*0.72)\\ \text{MinAverage weekly transshipment cost}=\big((\alpha/(1-L)*P2+\beta/(1-L)*P2+\gamma/(1-L)*P2)\big)\\ \text{MinAverage weekly cost}=\text{MinAverage weekly purchasing cost}+\text{MinAverage weekly transshipment cost}\end{gathered} \quad (7)$$

Note: L is the average weekly loss rate

ISSN: 2688-9323

2. Decision variables

$Y_{ij}$iThe decision variable refers to whether the first supplier will select the first transporter.j.

3. Constraints

Constraints 1:

The company has to reserve at least the production capacity for the next two weeks, and because the weekly production capacity is 28,200 cubic meters, each cubic meter of Class A raw materials, 0.66 cubic meters of Class B raw materials, or 0.72 cubic meters of Class C raw materials:

$$\alpha/0.6 * m + \beta/0.66 * n + \gamma/0.72 * p \geq 5.64 * 10^4 \quad (8)$$

Constraints 2:

The transporter transported up to 6,000 cubic meters of raw materials per week, assuming that the weekly supply of the 50 suppliers is the vector Z.

$$Z = \leq \begin{bmatrix} W_1 \\ W_2 \\ W_3 \\ \cdots \\ W_{50} \end{bmatrix} \quad \begin{bmatrix} 6000 \\ 6000 \\ 6000 \\ \cdots \\ 6000 \end{bmatrix} \quad (9)$$

Constraints 3:

$$q = m+n+p \quad (10)$$

Constraints 4:

A transporter can only deliver one supplier's raw materials within a week.

The minimum number of suppliers was obtained by performing a linear analysis of the above objective functions and constraints.

## 4.3. Model Establishment and Solution of Problem 3

α, β, γAccording to the weekly supply of A BC raw materials obtained in Question 2, we can continue to be used, v. v suppliers are selected for supply, and the number of suppliers of A BC raw material is s, o and u respectively. Linear planning analysis was performed based on the above data.

1. objective function:

Third, we need to consider the possible problems during the transfer of raw materials, including the cost of transport and storage, the loss situation and how to choose the transporter to minimize the consumption, so the target function is (24 weeks) the raw material procurement cost and transport cost total, and the loss rate is the lowest:

$$\text{Min24-Week Cost} = 24(1.2+1.1+) + () * p2 / (1-L)\ (3-1)\alpha\beta\gamma\alpha + \beta + \gamma$$
$$\text{Min } (L) \quad (11)$$

2. Decision variable:

For the third question, the key factor in cost is the total amount of the three raw materials purchased ABC. So the decision variable is: .24α, 24β, 24γ

ISSN: 2688-9323

3. Constraints:

Constraints 1:

This plan still needs to meet the production output of the enterprise in the next two weeks, so constraints are established based on the respective cost of A BC Class III raw materials 1,1.1,1, and the conversion rate of their respective output: 0,0, and 0 and the number of respective selected suppliers s, o, u..2.6.66.72.

$$\alpha/0.6 * s + \beta/0.66 * o + \gamma/0.72 * u \geq 5.64 * 10^4 \quad (12)$$

Constraints 2:

Due to the cost consideration, the purchase volume of A is increased while the original purchase amount remains unchanged, so the supply of A must be more than C.

$$s > g \quad (13)$$

Constraints 3:

This procurement still requires the suppliers of A BC Class III materials, s, o, u, to be equal to the total number of suppliers selected in this article, v, i. e:

$$v=s+o+u \quad (14)$$

Constraints 4:

Transporters can transport up to 6,000 cubic meters of raw materials per week.

$$\begin{aligned} s &<= 6000 \\ o &<= 6000 \\ u &<= 6000 \end{aligned} \quad (15)$$

Solve the above objective functions and obtain the ordering and transportation scheme to meet the constraints.

## 4.4. Model Establishment and Solution of Problem 4

### 4.4.1. Data Quantification and Visualization Analysis

By analyzing the data of Annex 1, combining the visual statistical diagram of the order quantity and supply quantity of three raw materials A, B and C in problem 2. Since the data fluctuate regularly in 24 weeks, the order quantity and supply quantity of the next 24 weeks in the first 24 weeks in five years can obtain the line diagram of Figure 5 and Figure 6.

