Research on the Problem of Enterprise Raw Material Ordering and Transportation Based on EOQ Model

Chunli Wang, Huiwen Zheng, Yingzhen Qiu, Lijun Liao, Aiying Xu*
Guilin Tourism University, Guilin, Guangxi, China
**Corresponding Author.*

Abstract: For the ordering and transportation of raw materials in production enterprises, it researches the relationship and characteristics of the company's order quantity and the supplier's supply quantity by using the correlation analysis method. The average model is used to analyze the supplier's supply quantity. Besides, it predicts the satisfying relationship between the supply quantity and the order quantity. Then, it uses the 0-1 linear programming model and the limit model to calculate the number of suppliers selected by the enterprise. Besides, it uses Excel calculation and analysis method to give the most economical ordering plan. The research performs data analysis on the chart, establishes an EOQ function model using the knowledge of mathematical functions. It calculates the optimal solution, and formulates the production plan after the transformation of the enterprise by using the assumption method. Therefore, the weekly production capacity of the enterprise can be improved.

Keywords: Hypothesis Testing; Optimal Solution; Quantitative Analysis; EOQ Model; Raw Material Ordering and Transportation

1.Introduction

As we all know, China's economy has entered a stable "new normal" stage. Nowadays, a series of severe problems such as insufficient demand, overstocked inventory, and declining profits will bring great challenges to the survival and development of many enterprises in our country. In such a fierce competitive environment, more and more entrepreneurs and scholars have realized more clearly that procurement management is one of the most effective means of cost control. Efficient procurement process and scientific management are an important part of an enterprise. It is an important way to improve competitiveness and reduce production costs. Therefore, effective control of procurement-related links can achieve better economic benefits. It plays an important role in maintaining and enhancing competitive advantages for enterprises.

At present, many experts and scholars' research on the optimal solution of enterprise raw material ordering and transportation mainly focus on perfecting and improving the enterprise's procurement management plan. Lu Zhiwei[1] systematically analyzed the non-productive procurement activities of TZF Company, summed up the problems existing in the current procurement process of the company, and the demand for changes in procurement management in today's social environment. Zhao Mingyue [2] researches and discussed on the management of the procurement process of R decoration engineering company deeply through the ASME method, fishbone diagram method, ECRS principle and ABC management principle and other methods. He analyzes the problems existing in the procurement process and improves it. Yan Qiuhan[3] used the TO module to optimize the route. Chen Gang et al. [4] established a multi-objective optimization model to minimize the total system time, total cost and maximize the road safety of the distribution route. From the research status, the current research direction mainly considers two aspects including cost saving and route optimization.

2. Construction of Raw Material Optimization Order Index System

The research synthesizes the research of various scholars on the optimal solution of enterprise raw material ordering and transportation. The author will extract the supplier's supply characteristics from the procurement table of M company. It analyzes the optimal ordering of the company's raw materials from the four dimensions of supply, order volume, consumption, and cost. The order quantity of the

enterprise includes the final received quantity. The supply quantity includes actual provided quantity. The consumption quantity includes the consumption rate during the transshipment process. the cost includes the purchase cost, order cost, and transshipper. As it is shown in Figure 1:

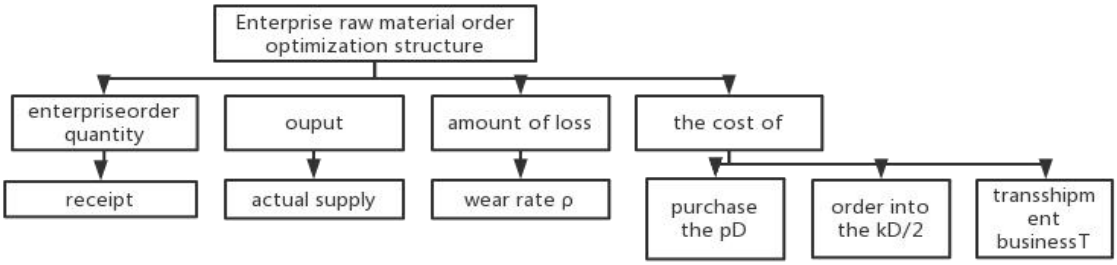

Figure 1. Evaluation Chart of Optimal Structure of Enterprise Raw Material Ordering

3. Analysis Based on the Ranking of the Order Quantity of Enterprises and the Ranking Of Supplier Supply Quantity

3.1 Research Ideas

The ranking analysis that affects the order quantity of the enterprise and the supply of the supplier is an important prerequisite for studying the cost and transportation optimization of raw materials. The ranking analysis of the order quantity of the enterprise and the supply of the supplier should start from three aspects: the demand for different raw materials, the supplier's supply volume and the relationship between the supplier's order volume and supply volume. Using the average model, the data is processed to obtain a ranking of the order quantity, the quantity supplied and the relationship between them.

