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Research on Intelligent Selection Quotient Model of Category Control Based On Entropy Weight -TOPSIS Optimization Method

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Abstract
In today's globalized and competitive business environment, enterprises pay more and more attention to supply chain management. Efficient, low-cost and accurate supplier selection methods determine the quality and economic benefits of enterprise supply chain. However, traditional manual selection selection model has many disadvantages, such as strong subjectivity, low efficiency and lack of automatic output of the whole process from purchasing plan to the most preferred supplier plan. To solve these problems, the author puts forward a category control intelligent selectors model based on entropy weight -TOPSIS optimization. Firstly, a supplier management model based on category control is established to analyze the procurement plan. Secondly, a multi-indicator evaluation model of entropy weight -TOPSIS method is established to determine the weights of each indicator and the comprehensive score of suppliers according to the entropy weight method, and select the optimal supplier scheme by TOPSIS. Finally, an intelligent supplier selection software platform is built based on this model, and through the actual case analysis, it shows that the software can achieve independent output of procurement supplier schemes, improve the efficiency of the selection scheme, and provide a new method of automatic output of the whole process for enterprises to select suppliers.

Keywords : *Category control; Intelligent merchant selection; Entropy weight method; TOPSIS evaluation method*

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I. Introduction

The choice of suppliers has a critical impact on the quality of a company's products. With the continuous development of society, the demand between enterprises and suppliers continues to increase, and the workload of purchasing and selecting suppliers has increased significantly. This also leads to an increase in the difficulty of selection and a decrease in efficiency. Although the business selection system of domestic enterprises has been improved[1]. There are still many problems. For example, in terms of the business selection model, relying on the manual business selection model, the labor intensity of the procurement personnel is high, the efficiency of the business selection is low, and there are inevitably subjective factors in suppliers selection. In terms of category control, the failure to use the combination of product names to generate subcontracting schemes led to a variety of supplier selection schemes, which increased procurement costs and reduced the quality of schemes. Therefore, it is urgent to

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carry out research on intelligent supplier selection model for category control to provide efficient and automated model for purchaser selection.

At present, scholars at home and abroad have done a lot of relevant research on the quotient selection model, in which in order

to reasonably select the best supply scheme, researchers have adopted different research methods. The analytic hierarchy process proposed by the American scholar T.L. Saaty is widely used in the evaluation model

of procurement suppliers. Among them, Wan Xin et al. used the analytic hierarchy process to determine the weight of the supplier's evaluation index, established a supplier evaluation model, and gave suggestions for supplier selection according to the evaluation results[2]. In order to reduce the subjectivity of expert scoring, Huang Yajiang et al. calculated the weights of each evaluation index of software suppliers based on fuzzy analytic hierarchy process, which reduced the influence of human factors to a certain extent and provided a basis for enterprises to choose software suppliers[3]. Li Xuelan et al. established an index system based on TOPSIS method, which provides an effective basis for enterprises to select and evaluate third-party suppliers[4]. With the rise of artificial intelligence, many scholars have begun to apply neural networks to the decision-making process of suppliers. Wu, D S et al. proposed a method combining neural network (NN), data envelopment analysis and decision tree for supplier selection, and proved the reliability of the method through a case[5]. Jia Anchao et al. also proposed a supplier selection evaluation model based on the combination of rough set and BP neural network, and the experimental results also proved that the calculation results are more objective and scientific[6].

However, the above research is subjective or the theoretical model is too complicated for supplier selection, and there are few researches on category control at present. The whole process method from purchasing plan to automatic output of the most preferred supplier plan is still lacking, which is difficult to meet the actual needs of enterprises. Therefore, in order to solve the above problems, the intelligent selection quotient model of category control based on entropy weight -TOPSIS optimization method is proposed, which first distinguishes the procurement plan through coding, product name and amount, and automatically outputs the best supplier of single-source procurement and catalog procurement materials. Secondly, taking into account factors such as supplier evaluation results, historical transaction times, supply cycle and product quality control level, the entropy weight method is used to determine the reasonable weight of the evaluation index, and the comprehensive score of the supplier is calculated for the optimization of the supplier selection plan. Finally, the compatibility and difference method is used to calculate the weights of scheme quality and package amount, and the optimal quotient scheme is selected by using the TOPSIS approximation method to the ideal solution. Among them, the intelligent supplier selection model proposed in this paper can automatically complete the decisions of the best supplier selection, greatly reduce the labor intensity and procurement cost of procurement personnel, improve the efficiency and quality of supplier selection, provide new ideas and new models for modern enterprise procurement and selection, and promote the steady development of the enterprise market.

II. Analysis and establishment of intelligent supplier management model based on category control

2.1 Analysis and establishment of intelligent procurement selection model

Compliance is a crucial prerequisite in the procurement selection process of state-owned enterprises. Therefore, this paper studies the enterprise intelligent procurement and selection model from the perspective of compliance. Since the analysis process does not require subjective judgment from people, this project uses the performance advantages of the computer to establish an automatic and efficient business selection model, integrate the rules and regulations of the state and enterprises into this model, realize the automatic output of the procurement and selection plan and ensure the compliance of the output plan. Taking the procurement documents issued by a company as an example, the document clearly stipulates the procurement methods of various materials, mainly including: single-source procurement, bidding procurement, catalog procurement, reference catalog procurement,immediate purchase and settlement, inquiry price comparison and competitive negotiation. According to the criteria for the identification of procurement methods, it is divided into three modules, namely, catalog procurement module, sourcing procurement module and other procurement mode modules. The details are shown in Figure 1.

