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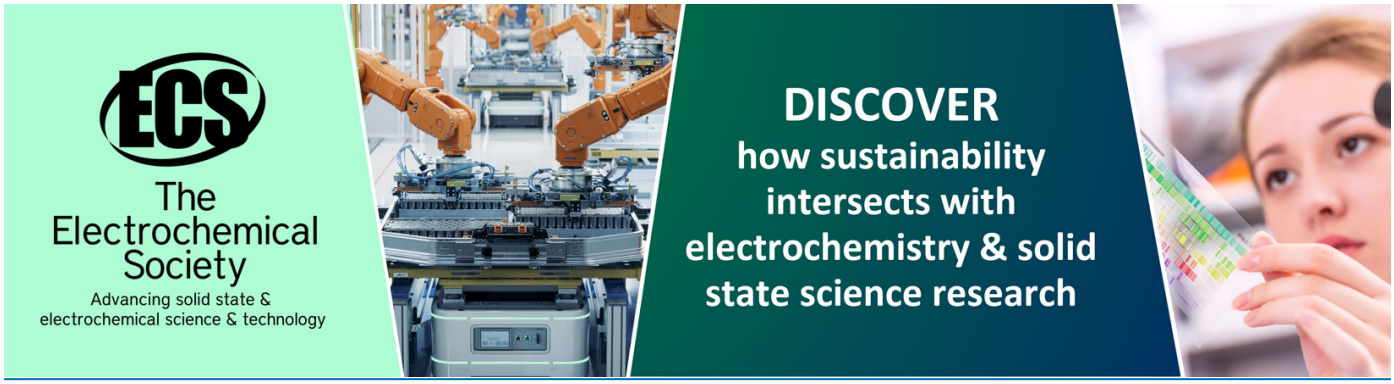

Research on mathematical modeling of order and transshipment optimal distribution

Lin Cui[1], Yin Liu[1], Zhi Liu[2a*]

[1]School of Intelligent Engineering, Shandong Management University;

[2]College of Information Engineering, Shandong Management University, Jinan, Shandong, 250300, China

[a*]xsw.lz@163.com

Abstract—Aiming at the problems of production arrangement and ordering, this paper conducts quantitative analysis, overall analysis and individual analysis on the supply characteristics of 402 suppliers, and constructs a ratio ranking model of 402 suppliers in the past five years, which reflects the important mathematical model to ensure the production of enterprises. And multi-index evaluation model, comprehensive use of Matlab, Excel and other software programming to solve, to determine the 50 most important suppliers. On the basis of mathematical modeling, a control scheme is given, and further analysis is completed, so as to optimize the ordering and transportation of raw materials in the production enterprise.

1. Introduction

Most of the production scheduling, ordering, and optimal problems are planning problems. The most important thing about planning problems is that they need decision variables, objective functions and constraints. In this paper, the selection of suppliers is a decision variable, and the selection of suppliers is a 0-1 planning model. This model provides a general model of production planning for enterprises, which has practical significance[1]. The selection of the three materials A, B, and C is arbitrary, as long as a certain amount is reached. The order quantities of A, B, and C are decision variables and continuous variables, so their domains only need to be non-negative. In this paper, matlab and EXCEL are used to construct its mathematical simulation model, which provides a reference for the decision of production arrangement[2].

Scholars at home and abroad have done a lot of research on production arrangements, ordering and determining the optimal supplier. Hou Xinru[3] proposed a new supply chain inventory management model—suppliers manage inventory; Kong Jin and Li Fang[4] analyzed manufacturers' response strategies for supply interruptions, and analyzed the response strategies of two manufacturers and two suppliers. Research on the time-sensitive supply chain composed of suppliers; Shao Zhou[5] analyzed the key points that should be paid attention to when selecting suppliers by expounding the main changes brought about by the procurement model of the framework agreement, and discussed the specific process, measurement indicators and method application; Sun Yanyan[6] expounded the factors that should be considered when scientifically optimizing the selection of suppliers, and finally put forward exploratory suggestions for strengthening supply management.