3.2 Research Methods

The paper conducts quantitative analysis according to the needs of M enterprises and various supply characteristics of suppliers. Finally, it selects 402 suppliers from the suppliers in the past five years. It uses the mathematical model to obtain the average value [5]. The supplier's supply capacity is used for data processing, where i represents the number of weeks of purchase, and X represents the supplier's supply.

$$\bar{X}=\frac{X_1+X_2+\cdots+X_n}{n}=\frac{\sum_{i=1}^{n}X_i}{n} \quad (1)$$

It substitutes the data into the model. Finally, it solves the average supply of the top 50 suppliers among the 402 suppliers. As it is shown in Table 1.

In order to show the raw materials required by M company more clearly, the top 50 suppliers of raw materials required by it are now drawn into a statistical graph. As it is shown in Figure 2.

In order to see the relationship between the order quantity of M enterprise and the supply quantity of each supplier more clearly, the weekly order quantity of the enterprise (Figure 2) and the weekly supply quantity of each supplier (Table 1) are now calculated. The researches combined and drawn them into a relationship chart, as it is shown in Figure 3.

Table 1. Average Supplier Supply

supplierID	S229	S361	S140	S108	S151	S340	S282	S275	S329	S139	S131	S308
supply(M^3)	1478	1367	1258	1003	810	714	705	660	652	632	572	570
supplierID	S330	S356	S268	S306	S194	S348	S352	S143	S201	S307	S395	S247
supply(M^3)	569	542	540	525	422	385	370	344	341	325	316	236
supplierID	S037	S395	S247	S037	S374	S126	S284	S365	S031	S040	S338	S364
supply(M^3)	211	316	236	211	205	198	194	173	171	132	125	119
supplierID	S367	S294	S086	S244	S210	S218	S003	S074	S114	S273	S292	S189
supply(M^3)	109	78	74	68	65	64	54	54	45	39	38	37
supplierID	S208	S078	—	—	—	—	—	—	—	—	—	—
supply(M^3)	36	35	—	—	—	—	—	—	—	—	—	—