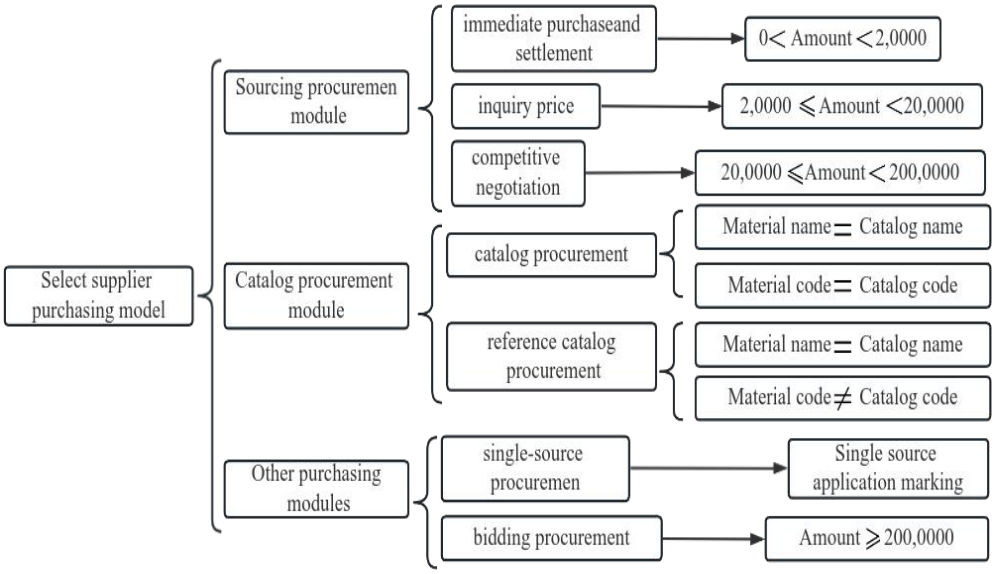


Figure 1: Flow chart of procurement method

2.1.1 Catalog procurement module analysis

The catalogue purchasing module realizes the catalogue purchasing and the way of reference catalogue purchasing through the judgment of catalogue name and code, and realizes the automatic generation of the selection scheme.

Catalog procurement and reference catalog procurement, are to classify all kinds of products required by enterprises, and establish a unified database, which mainly includes material code and name, catalog code and name as well as catalog supplier data. When the material code and name of the materials to be purchased match the catalog code and name exactly, catalog procurement is adopted, and the supplier is selected from the corresponding catalog supplier. If only the catalog name is consistent, the code is inconsistent, then refer to the catalog procurement, the default selection of suppliers in the catalog.

2.1.2 Sourcing procurement module analysis

Sourcing procurement module is based on the estimated amount of judgment, to achieve the automatic identification of sourcing procurement mode, the module mainly includes immediate purchase and settlement, inquiry price and competitive negotiation.

immediate purchase and settlement means that suppliers pay the corresponding amount directly when purchasing materials. Inquiry and comparison procurement is a kind of procurement method in which the purchaser sends an inquiry to the relevant supplier for quotation, compares and determines the supplier on the basis of quotation. Competitive negotiation is a procurement method in which the purchaser negotiates with several suppliers on procurement matters and finally determines the supplier from them.

Analyze materials in the procurement information list that are not included in other procurement and catalog procurement modules. If the estimated amount of a single item is less than 20,000, it is used to buy and settle. If the estimated amount of a single item is greater than or equal to 20,000 yuan and less than 200,000 yuan, the inquiry price is used for procurement. If the single estimated amount is less than 2 million and greater than or equal to 200,000, competitive negotiation will be adopted.

2.1.3 Analysis of other procurement methods

This module mainly includes single source procurement and bidding procurement. Single-source procurement refers to the way in which a purchaser purchases from a single supplier. Bidding and procurement is a tender announcement issued by the tenderer, inviting bidders to bid, and a comprehensive comparative analysis of the price, quality and production capacity proposed by the bidders, so as to determine the most suitable bidder as the preferred supplier.

Analyze the information about the purchased materials, and if the single-source purchase request is marked as yes, the single-source purchase is adopted. According to the relevant regulations of the state and the enterprise, if the single estimated amount is greater than or equal to 2 million, the bidding method should be used for procurement.

Through the establishment of this model, we can realize the automatic output of the best suppliers of single-source procurement, bidding procurement and catalogue procurement materials, and carry out the

research of supplier evaluation method and supplier selection system for sourcing procurement materials that need to participate in procurement selection.

2.2 Comparative analysis of procurement supplier evaluation methods

At present, procurement supplier evaluation methods mainly include qualitative method, quantitative method[7] and multi-attribute decision method[8]. Qualitative method is based on the past experience and the relationship between suppliers to make subjective judgment, lack of scientific basis and rarely adopted. Quantitative method is a method to reduce costs through bulk procurement, but when enterprises pay too much attention to cost, it will also lead to the decline of product quality. Multi-attribute decision method is a method used to solve decision problems with multiple evaluation indicators. Common multi-attribute decision methods mainly include analytic hierarchy process[9], fuzzy evaluation[10] and TOPSIS method[11]. Supplier selection is a contradictory multi-attribute problem, which requires multi-attribute decision method to evaluate and analyze suppliers. Therefore, in view of the above methods, the advantages and disadvantages of various evaluation methods are expounded through list analysis and comparison. as shown in Table 1. It provides reference for selecting the appropriate method.

