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Transportation of Raw Materials, Recondite Question in Manufacturing Enterprise

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Abstract

Based on the optimization theory, this paper studies the mathematical modeling problem related to the ordering and transportation of raw materials. The paper starts with reasonable assumptions, based on which the following factors are used as index: "average supply", "order completion rate", "average order value" and "standard deviation of supply" of each supplier, and the weight of each index is determined by using entropy weight method. On the premise of reasonable weight, the distance method of good-bad solutions (TOPSIS) is used to evaluate and rank each supplier, and finally, the most important supplier is selected. Then, a 0-1 programming model is established, in which "minimum order price" and "minimum loss" are taken as the objective functions, and the two-week inventory of the enterprise is combined with factors such as the loss rate of the forwarder, using MATLAB programming TOPSIS algorithm to solve the model to obtain the optimal ordering and transshipment plan. Considering the possibility that the enterprise needs low utilization of raw materials A and C, a bi-objective programming model is established to determine the weekly ordering and transshipment plan within the target weeks. On the other hand, when the number of suppliers is sufficient, the capacity of the forwarders limits the expansion of the capacity of the enterprise. Therefore, combined with the existing data, a linear programming model with the maximum production capacity as the objective function is established to obtain the maximum production capacity and formulate ordering and transshipment schemes. Finally, the solution process and results are summarized and analyzed.

Keywords

production of building material enterprise, entropy weight method, TOPSIS, zero-one programming, goal programming, the optimization problem

1. Introduction

At present, the market competition within the construction industry is becoming increasingly fierce, and if the industry wants to survive and occupy a place, it must establish a more scientific and accurate chain of "procurement, production, sales, and transportation". The ordering (purchasing) and transportation of raw materials are particularly important for building materials companies, as it determines the stability of product quality. According to the actual situation of building materials manufacturers, it is very significant to find their raw material suppliers, raw material orders, third-party logistics companies, and supply quantities, and the comprehensive analysis of the index is required to establish a more scientific, accurate, and practical mathematical model to assess the capacity of suppliers. TOPSIS is a multi-criteria decision analysis method, initially proposed by Ching-Lai Hwang and Yoon in 1981, then developed by Yoon in 1987, and further developed by Huwang, Lai, and Liu in 1993. It is a technique for order preference by similarity to an ideal solution. Mohamed Marzouk used the distance method of good-bad solutions (TOPSIS) to evaluate the social sustainability of different suppliers in the construction supply chain based on 17 identified attributes (Kamalakannan, Ramesh, Shunmugasundaram, Sivakumar, & Mohamed, 2019). Through the empirical analysis of prefabricated supply chain network of a building, Wu Jing et al used four quantitative indexes as the basis to measure and identify the core nodes of the complex network of the construction supply chain and proved the validity and feasibility of the method, which provides new ideas for the management of construction supply chain (Kamalakannan, Ramesh, Shunmugasundaram, Sivakumar, & Mohamed; Mohamed Marzouk, 2021). Based on the collected data and the situation of construction and decorative plate production enterprise, this paper analyzes 402 suppliers and 8 forwarders in recent 5 years, the most important suppliers are selected by using the same method of TOPSIS, and considers the minimum ordering price, minimum loss and maximum production capacity of the enterprise, then the multi-objective programming is used to give the optimal ordering and transshipment scheme, and the model and algorithm are studied further (Zhu, Li, Feng, Gu, & Zhu, 2019).

2. Establishment and Solution of the Model Reflecting the Importance of Production in Guaranteeing Enterprise

2.1 Hypothesis of the Model

Before establishing the model, the following assumptions are made according to the actual situation:

Hypothesis 1. It is assumed that the weekly average of the loss rate of the forwarder represents the total loss level of the forwarder.

Hypothesis 2. It is assumed that the weekly average of the supplier's supply is representative of its supply capacity.