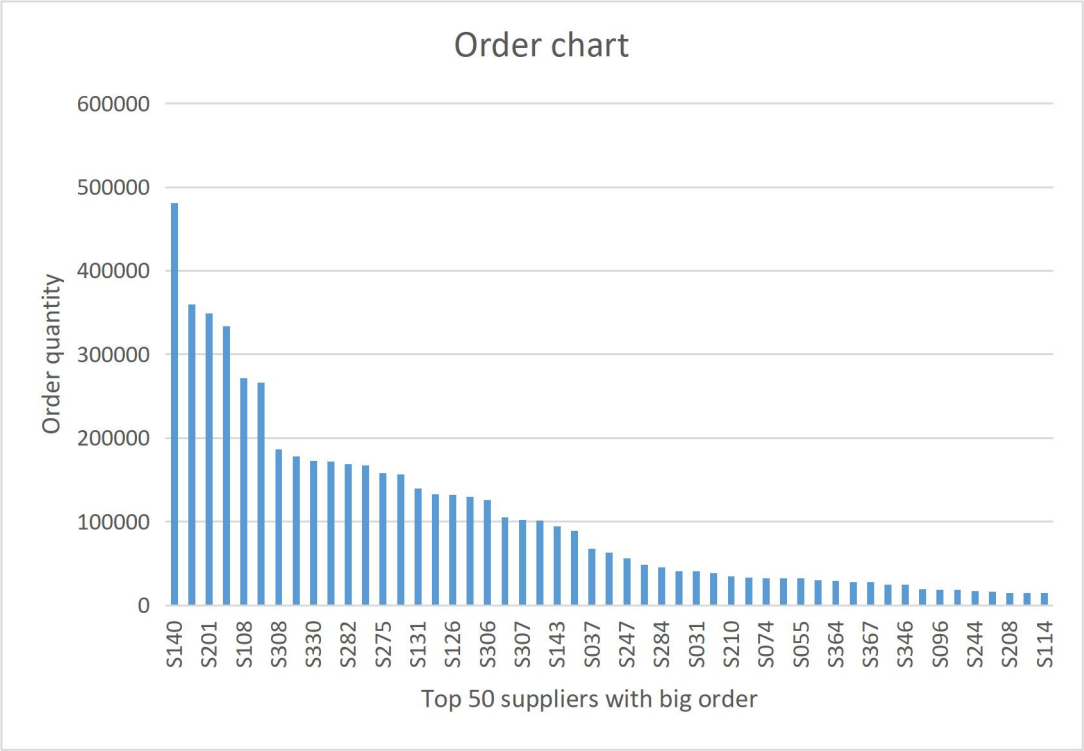

Figure 2. Ordering Statistics for the Top 50 Raw Material Quantities(M^3)

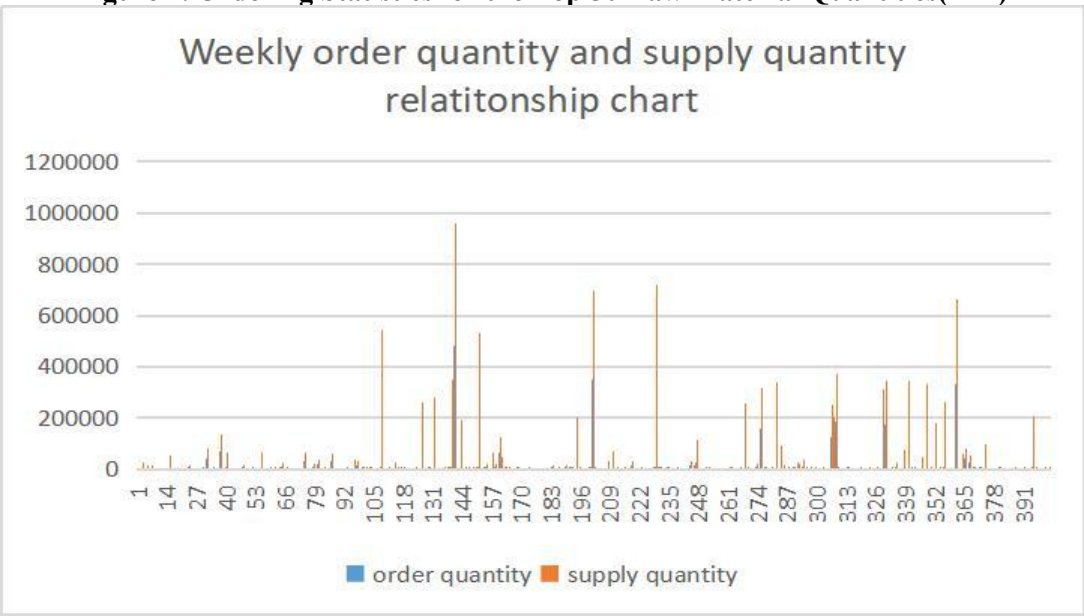

Figure 3. Relationship Between Order Quantity(M^3) and Supply Quantity(M^3)

3.3 Analysis of Results

The top 50 most important suppliers can be obtained by arranging the average supply of suppliers in descending order. From the relationship diagram of order quantity and supply quantity, it can be concluded that the smaller the difference between the two data. The stronger the supplier's supply capacity, the more able to meet the enterprise's order quantity.

4. Analysis Based on the Least-Supplier Solution

4.1 Research Ideas

The number of suppliers is the objective function in selecting the least number of suppliers to supply the raw materials that meet the production requirements. At the same time, it is necessary to give each supplier an upper limit. It uses the 0-1 planning model for planning. When reaching the optimal solution, it tries to

select top-ranked suppliers for supply. At least the term can be applied to limit problems in mathematics. Let the variable take the limit value, which can be satisfied in the ideal state. At this time, the value of the supplier and the supply quantity to be provided are equal to the order quantity of the enterprise. That is, the supply quantity = the order quantity. Therefore, it can focus only on suppliers. For what is required is the most economical, it can be supplied according to the chart analysis. Finally, it achieves the most economical purpose.