Table 1: Supplier evaluation method

Evaluation method	advantage	disadvantage
Analytic hierarchy process	Relying on subjective evaluation to make program decisions requires less data and shorter decision-making time. Neither the pursuit of advanced mathematics, nor one-sided focus on logic.	The judgment of decision-makers is too much influenced by their subjective preferences, and the evaluation results they produce lack objectivity and accuracy.
Fuzzy evaluation method	The mathematical model is simple, and the evaluation effect of multi-factor complex problems is better. Able to make a reasonable quantitative evaluation of uncertain information data.	The subjective judgment of human beings is used when setting weights, so that there is a certain deviation in the comprehensive evaluation results.
Neural network method	The neural network has the ability to adapt, which can give an objective evaluation of the multi-index evaluation problem and weaken the influence of human factors.	A large number of training samples are required, and the evaluation model is too complex and can only be processed with the help of computers, and the related technology is not mature enough.
Entropy weight method	It can objectively reflect the importance of different indicators, and is not affected by subjective factors, and the calculation results are more objective and reliable.	It is greatly affected by data error, and it is necessary to pay attention to the accuracy of data in practical application.
TOPSIS method	Avoiding the influence of human factors and introducing ideal solutions and negative ideal solutions can better measure the distance between the alternative and the ideal solution.	The evaluation indicators are independent of each other and do not take into account the interrelationship between attributes.

Through the comparative analysis of the above methods, analytic hierarchy process and fuzzy evaluation method must be established on the basis of expert scores to determine the weight of each indicator, which makes it difficult to guarantee the objectivity. The neural network evaluation model is too complex. In contrast, entropy weight method can give weight to each index objectively and avoid the influence of human factors. TOPSIS method is suitable for multi-program, multi-index evaluation system, while directly standardizing the data, the evaluation results are more accurate. Therefore, this paper selects the entropy weight method to calculate the weight of each index, selects the best supplier by TOPSIS evaluation method, and establishes the automatic selection model of entropy weight -TOPSIS optimization method. The model can objectively assign weights to evaluation indicators and scientifically rank the advantages and disadvantages of schemes, so it has certain advantages on the whole.

III. Model algorithm analysis of entropy weight -TOPSIS optimization method

3.1 Entropy weight -TOPSIS optimization method selection quotient system

Entropy weight method is mainly used to assign weights to evaluation indicators and quantify the comprehensive score of supplier quality. TOPSIS mainly compares the pros and cons of each scheme by the degree of approximation to the ideal solution. For sourcing materials, the entropy weight -TOPSIS optimization selection system is established by combining them. Its flow chart is shown in Figure 2.

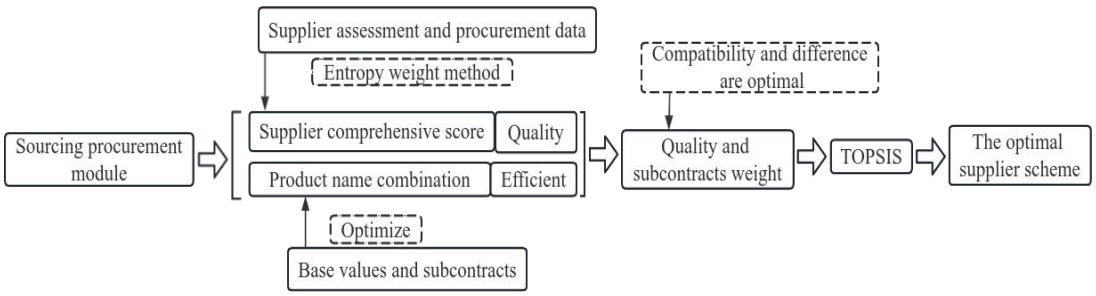


Figure 2: Entropy weight -TOPSIS selection flow chart

Firstly, the raw data is processed, the index weight is calculated by entropy weight method, and the comprehensive score of supplier quality is quantified. Meanwhile, the average value of suppliers under the product name combination is taken as the comprehensive score of the scheme, and the average value of all suppliers is taken as the benchmark value to filter the schemes. The schemes whose comprehensive score value is higher than the benchmark value are retained. For the selected procurement schemes, only the schemes with the highest score under the same amount of package are involved in the subsequent calculation to improve the efficiency of suppliers. By selecting compatibility degree and difference degree, the weights of quality and package amount are determined. Finally, TOPSIS method is used to calculate the optimal recommendation selector scheme

3.2 The supplier comprehensive score is calculated based on entropy weight method

In order to ensure the long-term and stable supply of products by suppliers, it is necessary to carry out effective control and regular evaluation of suppliers. When selecting suppliers, we should not only refer to the supplier evaluation results, historical transaction times, supply cycle, product quality control level and other factors, but also fully consider the external factors, that is, the influence of market trends and demand changes on supplier selection. This paper assumes that the selection environment in a certain period of time, that is, the market and demand are unchanged, and then the other evaluation indicators are calculated. Because the influence degree of different evaluation indexes is different, it is necessary to determine the weight of each evaluation index reasonably. Based on the comparison results of the above procurement supplier evaluation methods, this project chooses entropy weight method to objectively assign weight to each evaluation index. The specific calculation process is shown as follows.

