Information Systems and Economics (2022)
Clausius Scientific Press, Canada

DOI: 10.23977/infse.2022.030106
ISSN 2523-6407 Vol. 3 Num. 1

Research on the process of Raw material ordering and Transportation based on Entropy weight and Integer programming

Meng Zhang[1], Xiaolu He[1], Dangxian Li[2]

[1]School of Environment and Civil Engineering, Dongguan University of Technology, Dongguan, Guangdong, 523808, China

[2]School of Mechanical Engineering, Dongguan University of Technology, Dongguan, Guangdong, 523808, China

Keywords: Ordering and transportation, Entropy weight method, Index system, 0-1 planning

Abstract: In this paper, aiming at the problem of ordering and transportation of raw materials in existing production units, the entropy method is used to establish a comprehensive capability evaluation model to reflect the importance of suppliers, and the important suppliers are screened out from the model. First of all, four indicators of average supply intensity, supply accuracy, order rate and supply stability are established as dependent variables of entropy method to evaluate the importance of suppliers, and the top 50 suppliers are obtained. Then considering that the selection of the least suppliers should not only meet the production needs of enterprises, but also ensure the stability of production, but also meet the business principle that the lower the cost, the better. Taking the maximum supply capacity of the supplier as a fixed value as the predicted value of its supply capacity in the next 24 weeks, taking this value as the decision variable and the ordering cost as the objective function, a 0-1 integer programming model is introduced to solve whether each supplier is selected or not. To solve the number of 1 in the 0-1 matrix is to solve the minimum number of suppliers.

1. Introduction

For manufacturing enterprises, the ordering and transshipment of raw materials is a critical process. This is not only closely related to the cost of the enterprise, but also related to the transportation and work efficiency of the whole enterprise [1]. Therefore, this paper establishes the relevant raw material ordering and transportation scheme optimization model, carries on the mathematical modeling analysis to this process, and selects a wood production enterprise to carry on the research.

2. Data preprocessing

In order to facilitate the subsequent model establishment, it is necessary to find out the supply law of the supplier, so it is necessary to preprocess the data. Use Matlab to draw the supply volume data chart of each supplier within 240 weeks. After analysis, the following conclusions are drawn [2]. The

supply data of each supplier in recent five years (i.e. 240 weeks) have periodic changes, that is, the supply data have similar distribution in the same time period. These supply data have obvious periodicity, and the cycle is 24 weeks. Within the same time period, the supply volume will fluctuate slightly.

3. Determine evaluation indicators

(1) **Average supply intensity**: Add up the supply volume of each supplier within 240 weeks, take the average value, and define this value as the average supply intensity rj1.

$$r_{j1} = \frac{\sum_{i=1}^{240} g_{ji}}{240},\ (j=1,\ 2,\ ...,\ 402) \tag{1}$$

g_{ji} represents the supply volume of the j_{th} supplier in week i, j =1, 2, …, 402.

(2) **Supply accuracy**: Divide the difference between the weekly supply quantity [3] and order quantity of each supplier by the order quantity, and then calculate the square of the value, that is, the supply accuracy of the week. Then add the accuracy of the supplier for 240 weeks to get the average value, and then this value is defined as the supply accuracy. Supply accuracy indicates the degree of deviation between the actual supply quantity and the order quantity of the supplier.

$$r_{j2} = \frac{1}{240}\sum_{i=1}^{240}\left(\frac{g_{ji}-d_{ji}}{d_{ji}}\right)^2 (j=1,2,...,402;i=1,2,...,240) \tag{2}$$

(3) **Order rate**: Set the index as the supply volume of 15 cubic meters in a week, and the completion index is greater than or equal to the supply volume [4]. Divide the weeks of the supply quantity of each supplier's completion index by the total weeks 240, and then multiply by 100%, and this value is defined as the order rate. Therefore, it is more important to the enterprise. The mathematical expression is:

$$r_{j3} = \frac{f_j}{240}\times 100\%, (j=1,2,...,402) \tag{3}$$

Where f_j represents the number of weeks that the j-th supplier has completed the index within 240 weeks, j = 1, 2,…,402.

(4) **Supply stability:** The difference between the weekly supply quantity of each supplier and the average value of its 240 week supply quantity is calculated [5], and the square of the value is the deviation degree between the weekly supply quantity and the average supply quantity.

$$r_{j4} = \sqrt{\frac{\sum_{i=1}^{240}(g_{ji}-\overline{g}_{ji})^2}{240}} \tag{4}$$

Where g_{ji} represents the supply volume of the jth supplier in week i, g_{ji} represents the average supply volume of the jth supplier in week 240, j = 1,2, 402; i=1, 2, …, 240.