4.2 Research Methods

The researches determine the unknown variables (decision variables) to be determined according to the 0-1 linear programming model [6], and represent them with algebraic notation. According to the data, it can be calculated that the production cost of class A material and class C material is the same and lower than that of class B Material costs.

Table2. A, B, C Diagrams of Raw Materials

Type of raw material	A	B	C
Raw materials consumed per M of product（M^3）	0.6	0.66	0.72
Unit Price	1.2	1.1	1
Production cost	0.72	0.726	0.72

The research finds all the limits or constraints in the problem. It writes the linear equations or linear inequalities for the unknown variables. It uses the limit problem to select the minimum supplier, supplies the raw materials that meet the production. Besides, it uses the 0-1 linear programming model to solve the minimum supplier, where C is the weekly transport volume (M^3) of each forwarder. i is the number of suppliers:

$$\min Z = \sum_{j=i}^{n} C_j X_j \tag{2}$$

$$s.t.\begin{cases} \sum a_{ij} x_j \geq b_j \\ x_j = 0 or 1 \end{cases}, \mathrm{i} = 1,2,\cdots,\mathrm{m}; \mathrm{j} = 1,2,\cdots,\mathrm{n}. \tag{3}$$

It finds the goal or criterion of the model, and it writes it as a linear function of the decision variable. Writing the limit value, the research finds the minimum value.

$$\min Z = f(x) = \sum_{j=i}^{n} C_j X_j \leq b_{i,i=1,2,\cdots,m.} \tag{4}$$

Decision Variables：*X1,X2,....Xn*

Knowing the weekly transportation volume of each forwarder(M^3) : C =6000, the average number of raw materials consumed per cubic meter of various raw materials and the weekly production capacity can be obtained. In this way, it can obtain the average weekly raw materials required.

Average model of raw materials consumed is following:

$$\bar{X} = \frac{X_1 + X_2 + \cdots + X_n}{n} = \frac{\sum_{i=1}^{n} X_i}{n} \tag{5}$$

$$G = w \cdot b \tag{6}$$

Where G is the raw material required per week, w is the production capacity, and b is the average consumption.

4.3 Analysis of Results

When solving the problem of the demand to be satisfied, using the limit and 0-1 linear programming model, it is concluded that the enterprise can only meet the production demand by selecting at least 4 suppliers to supply raw materials. According to the meaning of the question, it is calculated that the production cost of A-type materials and C-type materials is the same. They are lower than the cost of B-type materials. The production capacity of A-type materials of the same unit is greater than that of C-type materials. Therefore, the ordering plan of A-type raw materials is selected for 24 weeks is the most economical. Considering that there will be a certain loss of raw materials during the operation, it is more scientific and cost-effective to choose the operator with the smallest operating loss rate.

5. Analysis of the Future Ordering Plan Based on the Optimal Plan

5.1 Data Preparation

Substituting the data into the average model, it can obtain the average loss rate of the 8 forwarders. It is shown in the Table 3.

Table 3. Average Loss Rate Per Fowarder (%)

Transshipment Business	Average Loss Rate（%）

T8	1.01
T7	2.08
T6	0.54
T5	2.89
T4	1.57
T3	0.19
T2	0.92
T1	1.90

5.2 Researth Proposal

According to the formula, the weekly production capacity of various raw materials can be obtained:

$$F = E \cdot \frac{(1-\bar{\rho})}{b} \tag{7}$$

Among them, F is the weekly production capacity of various raw materials. E is the supply quantity, $\bar{\rho}$ is the average loss rate. b is the average consumption of various raw materials per cubic meter.

According to the formula obtained from Figure 4: $M = p \cdot G$ (M is the total price, p is the unit price, G is the quantity). The transport scheme can be obtained. In order to express the transshipment plan more intuitively, it can be combined with the data in Table 2 to draw a statistical graph of the average loss of each transshipper. As it is shown in Figure 4.