1. Normalization of all evaluation indicators

Because of the different dimensions of each evaluation index, it is necessary to normalize each evaluation index. Normalization is the mapping of data to a specified range to eliminate the impact of different dimensions on the evaluation results. The most common normalization method is Min-Max normalization. The supplier evaluation indicators in this project are all benefit indicators, and their normalization formula is shown in formula (1) .

$$x_{ij}^{'} = \frac{x_j - x_{min}}{x_{max} - x_{min}} \quad (1)$$

Where *i* stands for evaluation scheme and *j* stands for evaluation index. x_{min} and x_{max} are the minimum and maximum values of the *j-th* evaluation index. The original data is imported for calculation.. The sample data is shown in Table 2.

Table 2: Material parameters of each component of the soluble ball holder

Supplier name	input data				Normalized result			
	examination score	trade frequency	Supply cycle	product Quality control	examination score	trade frequency	Supply cycle	product Quality control
Beijing Emerson	62	14	58	99	2.63	70	96	100
Beijing kailong analytical instrument	90	17	32	99	76.32	85	44	100
Beijing yilide technology	72	4	58	64	28.95	20	96	10.26
Chengdu aike petroleum equipment	69	9	45	63	21.05	45	70	7.69
Chengdu aoruite	91	19	48	97	78.95	95	76	94.87
Chengdu Gelaihe	63	4	57	82	5.26	20	94	56.41
Chengdu Guiting technology	76	10	57	94	39.47	50	94	87.18
.....	...	...	...	...	...	...	...	...

2. Weight calculation of each evaluation index

Firstly, the proportion of indicators is calculated. The calculation formula of the proportion of the *j-th* evaluation indicator of the *i* supplier in this index is given by:

$$\omega_{ij} = \frac{x_{ij}}{\sum_{i=1}^{n} x_{ij}} \quad (2)$$

Secondly, the entropy of evaluation index and the redundancy of information entropy are calculated. The formula for calculating the entropy e_j and information entropy redundancy d_j of the *j-th* index is given by:

$$e_j = -\frac{1}{ln\, n} \sum_{i=1}^{n} \omega_{ij} \ln \omega_{ij} \quad (3)$$

$$d_j = 1 - e_j \quad (4)$$

Finally, the corresponding weights are calculated according to the difference degree of each index. The calculation formulas and results are shown in Equation (5) and Table 3 respectively.

$$w_j = \frac{d_j}{\sum_{j=1}^{m} d_j} \quad (5)$$

Table 3: Table of weight calculation results of each index.

	Supplier name	Unit examination Nuclear score	trade frequency	Supply cycle (after forward conversion)	product Quality control
input data	Beijing Emerson	62	14	58	99
	Beijing kailong analytical instrument	90	17	32	99
	Beijing yilide technology	72	4	58	64
	Chengdu aike petroleum equipment	69	9	45	63
	Chengdu aoruite	91	19	48	97
	Chengdu Gelaihe	63	4	57	82
	Chengdu Guiting technology	76	10	57	94
	.....	...	...	...	...
	Weight calculation result	0.28	0.26	0.23	0.23

3. Supplier comprehensive score calculation

According to the weight calculation results of each evaluation index, the comprehensive score of each supplier is obtained by multiplying the original data of each evaluation index with the weight. The specific calculation formula is as follows:

$$X_i = \sum_{j=1}^{m} x_{ij} w_j \quad (6)$$

The comprehensive score results of suppliers calculated by the above formula are shown in Table 4:

Table 4: Calculation Results of Supplier's Comprehensive Score

Supplier name	computing formula	Comprehensive score
Beijing Emerson	2.63*0.28+70*0.26+96*0.23+100*0.23	64.02
Beijing kailong analytical instrument	76.32*0.28+85*0.26+44*0.23+100*0.23	76.59
Beijing yilide technology	28.95*0.28+20*0.26+96*0.23+10.26*0.23	37.74
Chengdu aike petroleum equipment	21.05*0.28+45*0.26+70*0.23+7.69*0.23	35.46
Chengdu aoruite	78.95*0.28+95*0.26+76*0.23+94.87*0.23	86.11
Chengdu Gelaihe	5.26*0.28+20*0.26+94*0.23+56.41*0.23	41.27
Chengdu Guiting technology	39.47*0.28+50*0.26+94*0.23+87.18*0.23	65.72
.....	...	...

3.3. The benchmark value and the amount of packages are used to optimize the procurement plan

For all the procurement schemes generated, the average comprehensive score of suppliers in the scheme is selected as the comprehensive score value of the scheme, the comprehensive score of all suppliers is used as the benchmark value, and the scheme whose comprehensive score value is less than the benchmark value is excluded.

For the materials to be purchased in sourcing procurement, a supplier selection scheme is generated through the free combination of product names, and the top 3 suppliers in each package in the scheme are selected by default.

In the same package amount, only the scheme with the highest average comprehensive score of the supplier is retained. If the highest average score of the scheme is the same, all the schemes are retained. The final optimal scheme results are shown in Table 5.

