Original Research Article

Research on Optimal Ordering Scheme of Raw Materials Based on Multi-Objective Programming Model

Jingqi Luo

Northwest University, Xi'an, Shaanxi, 710127

Abstract: By analyzing the characteristics of 402 suppliers,this paper formulates the optimal ordering scheme for enterprises according to different ordering objectives,and determines the maximum potential of enterprise capacity improvement by predicting the upper limit of suppliers'supply capacity.Firstly,we establish a multi-objective programming model aiming at the lowest cost,and then use genetic algorithm to determine the specific ordering scheme.Finally,through sensitivity analysis,it is found that the cost fluctuation under the optimal ordering scheme is within a certain range and does not change much.Combined with the distribution diagram of supplier completion rate,it can be seen that the completion rate of most suppliers is relatively stable.

Keywords: Genetic Algorithm; Multi Objective Planning; Ordering Scheme

1. Introduction

Suppliers belong to an open system of the supply chain.With the development of the times,suppliers play an important role in the supply chain,and the supplier selection mechanism is diversified.Therefore,when enterprise decision makers select suppliers to analyze the specific situation of the enterprise in detail,they should formulate corresponding ordering strategies according to the long-term development strategy of the enterprise.This paper makes a choice for the minimum number of raw material suppliers that the enterprise can meet the production,and formulates the most economical raw material ordering scheme every week in the next 24 weeks.

2. Model Establishment and Solution

2.1 Establish the Most Economical Planning Model for Raw Material Ordering

2.1.1 Determination of Decision Variables

This paper formulates the most economical raw material ordering scheme for the enterprise every week in the next 24 weeks. First,select suppliers with strong comprehensive ability.We assume that these suppliers can complete the orders given to them by the enterprise.It may be assumed that the order quantity is roughly equal to the supply quantity.The ordering scheme is to determine the supply quantity of the supplier.

Therefore,0-1 matrix S is introduced to define that the suppliers selected in this question are among the above selected suppliers.

Taking class A supplier as an example,21×24 matrix X^A representing supply quantity:

$$X^A = \begin{pmatrix} x_{1,1}^A & x_{1,2}^A & \cdots\cdots & x_{1,24}^A \\ x_{2,1}^A & x_{2,2}^A & \cdots\cdots & x_{2,24}^A \\ & \cdots\cdots & & \\ x_{21,1}^A & x_{21,2}^A & \cdots\cdots & x_{21,24}^A \end{pmatrix} \quad (1)$$

Where, x_{ij}^A represents the supply volume of the ith class A supplier in week j.Similarly,the supply capacity matrices X^B and X^C of class B and class C enterprises can be established.

2.1.2 Determination of Constraints

Constraint 1:capacity limit

The order quantity shall not be less than the inventory of production raw materials for two weeks.The order of raw materials in the first week shall not be less than the demand of products in the first two weeks(including this week),and the supply of the next week only needs to be guaranteed in the remaining weeks:

$$\left(\frac{S^A.*X^A}{0.6}+\frac{S^B.*X^B}{0.6}+\frac{S^C.*X^C}{0.72}\right) \geq \begin{pmatrix} 5.64\times10^4 & & & \\ & 2.82\times10^4 & & \\ & & \cdots\cdots & \\ & & & 2.82\times10^4 \end{pmatrix} \quad (9)\ (2)$$

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Among them, S^A、S^B、S^C are 0-1 constant matrices.In order to ensure that the suppliers selected here are from the selected suppliers. X^A X^B X^C are decision variable matrices.

Constraint 2:limit of maximum supply capacity

The supply quantity obtained at a supplier's premises in the current week will not exceed the maximum supply quantity of the supply quantity in that week.Take the first week's supply volume of the first class A supplier as an example:

$$x_{11}^A \le \max_1^A \quad (3)$$

Where, $\max^A$ is the value coefficient.

2.1.3 Determination of Objective Function

The most economical raw material ordering scheme is required,that is,the minimum cost.For the cost here,we only consider the cost of purchased raw materials,that is,the cost paid to the supplier.According to the requirement"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",assuming that the unit price of material C is 1,then a is 1.2 and B is 1.1.