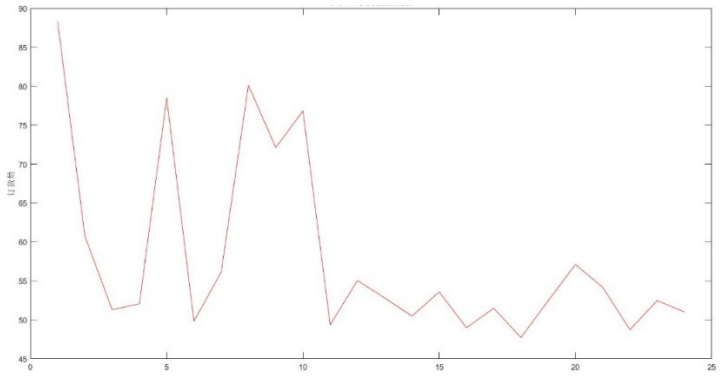


**Figure 5.** ince the data fluctuate regularly in 24 weeks (a)

ISSN: 2688-9323

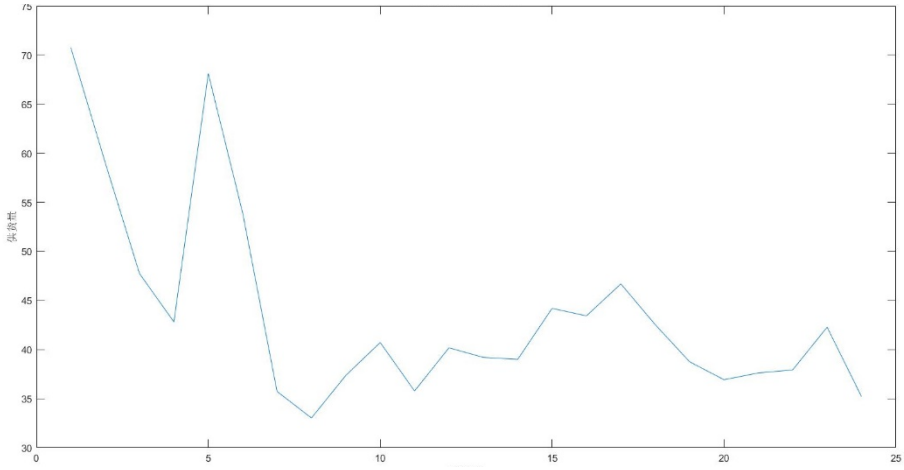


**Figure 6.** ince the data fluctuate regularly in 24 weeks (b)

## 4.5. GM (1,1) Model Principle

GM (1,1) model is a commonly used prediction model in gray system theory, which is widely used in supply prediction. This model accumulates the original data, calculates the cumulative results through the multivariate first-order variable differential equation, and finally obtains the prediction value. The modeling process is as follows:

For an initial time series, it is:

$$O^{(0)}(K) = \left\{O^{(0)}(1), O^{(0)}(2), \cdots, O^{(0)}(n)\right\} \tag{16}$$

Formula: For a supplier supply per week, n is weeks (240 weeks), K indicates different suppliers, K takes 1,2,3, ..., 402.

To do the tired, you can get:

$$O^{(0)}(K)$$

$$= O^{(1)} \left\{O^{(1)}(1), O^{(1)}(2), \cdots, O^{(1)}(n)\right\} \tag{17}$$

$$= O^{(1)}(K) \sum_{i=1}^{K} O^{(0)}(i) \quad \text{K=1,2,3, ...,402} \tag{18}$$

The differential equations for the GM (1,1) model are as follows:

$$\frac{dO^{(1)}}{dt} + aO^{(1)} = b \tag{19}$$

In formula: a, b is with coefficient, which is called development coefficient and gray action quantity respectively. A, b was determined using the least squares method.

The 43 GM (1,1) model was solved

The gray prediction model can be obtained by a and b:

ISSN: 2688-9323

$$\hat{O}^{(0)}(K+1) = \left[O^{(0)}(1) - \frac{b}{a}\right]e^{-aK} + \frac{b}{a} \tag{20}$$

By subtracting the results obtained by the prediction model, the prediction value of the model is:

$$\hat{O}^{(0)}(K+1) = \hat{O}^{(1)}(K+1) - \hat{O}^{(1)}K \tag{21}$$

This predicts the maximum enterprise capacity per week.

## 4.6. Multi-objective Planning Model based on Type 0-1 Integer Programming

Since the enterprises have the potential for upgrading, the ordering and transfer plan for the next 24 weeks should be abstracted as the ordering and transfer plan for the first 24 weeks of the sixth year, so the data for the first five years can only be used as a reference and not directly. This group uses the GM (1,1) model to predict the supply volume for the next 24 weeks to reset the enterprise ordering volume of supplier raw materials (A, B, C).This paper takes 24 weeks as a whole, with the total supply of the first 10 suppliers to predict the overall supply of the following supplier, because the supply may be affected by the quarter, so use the first five years ago 24 weeks data forecast the first 24 weeks data, so as to reset the enterprise for supplier raw materials (A, B, C), and then build a multi-target planning model.

1. objective function

α, β, γFirst, find the corresponding weekly receiving amount of A raw materials, B and C; select the suppliers selected to provide them according to the integer 0-1 plan and calculate the total number as q. in order to meet the purpose of two weeks of production consumption of raw materials, class A suppliers to select m home, class B suppliers to choose n home, and class C suppliers to choose p home, then according to the above conditions, this paper can conduct multi-target linear planning.

The objective function is the maximum weekly capacity of the enterprise with the following formula:

$$\text{Max Business Weekly capacity} = \alpha/0.6 + \beta/0.66 + \gamma/0.72 \tag{22}$$

2. Decision variables

$Y_{ij}$The decision variable refers to whether the i-th supplier will select the j-th transporter.