Table 5: Scheme selection result table

Scheme name	Package name	Brand coding	Supplier name	Supplier quality	Average of quality score
Scheme one	one	38031214,38810232,38028108,38810212 38100101,38100104,38107101,38110118	64.02	75.73 76.59 84.76	79.03
Scheme two	one	38031214,38810232,38028108,38810212 38100101,38100104,38107101	76.59	75.73 76.59 84.76	79.03
	two	38110118	37.74	81.38 84.76 86.11	84.08
Scheme three	one	38810232,38810212,38100101 38100104,38110118,38107101	35.46	75.73 76.59 84.76	79.03
	two	38028108	86.11	80.49 81.38 84.76	82.21
	three	38031214	41.27	76.59 81.38 84.76	80.91
.....	...	...	...	...	...

3.4. Calculation of the package amount and quality weight based on compatibility degree and difference degree

The basic principle of the intelligent procurement selection model based on category control is to minimize the package amount while ensuring the maximum quality of each supplier. However, the importance of quality and package amount can not be defined subjectively, so this paper adopts the method based on compatibility and difference degree to calculate the weight of quality and package amount, and fundamentally solve this problem.

Compatibility refers to the weighted average of the grade correlation coefficient between the evaluation scheme and other evaluation schemes. The difference degree refers to the average value of the number of evaluation objects that exceed the upper bound of the specified serial number in the remaining evaluation schemes when the ranking of the scheme is taken as the

benchmark. When the compatibility and difference optimization method is used to calculate the weight of quality and the amount of packages, the amount of packages is normalized first, and then the compatibility and difference are calculated as follows:

1. Knowing the weights sum of quality and amount of packages is 1, the weights of $h+1$ quality and amount of packages are formulated in accordance with the quality weights starting from 0.005, and the composite scores of the programme under different values of the weights are calculated, and the ranking of the subcontracting programme is obtained in accordance with the results of the calculations.

2. Calculation of the compatibility E of all package schemes under different value schemes. Compatibility is obtained by their grade correlation coefficient. According to the theory of multivariate statistical analysis, the grade correlation coefficient between the two evaluation schemes i and j can be obtained by the following calculation formula:

$$r_{ij} = 1 - \frac{6}{n(n^2-1)} \sum_{k=1}^{n} (a_k^i - a_k^j)^2 \quad (7)$$

Where $i, j = 1,2,\ldots h+1$, n is the number of evaluation objects within a certain sequence number range, a_k^i and a_k^j represent the ranking of the No.k object in the i and j schemes respectively. The compatibility E_y between a certain value scheme y and other h value schemes is calculated as follows:

$$E_y = \sum_{j=1}^{h} \omega_j r_{yj}, j \neq y \quad (8)$$

Where, ω_j is the weight of the *j-th* value scheme. Usually, when there is no special preference for each evaluation scheme, $\omega_j = \frac{1}{h}$ is chosen. The greater the compatibility of the scheme, the more representative and reliable it is.

$\omega_j = \frac{1}{h}$ is chosen. The greater the compatibility of the scheme, the more representative and reliable it is.

3. Calculate the difference degree Φ of different value schemes. For the y value scheme, the formula for calculating the difference degree is as follows:

$$\Phi_y = \frac{1}{h} \sum_{j=1}^{h} \phi_{yj} \quad (9)$$

Where, $\emptyset_{yj}$ represents the evaluation objects within a certain sequence number range of the evaluation scheme, and the number of objects beyond the specified sequence number range in the *j-th* scheme. According to the average value of compatibility and difference ranking, the scheme is sorted comprehensively, and the package amount and quality weight of the scheme with the highest comprehensive ranking are selected. Table 6 shows that the weight values of quality and package amount are 0.25 and 0.75, respectively.

Table 6: Compatibility and difference calculation results table

Scheme	Quality weight	Package weight	compatibility degree	difference degree	compatibility degree sort	difference degree sort	Synthesis sort
1	0.005	0.995	0.901 89	0	23	50	36.5
2	0.01	0.99	0.901 89	0	23	50	36.5
...	...	...	...	...	...	...	...
50	0.25	0.75	0.625 6	1.122 4	91	58	74.5
...	...	...	...	...	...	...	...

3.5. The TOPSIS method is used to generate the optimal quotient scheme

TOPSIS method is a common method in multi-attribute decision analysis. The basic principle is to sort the evaluation scheme by detecting the distance from the optimal solution and the worst solution. If the evaluation object is near the optimal solution and away from the worst solution at the same time, it is the best scheme. The specific calculation process is shown as follows.

1. Using the weight of quality and package amount obtained by compatibility and difference degree, the quality and package amount of each subcontract plan are weighted to get X_{ij}, and then the quality and package amount are standardized. The formula is as follows:

$$\Phi_y = \frac{1}{h}\sum_{j=1}^{h}\phi_{yj} \tag{10}$$

Where i is the evaluation scheme, and j is the evaluation index.

2. By the following equations (11) and (12), the distance between each scheme and the optimal and the worst solution is calculated.

$$D_i^+ = \sqrt{\sum_{j=1}^{m}(Z_j^+ - Z_{ij})^2} \tag{11}$$

$$D_i^- = \sqrt{\sum_{j=1}^{m}(Z_{ij} - Z_j^-)^2} \tag{12}$$

3. Finally, the fit coefficient between each scheme and the positive ideal solution is calculated by the following formula (13).

$$C_i = \frac{D_i^-}{D_i^+ + D_i^-},\ i=1,2,\ldots,n \tag{13}$$

The subcontracting scheme with the largest fit coefficient value is selected as the final recommended scheme, and the scheme with the lowest amount of packages and the scheme with the largest amount of packages are output as the reference scheme.