Hypothesis 3. It is assumed that the unit prices of A, B, and C are 1.2, 1.1, 1.0.

Hypothesis 4. The production loss brought by the enterprise is ignored

Hypothesis 5. Assuming that the order plan is equal to the supply plan, i.e., the supplier will not default

Hypothesis 6. The proportion of raw materials A, B, and C supplied by the actual supplier is not affected by the data used to estimate capacity.

2.2 Data Processing

The availability of the data is taken into account by considering that when the enterprise has an order value of “0” for week k and supplier i, the corresponding supply quantity of “0” for that supplier is redundant. However, if the order value is not “0” and the supply quantity is “0”, the data set is valid.

If the “average delivery quantity A_i”, “order completion rate ρ_i” and “standard deviation of delivery σ_i” of each supplier are determined from the suppliers themselves, in terms of their supply capacity, supply credit, and supply stability, The following three formulas will be calculated:

$$A_i = \frac{\sum A_{(i,k)}}{n_i} \tag{1}$$

$$\rho_i = \frac{\sum A_{(i,k)}}{\sum B_{(i,k)}} \tag{2}$$

$$\sigma_i = \sqrt{\frac{\sum\left(A_i - A_{(i,k)}\right)^2}{n_i}} \tag{3}$$

The above three formulas respectively evaluate the stability of different suppliers in terms of “quantity”, “rate” and “stability”.

In this paper, the “average order value B_i” received by the supplier is calculated by equation (4) to evaluate the trust degree of enterprises to suppliers:

$$B_i = \frac{\sum B_{(i,k)}}{n_i} \tag{4}$$

2.3 Determination of Index Weights

The data in 2.2 are processed by using the entropy weight method.

First of all, data normalization is processed, where “average supply A_i”, “order completion rate ρ_i” and “average order value B_i” are positive index, and are defined as variables 1, 2, and 3 ($j = 1,2,3$) respectively. Taking normalized average supply as an example, the calculation formula is:

$$A_i{}' = \frac{A_i - \min\{A_i\}}{\max\{A_i\} - \min\{A_i\}} \tag{5}$$

On the other hand, if the “supply standard deviation σ_i” taken as a negative index, and it is defined as the fourth variable ($j = 4$), the normalized supply standard deviation calculation formula $\sigma_i{}'$:

$$\sigma_i{}' = \frac{\max\{\sigma_i\} - \sigma_i}{\max\{\sigma_i\} - \min\{\sigma_i\}} \tag{6}$$

Then taking the normalized average supply $A_i{}'$ as an example, the proportiony_i and information entropy e_1 of each supplier’s index are calculated:

$$y_i = \frac{A_i{}'}{\sum A_i{}'} \tag{7}$$

$$e_1 = -\frac{1}{\ln(n_i)}\sum y_i \ln(y_i) \tag{8}$$

Next, the weight of the average supply ω_1 is calculated:

$$\omega_1 = \frac{1-e_1}{\sum(1-e_j)} \tag{9}$$

Similarly, the weights of order completion rate, average order value, and supply standard deviation $\omega_2, \omega_3, \omega_4$ are obtained, and the weight vector also be calculated:

$$\omega = [\omega_1\ \omega_2\ \omega_3\ \omega_4]^T = \begin{bmatrix} 0.3065 \\ 0.0192 \\ 0.2905 \\ 0.3838 \end{bmatrix} \tag{10}$$

2.4 Establishment of the Comprehensive Scoring Model

In this paper, TOPSIS is used and combined with the weights obtained from the entropy weight method to make full use of the information from the raw data and to accurately reflect the intrinsic connections between the raw data, and finally, the score of the supplier is calculated.