4. Entropy weight method model

4.1 Model building

The entropy weight method model is a kind of model based on the degree of influence on the results caused by the difference of each index. After standardizing the index data, calculate the information entropy of each index, determine the weight of each index according to the information

entropy, and finally add the weight of each index to obtain the comprehensive score of each supplier.:

$$Sum_i = \sum_{j=1}^{n} r_{jn}\omega_n, (j = 1, 2, ..., 402; i = 1, 2, ..., 240; n \le 4, n \in z) \quad (5)$$

Where r_{jn} represents the value of the jth supplier in the nth index, ω_n represents the weight of the nth index, j = 1, 2, 402; i=1, 2,…, 240; n≤4,n∈z.

4.2 Model solution and result analysis

The comprehensive score of each supplier is calculated by entropy weight method. The top 50 suppliers and their comprehensive scores are listed in the table below.

Table 1: Top 50 suppliers and comprehensive score

Ranking	1	2	3	4	5	6	7	8	9	10
Supplier	'S229'	'S361'	'S108'	'S151'	'S340'	'S282'	'S275'	'S329'	'S131'	'S330'
Score	0.9999	0.9606	0.8323	0.7609	0.7314	0.7265	0.7126	0.7096	0.6800	0.6780
Ranking	11	12	13	14	15	16	17	18	19	20
Supplier	'S308'	'S356'	'S268'	'S306'	'S194'	'S352'	'S143'	'S247'	'S284'	'S365'
Score	0.6772	0.6711	0.6705	0.6651	0.6289	0.6108	0.5990	0.5635	0.5469	0.5414
Ranking	1	2	3	4	5	6	7	8	9	10
Supplier	'S229'	'S361'	'S108'	'S151'	'S340'	'S282'	'S275'	'S329'	'S131'	'S330'
Score	0.5390	0.5287	0.5272	0.5226	0.5189	0.5143	0.5123	0.5069	0.5062	0.5030
Ranking	1	2	3	4	5	6	7	8	9	10
Supplier	'S229'	'S361'	'S108'	'S151'	'S340'	'S282'	'S275'	'S329'	'S131'	'S330'
Score	0.4869	0.4796	0.4756	0.4596	0.4464	0.4391	0.3087	0.3040	0.2999	0.2780
Ranking	1	2	3	4	5	6	7	8	9	10
Supplier	'S229'	'S361'	'S108'	'S151'	'S340'	'S282'	'S275'	'S329'	'S131'	'S330'
Score	0.2652	0.2418	0.2382	0.2205	0.2181	0.2153	0.1962	0.1927	0.1923	0.1899

Table 2: Unit production consumption of different materials

Material Science	A	B	C
Raw materials consumed per unit production(m^3)	0.60	0.66	0.72
Purchase unit price(r/m^3)	1.2	1.1	1
Unit production cost(r)	0.72	0.726	0.72

According to the entropy weight method, through the auxiliary operation of MATLAB and excel, 50 suppliers such as s229, s361, S108 and S151 in Table 2 are obtained. These 50 suppliers are the most important 50 suppliers. It is not difficult to see from table 2 that there is a large difference in the comprehensive score of the top 50. For example, the score of the first s229 is 0 9999, the 50th place, S273 score is 0 1899. Therefore, it is judged that the strength of the top 50 suppliers is quite different. 50 suppliers provide a, B and C materials, accounting for 36%, 26% and 38% respectively. The distribution is balanced, and C>A>B, which can better meet the needs of enterprises. It can be seen from table 3 that the unit production consumption of different materials C>B>A, and the unit cost B>A=C. The enterprise orders more economically, while the enterprise production is often linked to the cost, so it is most important to the enterprise.

5. Establishment of supplier minimum optimization model

5.1 Model establishment

Establish a 0-1 integer programming model: suppose that the j supplier is selected or not, there are 402 suppliers in total, forming a matrix Y with 402 rows and 1 column. It is assumed that the supply volume of each supplier in the next 24 weeks is the maximum of 24 weeks in the past five years. At this time, the supply quantity is a fixed value, which is used as the predicted value of the supply capacity of each supplier. Taking the year as the horizontal column and the maximum value of the corresponding period as the vertical column, the predicted value matrix is a matrix with 5 rows and 2 columns. Its mathematical expression is:

$$x_{ji} = Max\begin{pmatrix} x_{year1,\max 1} & x_{year1,\max 2} \\ \cdots & \cdots \\ x_{yearn,\max 1} & x_{yearn,\max 2} \end{pmatrix} \tag{6}$$

x_{ji} Represents the predicted supply capacity of the jth supplier in the ith week in the next 24 weeks, and max (x1, x2) represents the maximum value of x1, X2, n = 1,2,…,5; j=1,2,…,402; i=1,2,…24.