The entropy weight -TOPSIS selection model algorithm constructed in this paper is a multi-attribute decision analysis method, which can be used to select the best supplier among multiple suppliers. The model algorithm combines the advantages of entropy weight -TOPSIS method, fully considers the importance of each index, and outputs the optimal scheme efficiently and independently. At the same time, the algorithm is objective and easy to implement, and has wide application value in practical application.

IV. Category control intelligent selection software development and application case analysis

4.1 Entropy weight -TOPSIS optimization method selection quotient system

In this paper, an intelligent vendor software platform is proposed, which aims to provide an efficient and independent vendor scheme for enterprises. The platform uses a cloud-based architecture that includes a front-end control interface and a back-end data processing module. Enterprise users can input the information of materials to be purchased into the platform, which can realize the automatic output of the procurement method and the most preferred business plan.

The intelligent vendor software platform developed by us integrates a variety of algorithms and data processing technologies to realize intelligent vendor scheme management. Under the development environment of PyCharm, the platform is developed using Python programming language and Django framework. Through the visual interface and intelligent algorithm, the multi-dimensional evaluation of suppliers is realized. Enterprise users can easily have a comprehensive understanding of suppliers, design different benchmark values and weights of program quality and package number according to the specific needs and preferences of enterprises, and in the selection of evaluation indicators, the software also supports enterprises to establish evaluation models more suitable for enterprises according to the change of market environment and specific procurement needs. In order to recommend the most suitable supplier for the enterprise.

The initial page for the software platform is shown in Figure 3, which mainly includes two modules: information of materials to be purchased and selection of procurement methods. The procurement material

information module includes the functions of importing and analyzing the procurement plan and exporting the supplier selection plan. The procurement mode optimization module includes the functions of generating and optimizing the plan, calculating the weight of quality and package amount, and generating the optimal plan.

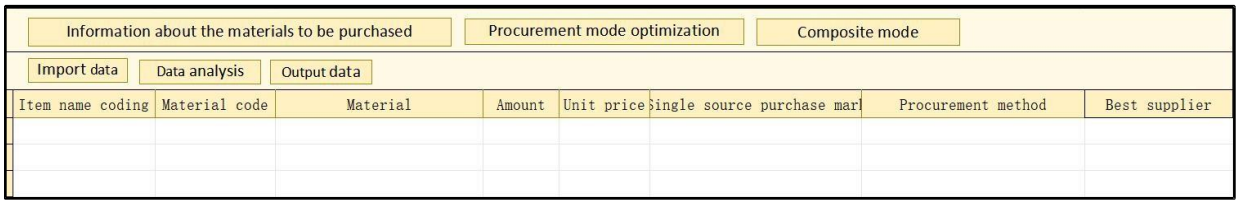


Figure 3: Category control intelligent selection software initial page

The main process of the intelligent vendor software platform is shown in Figure 4. First of all, the procurement plan is imported, and the information of procured materials is analyzed through the category control and selection management model, and the best suppliers of single-source procurement, bidding procurement and catalogue procurement materials are automatically exported, and the sourcing procurement data is exported to the procurement mode optimization module. The selection scheme is generated by the free combination of product names, and the scheme is screened and optimized according to the two methods of selecting the best under the reference value and the same package amount. Then the quality and package amount weights are calculated according to the compatibility and difference degree, and the optimal supplier scheme is generated according to the TOPSIS optimization method.

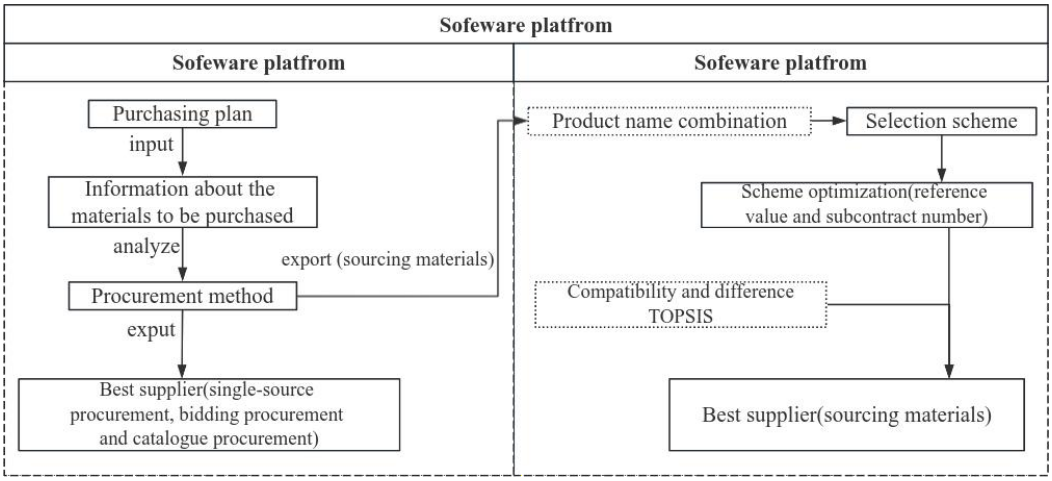
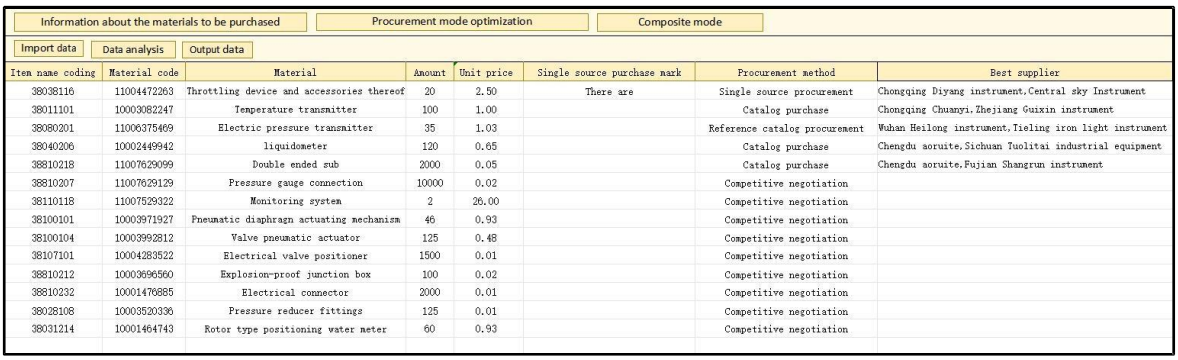