Firstly, the characteristics of the above four indexes are analyzed. Similar to the situation described in 2.3, “average supply A_i”, “order completion rate ρ_i” and “average order value B_i” are “maximal indexes” (i.e., the greater the value of the index, the more it meets expectations), only “supply standard deviation σ_i” is “minimal indexes” (i.e., the smaller the value of the index, the more it meets expectations). Therefore, the first step, the type of index need to be unified, that is, the “supply standard deviationσ_i” is converted to “maximum index σ_i''”, the conversion method:

$$\sigma_i'' = \max\{\sigma_i\} - \sigma_i \tag{11}$$

Secondly, the positive matrix is established:

$$X = \begin{bmatrix} A_1 & \rho_1 & B_1 & \sigma_1'' \\ A_2 & \rho_2 & B_2 & \sigma_2'' \\ \vdots & \vdots & \vdots & \vdots \\ A_{402} & \rho_{402} & B_{402} & \sigma_{402}'' \end{bmatrix} \tag{12}$$

For the convenience of expressing the following formula, set:

$$A_i = x_{i,1}, \rho_i = x_{i,2}, B_i = x_{i,3}, \sigma_i'' = x_{i,4}, j = 1,2,3,4 \tag{13}$$

For the normalized matrix Z of the positive matrix X, each element in $z_{i,j}$ is:

$$z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{402}(x_{i,j})^2}} \tag{14}$$

The standardized matrix Z then be calculated as:

$$Z = \begin{bmatrix} z_{(1,1)} & z_{(1,2)} & z_{(1,3)} & z_{(1,4)} \\ z_{(2,1)} & z_{(2,2)} & z_{(2,3)} & z_{(2,4)} \\ \vdots & \vdots & \vdots & \vdots \\ z_{(402,1)} & z_{(402,2)} & z_{(402,3)} & z_{(402,4)} \end{bmatrix} \tag{15}$$

Also, the maximum values Z^+ and minimum values Z^- are defined as follows

$$Z^+ = (Z_1^+, Z_2^+, Z_3^+, Z_4^+) \tag{16}$$

$$Z^+ = \left(max\{z_{i,1}\}, max\{z_{i,2}\}, max\{z_{i,3}\}, max\{z_{i,4}\}\right)\ (i = 1,2, \dots 402) \tag{17}$$

$$Z^- = (Z_1^-, Z_2^-, Z_3^-, Z_4^-) \tag{18}$$

$$Z^- = \left(min\{z_{i,1}\}, min\{z_{i,2}\}, min\{z_{i,3}\}, min\{z_{i,4}\}\right) \ (i = 1,2, \dots 402) \tag{19}$$

On this basis, the distance D_i^+ between the index corresponding to the supplier i and the maximum value is calculated as follows:

$$D_i^+ = \sqrt{\sum_{j=1}^{4} \omega_j \left(Z_j^+ - z_{i,j}\right)^2} \tag{20}$$

Similarly, the index for the i supplier and minimum distance D_i^- is calculated as follows:

$$D_i^- = \sqrt{\sum_{j=1}^{4} \omega_j \left(Z_j^- - z_{i,j}\right)^2} \tag{21}$$

Finally, the unnormalized score S_i of each supplier is calculated:

$$S_i = \frac{D_i^-}{D_i^+ + D_i^-} \tag{22}$$

After the scores of different suppliers are calculated by using formula (22), the important suppliers can be selected according to the scores.

3. The Model of the Ordering and Transshipment Scheme with the Lowest Order Price and the Lowest Loss is Established and Calculated

3.1 Calculation of Minimum Suppliers

In this paper, the top 50 most important suppliers in 2.4 are selected and the 0-1 variable g_i A is defined to satisfy (i=1,2,…,50):

$$\mathrm{g_i} = \begin{cases} 0, \text{the company does not order from this supplier} \\ \quad 1, \quad \text{The company orders from this supplier} \end{cases} \tag{23}$$