When calculating this question, the transportation loss can be regarded as the average loss of 402 suppliers in the first five years, which is calculated as 1 34%, because the receiving rate = 1-loss rate, the receiving rate is 98.5% 66%. The supply quantity of each supplier is multiplied by the receiving rate, and then divided by the unit production consumption of the corresponding supply materials. The obtained value is used as the supplier's production contribution to the enterprise. Sum the production contribution value of the selected suppliers to the enterprise every week. The sum value needs to meet the production demand of the enterprise, that is, greater than or equal to 2 At this time, the supplier meets the conditions of 820000 cubic meters per week. The mathematical expression is:

$$\sum_{j=1}^{420} \frac{98.66\% x_{ji} y_j}{p_j} \geq 2.82 \times 10^4 (j = 1,2,...,402, i = 1,2,...,24) \tag{7}$$

After the constraint formula is input into Matlab, the solution set of 0-1 integer programming model is solved, and the value obtained by summing the elements in the solution set is the minimum number of suppliers required to meet the production needs of enterprises. The mathematical expression is:

$$Count = \sum_{j=1}^{420} y_j, (j = 1,2,...,402; i = 1,2,...,24) \tag{8}$$

5.2 Solution and result analysis

The supplier minimum optimization model is used to solve the predicted value of each supplier's supply capacity in the next 24 weeks as the supply index, and then calculate its production contribution to the enterprise according to the type of material ABC.

As shown in Table through comparison, it can be found that the top 44 of the 46 suppliers belong to the 50 most important suppliers to the enterprise. It is not difficult to judge that the supply stability, supply intensity, supply fluctuation and reputation of the 46 suppliers have a reliable guarantee for the production of the enterprise.

Table 3: Unit production consumption of different materials

Ranking	1	2	3	4	5	6	7	8	9	10
Supplier	'S229'	'S361'	'S108'	'S151'	'S340'	'S282'	'S275'	'S329'	'S131'	'S330'
Ranking	11	12	13	14	15	16	17	18	19	20
Supplier	'S308'	'S356'	'S268'	'S306'	'S194'	'S352'	'S143'	'S247'	'S284'	'S365'
Ranking	21	22	23	24	25	26	27	28	29	30
Supplier	'S031'	'S040'	'S364'	'S367'	'S346'	'S055'	'S080'	'S294'	'S218'	'S266'
Ranking	31	32	33	34	35	36	37	38	39	40
Supplier	'S244'	'S123'	'S139'	'S348'	'S189'	'S003'	'S374'	'S307'	'S005'	'S292'
Ranking	41	42	43	44	45	46	47	48	49	50
Supplier	'S078'	'S074'	'S210'	'S273'	'S154'	'S208'				

6. Conclusion

In this paper, aiming at the problem of ordering and transportation of raw materials in existing production units, the entropy method is used to establish a comprehensive capability evaluation model for suppliers, which can reflect its importance. After preprocessing the data, considering that the selection of suppliers needs to weigh whether their supply meets the production needs of enterprises, the average supply intensity, supply accuracy and order rate are established. Four indicators of supply stability are used as dependent variables of entropy method to evaluate the importance of suppliers. Ranking the scores of each supplier and finding the top 50 suppliers is the most important supplier. The results show that there are 50 suppliers, such as S229, S361, S108, S151 and so on. Then, based on the 0-1 programming, the maximum supply volume of the supplier is regarded as the fixed value as the predicted value of its supply capacity in the next 24 weeks, and the number of 1 in the 0-1 matrix is solved, that is, the minimum number of suppliers is S229, S361, S361, S108, and so on.

References

[1] Ran Maoliang, Huang Hao, Zhong Ying Construction of evaluation model based on entropy weight method [J] Science and technology wind, 2018, (14): 207-208.

[2] Li Fuchang Research on three-stage decision-making model of inventory and transportation joint optimization considering marketing cost [J] Industrial technology and economics, 2016, (2): 39-44.

[3] Cao cejun, Li Congdong Summary of emergency organization assignment optimization based on mathematical programming [J] Journal of system simulation, 2021,33 (01): 1-12.

[4] Zhang Bo On the application of mathematical linear programming in enterprise management [J] Enterprise technology and development, 2020 (11): 213-215.

[5] Sang Yumeng, Han Xiuping, doctor Construction of logistics financial risk evaluation model based on entropy weight method [J] Business economics research, 2019, (9): 165-167.