The cost of purchasing materials is the quantity of A,B and C multiplied by their unit price.Taking the first week's supply of class A materials as an example,since there are 21 class A merchants,the calculation formula is:

$$1.2*\sum_{j=1}^{21} s_{1j}^A \times x_{j1}^A \quad (10)(4)$$

The direct cost for week i is:

$$1.2*\sum_{j=1}^{21} s_j^A \times x_j^A + 1.1*\sum_{j=1}^{14} s_j^B \times x_j^B + 1*\sum_{j=1}^{15} s_j^C \times x_j^C, (i=1,2,...,24) \quad (11)(5)$$

2.1.4 Model Establishment

The most economical ordering model is as follows:

$$\min \ 1.2*\sum_{j=1}^{21} s_{ij}^A \times x_j^A + 1.1*\sum_{j=1}^{14} s_j^B \times x_j^B + 1*\sum_{j=1}^{15} s_{ij}^C \times x_j^C, (i=1,2,...,24)$$

$$s.t \begin{cases} x_j \le \max_j \ (i=1,2,...,50; j=1,2,...24) \\ \left(\frac{S^A.*X^A}{0.6}+\frac{S^B.*X^B}{0.6}+\frac{S^C.*X^C}{0.72}\right) \ge \begin{pmatrix} 5.64\times10^4 & & & \\ & 2.82\times10^4 & & \\ & & ...... & \\ & & & 2.82\times10^4 \end{pmatrix} \quad (12) \end{cases} \quad (6)$$

2.2 Model Solution

Genetic algorithm is also used to solve the problem,but the coding mode of chromosome is changed,and the supply quantity is coded in integer form.The supply quantity of the supplier every week is represented by floating point numbers.Make statistical chart:

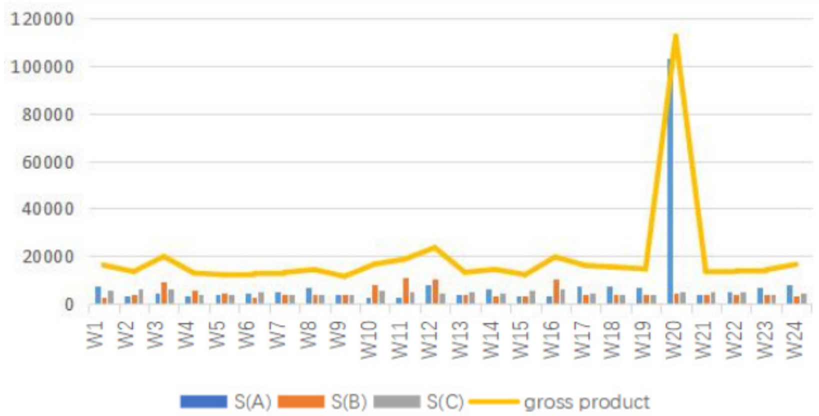

Figure 1 Distribution of minimum supplier results

2.3 Implementation Effect Evaluation Based on Sensitivity Analysis

When making the most economical order scheme,the average completion rate of each enterprise is used to measure the completion degree of the order placed.In fact,the completion rate of each supplier is a random variable.In order to study the impact on the cost if the supply quantity of some suppliers does not meet the order requirements or exceeds the order quantity.Sensitivity analysis was used.

Randomly select the completion rate of 50 suppliers in 10 weeks,and find out the ordering scheme cost of the average completion rate corresponding to the number of weeks,so as to obtain the cost comparison diagram of the optimal ordering scheme is as follows:

Figure 2 cost comparison of optimal ordering scheme

The chart analysis shows that the cost under the optimal ordering scheme fluctuates in a certain range and changes little.Combined with the supplier's completion rate variance and the completion rate distribution diagram,it can be seen that the completion rate of most suppliers is relatively stable.The change of completion rate has little impact on the cost of the optimal scheme.

3. Model Evaluation

In this paper,the average supply level of suppliers is determined in weeks.The determination method makes full use of the data,evenly distributes it to construct samples,and makes prediction according to the samples,which has higher reliability.However,the loss rate in transportation is ignored in the selection of the least supplier.And when selecting the index weight,it has a certain subjectivity.

We can take into account the supplier's supply frequency,periodicity and other characteristics,further accurately predict the supplier's weekly supply through time series analysis,and flexibly select different types of suppliers based on the company's demand urgency for goods.It also plays a good guiding role in the selection of suppliers by actual enterprises.

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