Since different suppliers provide different raw materials, thus the 0-1 variable for the supplier of raw material A is defined as g_{Ai}, the variables for raw material B and C are defined as g_{Bi} and g_{Ci}, and “least supplier” is used to define the objective function $minG$:

$$minG = \sum_{i=1}^{50} g_i \tag{24}$$

Assuming that the capacity of weekly supply shall not be less than twice the weekly capacity of 28200 m3, the constraint of the objective function is:

$$s.t.\ A_{WEEK1} = \sum_{i=1}^{50} \frac{1}{0.6} A_i g_{Ai} + \sum_{i=1}^{50} \frac{1}{0.66} A_i g_{Bi} + \sum_{i=1}^{50} \frac{1}{0.72} A_i g_{Ci} \geq 2 \times 28200 \tag{25}$$

Eventually, the following equation is formulated.

$$minG = 19 \tag{26}$$

It means that at least 19 suppliers are required to supply and the supplier number is obtained.

3.2 Formulation of Order Plan

This paper considers that the enterprise will screen out the order of all suppliers in the first week, and then predicts the orders from the second week to the twenty-fourth week on this basis. Then, the 0-1 planning model is built based on the above, and the decision variables are selected from 19 suppliers according to the definition of "whether the supplier is ordered g_i" and the objective function is defined as "minimum order price P" as follows:

$$minP = 1.2x_A + 1.1x_B + x_C \tag{27}$$

In the second week, the supply capacity shall be greater than or equal to 28200 m³ per week of production capacity. At the same time, we can get the constraints with the surplus of the first week, where the first week's supply is 35969.84 m³, the first week's capacity is 56766 m³, and the second week's supply is (i=1,2,..,19):

$$A_{WEEK2} = \sum_{i=1}^{19} \frac{1}{0.6} A_i g_{Ai} + \sum_{i=1}^{19} \frac{1}{0.66} A_i g_{Bi} + \sum_{i=1}^{19} \frac{1}{0.72} A_i g_{Ci} \tag{28}$$

The constraint condition is:

$$s.t.\ 56766 - 28200 + A_{WEEK2} \geq 2 \times 28200 \tag{29}$$

As a result, 9 target suppliers will supply 17833.59 m³in the second week.

Similarly, the availability and quantity of all suppliers from the third week, the fourth week until the twenty-fourth week can be obtained. It is worth noting that from the third week to the twenty-fourth week, the supplier supply remained stable with the same suppliers and the same supply quantity at 17878.54 m^3.

3.3 The Formulation of the Transport Scheme

In this paper, if "transshipment loss rate m_o" (o=1,2,3,…,8) is defined, each transshipment loss rate is:

$$m_o = \frac{\sum_{l=1}^{n_o} m_{o,l}}{n_o} \tag{30}$$

And the relationship between the supplier i and the forwarder o is represented by the 0-1 decision variable as:

$$t_{i,o} = \begin{cases} 0, & \text{Supplier i do not require forwarder o to forward} \\ 1, & \text{Supplier i requires forwarder o to forward} \end{cases} \tag{31}$$

Thus, the objective function $minY$ is defined as:

$$minY = \sum_{O=1}^{8} m_o A_i t_{i,o} \tag{32}$$

The constraints for the first week of transit are:

$$s.t. \begin{bmatrix} t_{1,1} & t_{2,1} & \cdots & t_{19,1} \\ t_{1,2} & t_{2,2} & \cdots & t_{19,2} \\ \vdots & \vdots & \ddots & \vdots \\ t_{1,8} & t_{2,8} & \cdots & t_{19,8} \end{bmatrix} \begin{bmatrix} A_1 \\ A_2 \\ \vdots \\ A_{19} \end{bmatrix} \leq \begin{bmatrix} 6000 \\ 6000 \\ \vdots \\ 6000 \end{bmatrix} \tag{33}$$

The transfer loss in the first week was calculated to be 372 m³.