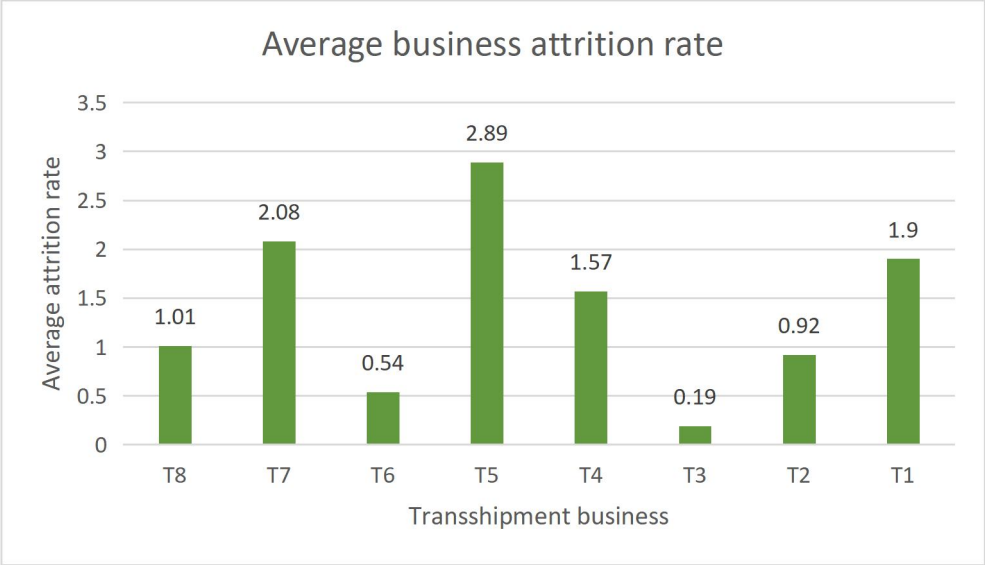

Figure 4. Average Loss Rate Per Forwarder (%)

Reasonable assumption: The problem of this transshipment process is a planning problem, and the loss of each forwarder is also different. Therefore, the loss of each forwarder corresponding to each week can be determined according to the average value of the loss of the corresponding week in each year. The loss rate is recorded as ρ_1, then there are:

$$\rho_1 = \begin{pmatrix} 1.90 \\ 0.92 \\ \cdots \\ 1.01 \end{pmatrix} \tag{8}$$

This objective function is the transshipment plan with the least loss. It can use the value of the supply obtained above. G_A , G_B , G_C , consider which transshipper can cooperate with. Then they combine the loss rate of the transshipper in the week to get the final result. The result of the mathematical expression is:

$$\min Z \begin{pmatrix} G_A \\ G_B \\ G_C \end{pmatrix} \cdot S_Z \cdot \rho_1 \tag{9}$$

5.3 Analysis of Results

Comparing the final total production capacity of different raw materials ordered by the enterprise, it obtains the optimal plan for future orders.

6.Analysis of the Ordering and Transportation of Raw Materials for Production Enterprises Based on the Optimization Method

6.1 Research Ideas

The connotation of optimization is to spend the least resources to do the most things. The solution is the optimization method. The purpose of the optimization method is to find an optimal solution for the rational use of human, material and financial resources for the researched

problem. It gives full play to the efficiency and benefit of the system, and finally achieve the optimal goal of the system. Nowadays, optimization methods have been widely used in various fields such as public management, economic management, engineering construction, national defense, etc. It is playing an increasingly important role. In order to make the enterprise use the scheme with the least production cost to realize the purpose of reducing the production cost of the enterprise, an optimal scheme based on the EOQ mathematical model [7] and the summation formula is established.

6.2 Research Methods

Let D be the total demand for the whole year, Q is the quantity of each order, K is the cost of each order, h is the cost of inventory, T is the cost of purchase , H is ordering cost,and p is the unit price of the purchase, we can get:

$$T = pD \tag{10}$$

$$H = \frac{KD}{2} \tag{11}$$

Then the economic order quantity is:

$$Q_0 = \sqrt{\frac{2KD}{h}} \tag{12}$$

Minimum total cost is：

$$C\min = \sqrt{2KDh} + pD \tag{13}$$

$$C = K\frac{D}{Q} + h\frac{Q}{2} + pD \tag{14}$$

Let

$$\frac{dC}{dC} = \frac{KD}{Q^2} + \frac{h}{2} = 0 \tag{15}$$

Summation formula is [8]:

$$\sum_{k=1}^{n} K = \frac{1}{2}n + (n+1) \tag{16}$$

In order to see the supply type and quantity of each supplier in Table 1 more clearly, the list of suppliers whose average supply is ranked in the top 50. It is divided into three tables by raw material supply category in Table 4, Table 5, Table 6.