Figure 4: Intelligent software selection flow chart

4.2 Software application case analysis

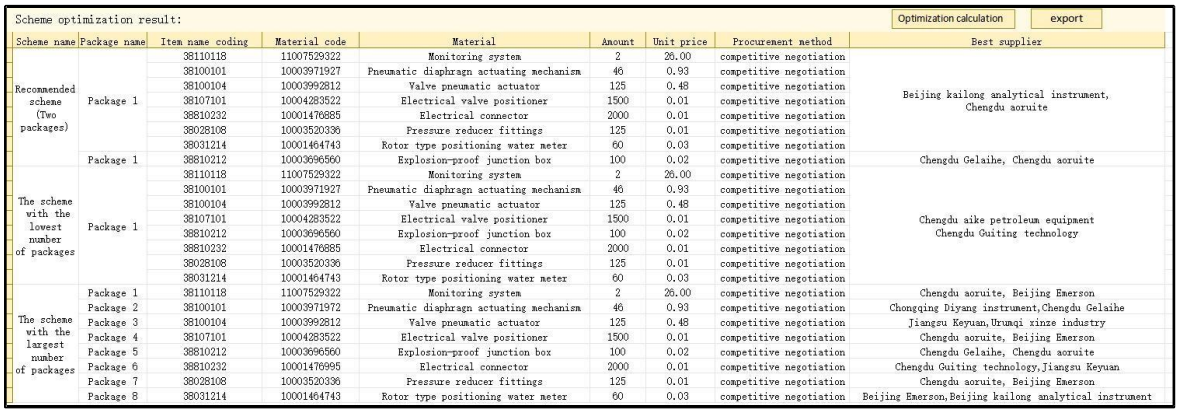
Taking the procurement plan issued by a company as an example, the procurement plan is imported into the software, and the software automatically outputs the best suppliers of single-source procurement, bidding procurement and catalog procurementmaterials, as well as the sourcing procurement materials that need to participate in the procurement selection, as shown in Figure 5.



Item name coding	Material code	Material	Amount	Unit price	Single source purchase mark	Procurement method	Best supplier
38038116	11004472263	Throttling device and accessories thereof	20	2.50	There are	Single source procurement	Chongqing Diyang instrument,Central sky Instrument
38011101	10003082247	Temperature transmitter	100	1.00		Catalog purchase	Chongqing Chuanyi,Zhejiang Guixin instrument
38080201	11006375469	Electric pressure transmitter	35	1.03		Reference catalog procurement	Wuhan Heilong instrument,Tieling iron light instrument
38040206	10002449942	liquidometer	120	0.65		Catalog purchase	Chengdu aoruite,Sichuan Tuolitai industrial equipment
38810218	11007629099	Double ended sub	2000	0.05		Catalog purchase	Chengdu aoruite,Fujian Shangrun instrument
38810207	11007629129	Pressure gauge connection	10000	0.02		Competitive negotiation	
38110118	11007529322	Monitoring system	2	26.00		Competitive negotiation	
38100101	10003971927	Pneumatic diaphragm actuating mechanism	46	0.93		Competitive negotiation	
38100104	10003992812	Valve pneumatic actuator	125	0.48		Competitive negotiation	
38107101	10004283522	Electrical valve positioner	1500	0.01		Competitive negotiation	
38810212	10003696560	Explosion-proof junction box	100	0.02		Competitive negotiation	
38810232	10001476885	Electrical connector	2000	0.01		Competitive negotiation	
38028108	10003520396	Pressure reducer fittings	125	0.01		Competitive negotiation	
38031214	10001464743	Rotor type positioning water meter	60	0.93		Competitive negotiation	

Figure 5: Purchasing method analysis results

For the materials to be purchased by sourcing procurement, the optimal supplier scheme can be generated by importing them into the procurement scheme optimization module, and the scheme with the least and most packages can be output as a reference scheme. The output result of the software's final scheme is shown in Figure 6.