However, this is different from equation (33), only 9 suppliers need to transship each week from the second week, the constraint condition from the second week is:

$$s.t.\begin{bmatrix} t_{1,1} & t_{2,1} & \cdots & t_{9,1} \\ t_{1,2} & t_{2,2} & \cdots & t_{9,2} \\ \vdots & \vdots & \ddots & \vdots \\ t_{1,8} & t_{2,8} & \cdots & t_{9,8} \end{bmatrix}\begin{bmatrix} A_1 \\ A_2 \\ \vdots \\ A_9 \end{bmatrix} \leq \begin{bmatrix} 6000 \\ 6000 \\ \vdots \\ 6000 \end{bmatrix} \tag{34}$$

The transfer loss in the second week was 99.70 m ³, and the subsequent transfer loss was almost the same (99.96 m ³in the third week).

As described in 3.2, the transfer scheme is the same from the third week to the twenty-fourth week.

The supply quantity at the beginning of the work is larger and the transit consumption is higher can be seen from the above results. The supply quantity from the third week is very stable (17878.5 m ³) as time goes on, which can reduce the cost of storage while meeting the production inventory requirements of the enterprise. The transshipment from the third week is very stable, with a weekly loss rate of about 0.559%, which can guarantee the transshipment efficiency while reducing unnecessary expense and consumption.

3.4 Establishment and Calculation of Two-objective Programming Model

This paper assumes that the raw material situation is a two-objective planning model—using as much raw material A and as little raw material C as possible. However, the multi-objective planning model is relatively complex and difficult to solve. Therefore, we combine the quantities of raw materials A and C to find their differences to construct the objective function $maxD$ and build a single-objective planning model. In the objective function, the coefficient before supply x_A of raw material A is 1, and the coefficient before supply x_C of raw material C is -1. We consider the supply of raw material B, but in order to avoid the influence of raw material B and supply x_B on the objective function, we set the coefficient before x_B is 0.01, and finally, the objective function is calculated:

$$maxD = x_A - x_C + 0.01x_B \tag{35}$$

If the capacity of the weekly supply is not less than twice the weekly capacity of 28,200 m ³, the constraint on this objective function is:

$$s.t.\ A_{WEEK1}{}' = \sum_{i=1}^{50}\frac{1}{0.6}A_i g_{Ai} + \sum_{i=1}^{50}\frac{1}{0.66}A_i g_{Bi} + \sum_{i=1}^{50}\frac{1}{0.72}A_i g_{Ci} \geq 2 \times 28200 \tag{36}$$

It is calculated that a total of 22 suppliers meet the requirements and the first week's supply is 35686.72 m ³under the above conditions.

This paper considers that the enterprise will select all the suppliers' orders in the first week, and then predict the order situation from the second week to the twenty-fourth week. Then the 0-1 planning model is built, and 22 suppliers are selected based on 5.3.1, the decision variables are defined in terms of "whether the supplier is ordered g_i", and the objective function is defined in terms of "minimum order price P".

$$minP = 1.2x_A + 1.1x_B + x_C \tag{37}$$

In the second week, the capacity corresponding to the supply should be not less than the weekly production for the next two weeks, and combined with the supply surplus of the first week, we can get the constraint. Where the supply quantity in the first week is 35686.72 m^3 and the capacity of the supply quantity in the second week is (i=1,2,..,22):

$$A_{WEEK2}{}' = \sum_{i=1}^{22} \frac{1}{0.6} A_i g_{Ai} + \sum_{i=1}^{22} \frac{1}{0.66} A_i g_{Bi} + \sum_{i=1}^{22} \frac{1}{0.72} A_i g_{Ci} \tag{38}$$

The constraint condition is:

$$s.t.\ \ A_{WEEK1}{}' - 28200 + A_{WEEK2}{}' \geq 2 \times 28200 \tag{39}$$

It is concluded that a total of 10 suppliers will supply 15,781.43 m^3 to this enterprise in the second week.

Similarly, all suppliers and volumes were available to us from the third week to the twenty-fourth week.