Table 4. Top 50 Suppliers of RAW MATERIALS A

Class A	S229	S282	S275	S329	S348	S352	S143	S201	S307	S395	S114	S273	S292	S189	S208	S078
Supply（M^3）	1478	705	660	652	385	370	345	341	325	316	45	39	38	37	36	35

Table 5. Top 50 Suppliers of RAW MATERIALS B

Class B	S140	S108	S340	S139	S131	S308	S330	S031	S040	S338	S364	S367	S055	S346
Supply（M^3）	1258	1003	714	632	572	570	569	171	132	125	120	109	100	96

Table 6. Top 50 Suppliers of RAW MATERIALS C

Class C	S361	S151	S356	S268	S306	S194	S247	S037	S374	S126
Supply(M^3)	1367	810	543	540	525	422	236	211	205	198
Class C	S284	S365	S080	S294	S086	S244	S210	S218	S003	S074
Supply(M^3)	194	173	80	78	74	68	65	64	54	54

According to the top 50 suppliers supplying A, B, C raw materials (Table 4, Table 5, Table 6), it calculates the supply of the selected suppliers of various raw materials, adding them to obtain the total supply. Then it calculates the total supply according to each supplier. The average loss rate of forwarders (Figure 4) selects the forwarder with the smallest loss, and finally it solves the actual volume of goods arriving at the manufacturer.

$$R = G_n \cdot (1 - \rho) \tag{17}$$

Among them, R is the received quantity, and G_n is the supply quantity of each group.

6.3 Analysis of Results

Using the transporter with the smallest transport loss rate to transport the group of suppliers with the largest utilization rate, the optimal solution with the least production cost can be obtained.

7. Conclusion

In this fast pace of economic globalization, market competition is also more intense and complex. In the fierce market competition environment, enterprises need to quickly adapt to the needs of the market. Purchasing is the most important part of an enterprise's operation. The traditional purchasing method can no longer meet the needs of the enterprise's purchasing

and operation under the new situation. To better achieve economic benefits, reducing production costs is the most effective way. Combining a variety of methods, this paper constructs the optimization structure of enterprise raw material ordering from four dimensions of analyzing M enterprise's ordering demand, supplier supply, consumption, and cost. The optimization method of ordering and transportation is used. The mean value method, the 0-1 linear programming model and the EOQ mathematical model are used. The solution results are analyzed by using Excel graphing. The formulation of the optimization plan can also provide a reference for other enterprises. It can be combined with specific data to conduct quantitative analysis using the method of this paper, which has certain reference significance.

Acknowledgment

This paper is supported by 2020 Project of Three-wide education of Institute of Information Technolo -gy of GUET(2020SQ03), Launch Fund for Scientific Research in 2020, G uilin Institute of Information Technology(XJ202083).

References

[1] Lu Zhiwei. Research on optimization of management procurement process of TZF company [D]. Tianjin Normal University, 2020.DOI:10.27363/d.cnki.gtsfu.2020.000619.

[2] Zhao Mingyue. Research on optimization of procurement process management of R decoration engineering company [D]. Capital University of Economics and Business, 2019. DOI: 10.27338/d.cnki.gsjmu.2019.000222.

[3] Yan Qiuhan. Optimization analysis of vegetable distribution cost in Daqing City [J]. Agricultural Equipment Technology, 2022, 48(02): 57-60.

[4] Chen Gang, Fu Jiangyue. Research on emergency logistics multi-objective LRP based on NSGAII [J]. Soft Science, 2016, 30(04): 135-139. DOI: 10.13956/j.ss.1001-8409.2016.04.29

[5] Cheng Yusheng, Cao Tiancheng. Imbalanced multi-label learning algorithm based on classification interval enhancement [J]. Data Collection and Processing, 2021, 36(03): 519-528.

[6] Zhan Wanrong, Yu Hai. Minimum Attribute Reduction Algorithm Based on 0-1 Programming [J]. Luoyang Normal University, 2021, 40(02): 1-4.

[7] Xing Wenlu, Zhou Xuchuan, Yu Meng. Analysis of JIT Management Mode Based on EOQ Theory under Different Procurement Forms [J]. Journal of Southwest University for Nationalities (Natural Science Edition), 2021, 47(02): 187-194.

[8] Xu Ting. Summation method of a class of numerical series [J]. Industry and Technology Forum, 2021, 20(07): 43-44.