2. Data sources and model assumptions

The data comes from the relevant data of a company's 402 suppliers in the past five years and 8 forwarders in the past five years. In order to solve the problem, the following assumptions are made:

(1) Assuming that there is actually no inventory in the first week, in order to ensure the production demand for two weeks in the first week, the inventory of the first week and the second week must be purchased at the same time;

(2) Assume that the data given by the title is true and reliable;

(3) It is assumed that the data given in the attachment is true and reliable;

(4) Assuming transportation is not affected by weather conditions.

3. Identification of the 50 most important suppliers

Most of the production arrangements and optimal vocabulary are planning problems, so this paper mainly looks for decision variables, objective functions and constraints.

Supplier selection is used as a decision variable. The selection or not is the 0-1 planning model, "1" represents participating in the supply, and "0" represents not participating in the supply. The selection of A, B, and C is arbitrary, as long as it reaches a certain amount. The order quantities of A, B, and C are decision variables and continuous variables, so the domain of definition only needs to be non-negative.

The constraints of this paper are:

(1) The company must collect all the raw materials from the supplier, that is, the supply quantity. The planned quantity is actually calculated according to the supply quantity, not the order quantity. Although the order quantity is available, after adding a random number, the random number must be used for the following things.

(2) The inventory of the enterprise should be kept not less than the inventory of raw materials that can meet the production needs of two weeks, that is to say, in the first week, the inventory of the first and second weeks needs to be purchased, and the inventory of the third week needs to be purchased in the second week. Inventory levels..., the first week was actually out of stock. At the same time, it is mentioned in the question that the company operates for 48 weeks a year, which means that the 24th week still needs to buy the 25th week's inventory, which is also counted in the later cost.

(3) The weekly raw materials of a supplier are transported by a forwarder, that is to say, when the decision variable is selected, we can make a matrix with the supplier as the horizontal axis and the forwarder as the vertical axis, which is a A 0-1 matrix, in which each column, which is the supplier's choice, can only add up to a maximum of 1.

(4) The transportation capacity of each forwarder is 6000, that is to say, if the supply quantity of each supplier can also be set, then multiply the matrix to get the total transportation of each forwarder, which needs to be less than or equal to 6000.

3.1 Preparation before modeling

According to the supplier's supply quantity and the enterprise's order quantity, construct important indicators of supplier's supply characteristics. The meaning of the question is that the supply enterprise provided by the supplier is all received. Therefore, this paper analyzes from two aspects: one is the supply of suppliers, and the other is supply risk. The three major indicators that determine the supply are the number of supplies, the average supply and the maximum supply; the three indicators that determine the supply risk are the completion rate, the accuracy rate and the margin of error.

(1) Number of supply

The number of supply is the number of times a supplier has received an order from a manufacturer, which reflects the manufacturer's trust and recognition of a supplier. The higher the supply times, the stronger the supply capacity of this supplier.

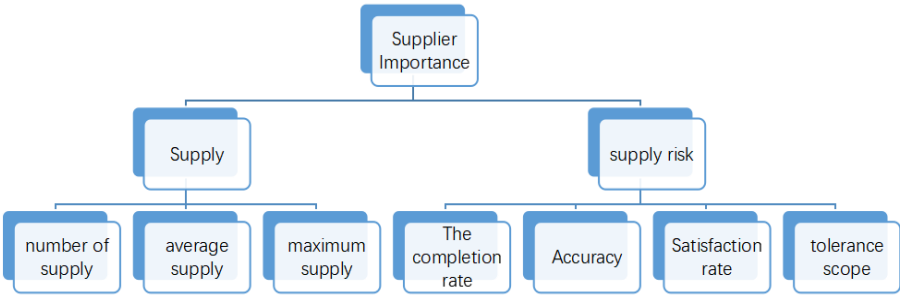

Figure 1 Multi-index evaluation model

(2) Average supply

The average supply reflects the supplier's supply capacity to a certain extent. The higher the number of deliveries, the more important the supplier is.