Scheme optimization result:

Optimization calculation | export

Scheme name	Package name	Item name coding	Material code	Material	Amount	Unit price	Procurement method	Best supplier
Recommended scheme (Two packages)	Package 1	38110118	11007529322	Monitoring system	2	26.00	competitive negotiation	Beijing kailong analytical instrument, Chengdu aoruite
		38100101	10003971927	Pneumatic diaphragm actuating mechanism	46	0.93	competitive negotiation	
		38100104	10003992812	Valve pneumatic actuator	125	0.48	competitive negotiation	
		38107101	10004283522	Electrical valve positioner	1500	0.01	competitive negotiation	
		38810232	10001476885	Electrical connector	2000	0.01	competitive negotiation	
		38028108	10003520336	Pressure reducer fittings	125	0.01	competitive negotiation	
		38031214	10001464743	Rotor type positioning water meter	60	0.03	competitive negotiation	
	Package 1	38810212	10003696560	Explosion-proof junction box	100	0.02	competitive negotiation	Chengdu Gelaihe, Chengdu aoruite
The scheme with the lowest number of packages	Package 1	38110118	11007529322	Monitoring system	2	26.00	competitive negotiation	Chengdu aike petroleum equipment Chengdu Guiting technology
		38100101	10003971927	Pneumatic diaphragm actuating mechanism	46	0.93	competitive negotiation	
		38100104	10003992812	Valve pneumatic actuator	125	0.48	competitive negotiation	
		38107101	10004283522	Electrical valve positioner	1500	0.01	competitive negotiation	
		38810212	10003696560	Explosion-proof junction box	100	0.02	competitive negotiation	
		38810232	10001476885	Electrical connector	2000	0.01	competitive negotiation	
		38028108	10003520336	Pressure reducer fittings	125	0.01	competitive negotiation	
		38031214	10001464743	Rotor type positioning water meter	60	0.03	competitive negotiation	
The scheme with the largest number of packages	Package 1	38110118	11007529322	Monitoring system	2	26.00	competitive negotiation	Chengdu aoruite, Beijing Emerson
	Package 2	38100101	10003971972	Pneumatic diaphragm actuating mechanism	46	0.93	competitive negotiation	Chongqing Diyang instrument,Chengdu Gelaihe
	Package 3	38100104	10003992812	Valve pneumatic actuator	125	0.48	competitive negotiation	Jiangsu Keyuan,Urumqi xinze industry
	Package 4	38107101	10004283522	Electrical valve positioner	1500	0.01	competitive negotiation	Chengdu aoruite, Beijing Emerson
	Package 5	38810212	10003696560	Explosion-proof junction box	100	0.02	competitive negotiation	Chengdu Gelaihe, Chengdu aoruite
	Package 6	38810232	10001476995	Electrical connector	2000	0.01	competitive negotiation	Chengdu Guiting technology,Jiangsu Keyuan
	Package 7	38028108	10003520336	Pressure reducer fittings	125	0.01	competitive negotiation	Chengdu aoruite, Beijing Emerson
	Package 8	38031214	10001464743	Rotor type positioning water meter	60	0.03	competitive negotiation	Beijing Emerson,Beijing kailong analytical instrument

Figure 6: Final project result

After manual inspection of the optimal scheme recommended by the software, the test results show that the vendor scheme recommended by the software is indeed the best vendor scheme in line with the regulations of the enterprise, and further proves that the software's intelligent vendor model based on category control and entropy weight -TOPSIS optimization algorithm can efficiently and objectively output the vendor scheme for the enterprise in a short time.

V. Conclusions

In this paper, the research process and main contents are introduced in detail from three aspects: category control selectors management model, entropy weight -TOPSIS optimization algorithm and intelligent selectors software platform. The details are summarized as follows:

1. In terms of supplier selection process management, based on the specific procurement plan and procurement system of the enterprise, and with the help of computer performance advantages, the procurement method of purchasing materials is analyzed by material name, code and amount, so as to achieve efficient and independent output procurement supplier selection
schemes. At the same time, the amount of package schemes is reduced based on product name combination and the efficiency of supplier selection is improved.
2. In terms of intelligent algorithms, the entropy weight -TOPSIS optimization algorithm is constructed, which combines the advantages of objective weighting by entropy weight method and efficient processing of multiple schemes by TOPSIS method to achieve accurate evaluation and ranking of suppliers and provide reliable supplier selection decision support for enterprises. At the same time, the introduction of this algorithm makes the selectors model have stronger intelligence and automation ability, and improves the efficiency and accuracy of the selectors process.
3. In terms of intelligent vendor software, a software system for category control intelligent vendor model based on entropy weight -TOPSIS optimization method is designed, which realizes functions such as vendor process automation and data visualization, and allows enterprises to consider the impact of market trends and demand changes in the establishment of evaluation indicators, thus improving the adaptability of the software model. It also greatly reduces the labor intensity of procurement personnel, improves the quality of selection solutions, and shortens the procurement cycle. The method proposed in this paper provides a new method and a new idea for the automatic output of the whole process from purchasing plan to the best selection plan for modern enterprises.

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- Review and Editing; Huaming Fan: Investigation, Supervision;

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