It is the same process used to develop the trans-shipment scheme in 3.3, where the objective function $minY'$ is defined in this section as

$$minY' = \sum_{O=1}^{8} m_o A_i t_{i,o} \tag{40}$$

The constraint conditions for the first week of transit are:

$$s.t. \begin{bmatrix} t_{1,1} & t_{2,1} & \cdots & t_{22,1} \\ t_{1,2} & t_{2,2} & \cdots & t_{22,2} \\ \vdots & \vdots & \ddots & \vdots \\ t_{1,8} & t_{2,8} & \cdots & t_{22,8} \end{bmatrix} \begin{bmatrix} A_1 \\ A_2 \\ \vdots \\ A_{22} \end{bmatrix} \leq \begin{bmatrix} 6000 \\ 6000 \\ \vdots \\ 6000 \end{bmatrix} \tag{41}$$

Loss volume: 364.04 m^3

Unlike the analysis in 3.3, the number of suppliers per week from the second week is not fixed, but the total number is stable at around 10, and the constraints and formula (34) for weekly transshipment are similar, the transport loss of turnover is about 89 m^3(the loss of the second week is 79 m^3).

It is concluded that the start-up of the supply volume and transshipment consumption more. As time goes on, the supply quantity is around 15,800 m^3 from the third week, which satisfies the production inventory requirements of the enterprise and reduces the cost of storage at the same time. The transshipment from the second week is very stable, the weekly loss rate is about 0.56%, which can guarantee the efficiency of transshipment while reducing unnecessary expenses and consumption.

3.5 Establishment and Calculation of Maximum Capacity Model

On the other hand, it is assumed that the capacity of the enterprise is increased, but it is restricted by both suppliers and forwarders. If the supplier's supply capacity is strong, almost to meet all supply-demand, but the number of suppliers is very limited (only 8), and the transshipment capacity is low. If each forwarder's transshipment capacity is 6000 m^3 per week, that is, the limit of transshipment capacity is 48000 m^3, even if the enterprise's production capacity is high, it will be limited by the volume of transshipment. Therefore, the maximum weekly production capacity shall be studied under the premise of maximum transshipment capacity $\mathrm{maxA_{WEEK}}$:

$$maxA_{WEEK} = \frac{1}{0.6} x_A + \frac{1}{0.66} x_B + \frac{1}{0.72} x_C \tag{42}$$

The 50 most important suppliers are selected while the supply capacity of each raw material is (unit: m ³/week).

$$\begin{cases} 0 < x_A < 23280 \\ 0 < x_B < 21434 \\ 0 < x_C < 27905 \end{cases} \quad (43)$$

We then combine equation (43) to calculate the constraint on the objective function (42):

$$s.t. \begin{cases} 0 < x_A < 23280, 0 < x_B < 21434, 0 < x_C < 27905 \\ x_A + x_B + x_C = 48000 \end{cases} \quad (44)$$

It is then calculated that:

$$maxA_{WEEK} = 70286\, m^3 \quad (45)$$

We have had to adjust our inventory requirements as a result of a 2.5-fold increase in weekly production capacity compared to the previous period, which has caused a surge in supply pressure to suppliers, especially in the first week of production. The supplier is required to supply raw materials for at least 1.5 weeks of production in the first week and at least 1.9 weeks of production in the second week.