(3) Maximum weekly supply

The maximum supply quantity refers to the maximum supply quantity that the supplier can provide. This value is the absolute value of the difference between the supply quantity and the order quantity, that is, the relative error. This value can reflect whether the weekly supply quantity of the supplier meets the requirements of the manufacturer. requirements

(4) Completion rate

Completion rate is measured by relative error, that is, the absolute value of the difference between the quantity supplied and the quantity ordered. The smaller the relative error, the better the supplier can meet the production needs of the enterprise, and the higher the reliability and trust.

(5) Accuracy

The accuracy rate is measured by the error rate. The ratio of the relative error to the order quantity is the error rate. The weekly error rate of each merchant is added to obtain the total error rate, which can reflect the supplier's supply level. The smaller the error rate, the more the supplier can meet the production needs of the enterprise in a long time and in general, and the more important it is to the enterprise.

(6) Satisfaction rate

The fill rate is the ratio of supply to order. A supplier is considered less reliable if its fill rate is low and supply is low.

(7) Error range

The error range is an acceptable range for the relative error of the supplier's supply, which can be set arbitrarily.

3.2 Indicator calculation

(1) Number of deliveries

According to the supply data, calculating the number of times each supplier has participated in supply in the past five years, we get:

$$n_i = \sum_{i=1}^{240} y_{i,t}\ y_{i,t} \in \{0,1\}, i=1,2,\cdots 402 \quad (1)$$

Among them, n_i is the supply times of supplier i in the past 5 years, $y_{i,t}$ is a variable, it means whether supplier i participated in the supply in the seventh week, "1" means participated in the supply, "0" "represents no participation in the supply.

(2)Average Supply Quantity

The weekly production capacity of the company is 28,200 cubic meters, and each cubic meter of production requires specific A or B or C raw materials. In order to ensure the needs of normal production, the company should try to maintain a raw material inventory that is not less than two weeks of production needs. The capacity values and relative prices of A, B, C are shown in Table 1.

Table 1 Data sheet related to raw materials

raw material	Required per cubic meter of capacity（m^3）	relative purchase price
A	0.6	120%
B	0.66	110%
C	0.72	100%

According to the data of supply quantity, calculate the average value:

$$m_i = \frac{1}{n_i}\sum_{i=1}^{n_i}\frac{x_{i,t}}{p_i}, \text{i=1,2,}\cdots 402 \quad (2)$$
$$p_i = 0.6, i \in A$$
$$p_i = 0.66, i \in B$$
$$p_i = 0.72, i \in C$$

Among them, m_i is the average supply of supplier i, p_i is the raw material required to produce one cubic meter, $x_{i,t}$ is the supply of supplier i in the seventh week, and set A represents the set of suppliers of class A raw materials , set B represents the set of suppliers of B-type raw materials, and set C represents the set of suppliers of C-type raw materials.

(3)weekly maximum supply

Based on the supplier's historical supply data given, find the maximum value of each supplier's historical supply data:

$$x_i^{max} = \max\{x_{i,t}, t = 1,2,\cdots,240\}, i = 1,2,\cdots,402 \quad (3)$$

Among them, $x_i^{\max}$ is the maximum weekly supply of supplier i.

(4)The completion rate

From the data of the supplier's supply and the enterprise's order, we can get:

Among them, g is the weekly supply quantity of each merchant, and d is the weekly order quantity of the enterprise to each supplier.

(5)Accuracy

According to the data of supplier's supply and enterprise's order quantity $\mathrm{n} = \frac{|\mathrm{g}-\mathrm{d}|}{\mathrm{d}}$, Among them, n is the accuracy rate of the manufacturer.

(6)Satisfaction rate

From the data of the supplier's supply and the enterprise's order quantity, we can get $f = \frac{g}{d}$, Among them, f is the satisfaction rate of the production enterprise.

3.3 Research methods

(1) Overall analysis

The demand of A, B, C, the overall completed quantity, the number of orders with errors within a certain range, and the mathematical model and solution algorithm for the construction of production order scheduling [7].

(2) Individual analysis

The maximum amount of supply each supplier can supply to the enterprise, the completion rate, the accuracy rate, and the number of orders within the range of error.