3. Constraints

Constraints 1: the company should reserve at least the production capacity of the next two weeks, and because the enterprise's weekly production capacity of 28,200 cubic meters, each cubic meter of product needs to consume class A raw materials, or 0.66 cubic meters of class B raw materials, or class C raw materials 0.72 cubic meters, you can get the first constraint:

$$\alpha/0.6 * m + \beta/0.66 * n + \gamma/0.72 * p \geq 5.64 * 10^4 \tag{23}$$

Constraint 2: The transporters can transport up to 6,000 cubic meters of raw materials per week, assuming that the weekly supply of the 50 suppliers is the vector Z

ISSN: 2688-9323

$$Z = \leq \begin{bmatrix} W_1 \\ W_2 \\ W_3 \\ \cdots \\ W_{50} \end{bmatrix} \begin{bmatrix} 6000 \\ 6000 \\ 6000 \\ \cdots \\ 6000 \end{bmatrix} \quad (24)$$

# 5. Model Test

## 5.1. Comprehensive Evaluation Model of Gray Correlation Degree

Grey correlation comprehensive evaluation model is a multi-factor relationship analysis model. This model is used to quantify the four evaluation indicators and calculate the gray correlation coefficient and correlation degree. The larger the correlation coefficient, the more important the supplier is, and the results are ranked according to the size of the correlation coefficient. The consistency test was used in the gray association analysis and the curve fit to determine the applicability of the model. Simulation data fit well for the 50 most important vendors, so this model applies.

## 5.2. Gray Prediction Model

For the enterprise G M (1,1) model, residual test and posterior difference test are used to test the established gray prediction model, compare the forecast weekly supply of each supplier with the actual weekly supply, and obtain the relative error and residual value. The absolute value of a small part of data error is greater than 20%, which basically meets the accuracy requirements of the gray prediction model. Since there are a few uncertain factors during ordering and transport, the gray prediction model is suitable for this problem.

# 6. Model Evaluation

## 6.1. Advantages of the Grey Association Assessment Model based on the Grey Association Analysis

Gray comprehensive evaluation method is a comprehensive evaluation method based on expert evaluation, guided by grey association analysis theory.Association is a measure of the magnitude of association between factors that quantitatively describes the case of relative changes between factors.Gray association analysis for supplier selection decision can target a large number of uncertainty factors and their relationship, combining quantitative and qualitative methods, make the original complex decision problem become more clear and simple, and convenient calculation, and to a certain extent exclude the subjective arbitrariness, the conclusion is more objective.

## 6.2. Disadvantages of the Grey Association Assessment Model based on the Grey Association Analysis

The sample data to be calculated has time series characteristics; and only identifies the quality of the, does not reflect the absolute level and cannot handle larger amounts of data.

## 6.3. Advantages of a Multi-objective Planning Model based on Type 0-1 Integer Programming

0-1 Integer planning simplifies the decision variables, and the decision variables can only take 0 or 1, which simplifies the calculation process, making the establishment of the objective functions and constraints clearer and clear, and helps in the planning.It is convenient to solve the Multi-objectives, and the model is widely used.

ISSN: 2688-9323

### 6.4. Disadvantages of Multi-objective Planning Models based on Type 0-1 Integer Programming

The model solution method is relatively single, and the most widely used is the exhaustive method, which is more complicated to handle a large number of data.

### 6.5. Advantages of the Gray Prediction Model

A large number of data samples are not required, and the calculation is more convenient, without a regular distribution for the data. The model is widely used, the corresponding test method for the prediction results is available, and the prediction accuracy is high.

### 6.6. The Advantages of the Grey Prediction Model

The selected data sample is required to be representative and requires the ability of users.

## References

[1] Shoukui, Sun Xijing. Mathematical modeling algorithm and application. Beijing: National Defense Industry Press House, 2011.8.

[2] Dai Xinmin, Zhu Jiaxiang. Grey 0-1 planning model study of supply cost optimization [J]. Financial Research, Issue 12,2008.

[3] Liang Linna, Li Jing. Study on supplier evaluation and selection of catering enterprises based on gray-weighted TOPSIS [J]. Productivity Research, No.9.2017.

[4] Wu Yongqiang, Li Mingkai, Tang Zhongnan, Wang Shusheng, Wang Jintao.Annual water consumption forecast of Hengshui city residents based on the dynamic gray model group [J]. Journal of Environmental Engineering and Technology. 2021.8.31.

[5] Yang Yu, Zeng Xianzong Bing, Guo Chunhua. Application of GM (1, N) Grey Model in Gas Well Capacity prediction [J] Journal of Guilin Institute of Technology. 2004. 7.

[6] Xu Jun. Use of Grey Comprehensive Assessment Method Based on Grey Correlation Analysis in the Preparation of Forest Cutting Limits [J] Inner Mongolia Forestry Survey Design.2013.3.

[7] Textmaterial preparation group. Operations Research (undergraduate edition), 4th Edition. Beijing: Tsinghua University Press, 2013.1 (2020.6 reprint).