Based on the above data and the established order plan in this paper, the objective function is "minimum order price":

$$minP = 1.2x_A + 1.1x_B + x_C \quad (46)$$

In the first week, the capacity of the supply shall not be less than 1.5 times of the weekly capacity (70286 m ³), so the capacity A_{WEEK1}'' corresponding to the first week's supply would be regarded as the constraint of the objective function:

$$s.t.\ A_{WEEK1}'' = \sum_{i=1}^{50} \frac{1}{0.6} A_i g_{Ai} + \sum_{i=1}^{50} \frac{1}{0.66} A_i g_{Bi} + \sum_{i=1}^{50} \frac{1}{0.72} A_i g_{Ci} \geq 1.5 \times 70286 \quad (47)$$

We combine the first week of supply surplus to get the constraints, and then through (46), (47) get a total of 47 suppliers in the first week with 69363m ³of supply, and the capacity of the second week of supply is (i=1,2,..,47):

$$A_{WEEK2}'' = \sum_{i=1}^{47} \frac{1}{0.6} A_i g_{Ai} + \sum_{i=1}^{47} \frac{1}{0.66} A_i g_{Bi} + \sum_{i=1}^{47} \frac{1}{0.72} A_i g_{Ci} \quad (48)$$

The constraint condition is:

$$s.t.\ A_{WEEK1}'' - 70286 + A_{WEEK2}'' \geq 1.9 \times 70286 \quad (49)$$

It is known that 44 suppliers will supply 64121 m ³in the second week.

The same calculations were made for all suppliers and supply volumes from the third week to the twenty-fourth week. However, the focus is on keeping the number of suppliers at around 30 from the third to the twenty-fourth week and the quantity supplied at around 45600 m ³(45673 m ³in the third week).

This section is the same as the formulation process of transport schemes in 3.3 and 4, and the objective function $minY''$ is defined as:

$$minY'' = \sum_{O=1}^{8} m_o A_i t_{i,o} \tag{50}$$

The constraints for the first week of transit are:

$$s.t.\begin{bmatrix} t_{1,1} & t_{2,1} & \cdots & t_{47,1} \\ t_{1,2} & t_{2,2} & \cdots & t_{47,2} \\ \vdots & \vdots & \ddots & \vdots \\ t_{1,8} & t_{2,8} & \cdots & t_{47,8} \end{bmatrix} \begin{bmatrix} A_1 \\ A_2 \\ \vdots \\ A_{47} \end{bmatrix} \leq \begin{bmatrix} 6000 \\ 6000 \\ \vdots \\ 6000 \end{bmatrix} \tag{51}$$

The loss is 470 470 m^3. For the specific transport scheme, please refer to attachment B.

The results differ from the analysis in 3.3 and 4 in that from the third week the suppliers per week were not fixed, but overall there were only two cases. The total quantity is about 30, the restriction condition of weekly transportation is similar to that of formula (51), the loss of turnover transportation is about 602 m^3(the loss of 5th week is 601 m^3, which is similar to that of 3rd Week).

4. Summary

Firstly, the entropy weight method is an objective method for determining weights compared to subjective methods such as the analytic hierarchy process (AHP), which has a certain degree of accuracy. Secondly, the weights determined by the entropy weight method could be amended to reflect the characteristics of high adaptability, but this shall be supported by certain data.

The TOPSIS method makes full use of the information from the original data to accurately reflect the gaps among the evaluation schemes. Therefore, the method does not strictly limit the data distribution and sample size, and the calculation data is convenient. At the same time, it makes full use of the original data and has less information loss.

Although the multi-objective programming model could address multiple objectives at the same time, it is restricted by the shortcomings of "unit inconsistency" and "subjective weighted distribution". Therefore, when using a multi-objective programming model, this paper transforms it into a single-objective problem by constructing the relationship between multi-objectives. This paper fully consults the literature and related articles when weighting, and calculates the weighting through scientific methods.

At the same time, a systematic mathematical model is provided in this paper, which can effectively and scientifically solve the problems from ordering, supply, transportation to actual production in order to reduce transportation loss and cost accumulation as much as possible, which is of great significance to the development of building materials enterprises.

Since almost all production companies are equipped with a "buy-transport-produce-sell" production and marketing process, if they encounter the problems described in this paper, they will be able to use the model proposed in this paper in a wider area to help them avoid risks, reduce losses and increase profits, and the model in this paper will also contribute to improving their competitiveness in the market.

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