4. Establishment of the Ratio Sorting Model

The problem we need to solve is the selection of suppliers, to identify the 50 most important suppliers. After analyzing the data, we use a ratio-ranked model for analysis. Specific steps are as follows:

The weekly supply g of each merchant is subtracted from the weekly order d of each merchant to obtain the relative error:

$$\mathrm{j} = |\mathrm{g} - \mathrm{d}| \quad (4)$$

The ratio of the relative error j to the order quantity d gives the error rate n:

$$n = \frac{|g-d|}{d} \tag{5}$$

Rank the total supply of each merchant, the more the supply, the higher the ranking, and the ranking value m is obtained.

The ranking value m is added to the error rate n. The smaller the value, the higher the ranking, and the total ranking score p is obtained:

$$p = m + n = m + \frac{|g-d|}{d} \tag{6}$$

The top 50 suppliers are selected according to the ranking.

4.1 Solving the Ratio Sorting Model

Calculate the data in each cell in the table, get the total ranking score of each supplier through Excel, and select the most important 50 suppliers. The higher the ranking supplier, the smaller the error rate, the larger the satisfaction rate, the larger the accuracy rate, the more reliable the supplier, and the greater the importance of the supplier. The results are shown in Table 2.

Table 2 Ratio sort table

Supplier ID	Material classification	Rank	Supplier ID	Material classification	Rank	Supplier ID	Material classification	Rank
S229	A	1	S395	A	18	S078	A	35
S361	C	2	S365	C	19	S218	C	36
S340	B	3	S284	C	20	S307	A	37
S275	A	4	S143	A	21	S244	C	38
S108	B	5	S031	B	22	S005	A	39
S282	A	6	S201	A	23	S189	A	40
S329	A	7	S040	B	24	S140	B	41
S151	C	8	S364	B	25	S139	B	42
S131	B	9	S126	C	26	S003	C	43
S268	C	10	S348	A	27	S292	A	44
S306	C	11	S346	B	28	S210	C	45
S356	C	12	S367	B	29	S154	A	46
S194	C	13	S294	C	30	S338	B	47
S330	B	14	S055	B	31	S374	C	48
S308	B	15	S273	A	32	S208	A	49
S352	A	16	S037	C	33	S074	C	50
S247	C	17	S080	C	34			

4.2 Result analysis

The model of ratio sorting is used for analysis, and the final solution is obtained by using the table sorting and MATLAB image reflection [8] to finally select the most important 50 suppliers as shown in Figure 2 below.

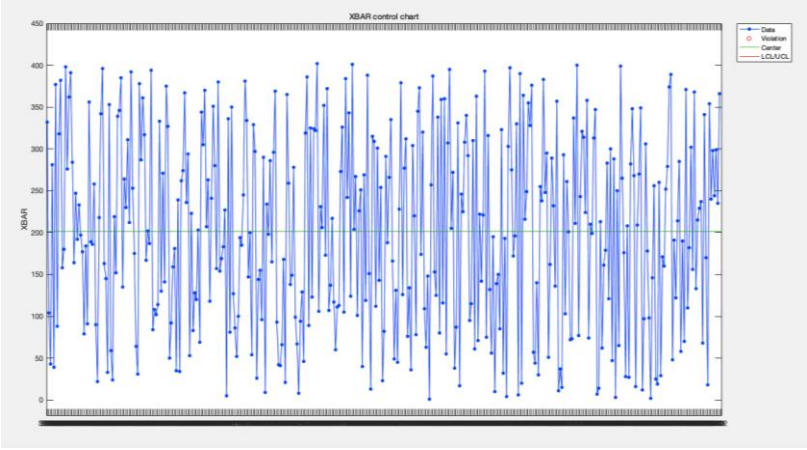

Figure 2 50 Best Suppliers

5. Conclusion

The purpose of this paper is to study the optimal problem of production scheduling and ordering, using the known data, using Matlab and excel software flexibly, and establishing a differential equation model and a ratio sorting model to further study the optimal plan, and finally obtain the optimal plan data.

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