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The Study of Selection of Coal-Fired Supplier in Thermal Power Enterprise Based on the Extension Analysis Method

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Abstract

Electric power market competition is intense. The competition between the various power plants will is the contest of economic efficiency as the core. Fuel cost is the center link of production management and economic accounting in thermal power plant, so selection management of the coal-fired supplier has great significance for the development of thermal power enterprise and improvement of the economic benefits. The paper constructs evaluation index system of coal-fired supplier, using the AHP method to determine the weight of evaluation index, and comprehensively evaluating to the coal-fired supplier with correlation functions in the extenics. The result indicates that it applies combination of the AHP and the extension analysis method to the selection of coal-fired supplier, which can accurately reflect relative importance of evaluation index, and directly reflect the detailed situation of supplier. This method is scientific, reliable and practical, which is applicable for various comprehensive evaluations.

Keywords*: thermal power enterprise, supplier, evaluation index, the extension analysis method*

1. Introduction

Along with the globalization of the fierce market competition, the life cycle of products becomes shorter. In order to adapt to the rapid and changing market demands, the enterprise emphasizes on its own core ability more and more, and obtains non-core production resources from the supplier through the supply chain. Traditional purchasing management often tends to a material with multiple suppliers, which feels secure. While the trend of modern purchasing management is to reduce the number of suppliers, and set up long-term stable cooperative partnership of mutual trust, mutual benefit and mutual help. In view of this, the choice of the supplier needs more caution and they must have comprehensive consideration of the performance of candidates in every area, and that selection method of suppliers is scientific and proper, which is also directly related to the survival and development of enterprises. So the study for the method of supplier selection has important theoretical significance and practical significance.

In the electric power enterprise, thermal power enterprise, especially the coal-burning electricity-generating enterprises, is the subject of competition of electricity market in current and future. As coal is the main raw materials of coal enterprise and the pros and cons of coal-fired suppliers directly affects the cost, quality, delivery of coal enterprise and total performance of coal and electricity supply chain. So scientific, reasonable and objective evaluation and the choice of coal-fired supplier must be one of the most important work to thermal power enterprise in supply chain [1].

At present, there are many methods for the selection of coal-fired supplier, such as statistical analysis, the analytic hierarchy process, the fuzzy comprehensive evaluation method, and gray system analysis. These methods analyze and solve problems from different angles and perspectives and have achieved good results in practical applications. However, these evaluation methods cannot describe the extension of evaluation objects, that is, their development and changes. The extension analysis method was established by the Chinese

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mathematician Cai. [2] Based on the formalize logic tools, the rules and methods required to solve the contradiction problem can be analyzed qualitatively and quantitatively. This paper combining the AHP method with the extension analysis method analyzes specific data in a power plant and establishes the right index system on the characteristics basis of the thermal power supplier. It also calculates evaluation index weight through the AHP and uses correlation function of extension theory to evaluate coal-fired suppliers comprehensively. So it forms extension evaluation method of coal-fired suppliers in coal enterprises.

2. The Establishment of the Coal-Fired Supplier Evaluation Index

The research for the selection of supplier firstly should be the study of evaluation indexes. The selection is a multiple attribute decision making problems. The establishment of evaluation index on the coal-fired supplier should consider the actual situation of thermal power enterprise to make conclusion and review of the various selection criteria of the coal-fired supplier. The selection can be concerned from five factors such as cost, quality, delivery, service and environment [3-6].

(1) Cost factor

Cost includes not only the purchase price, but also the spending in the process of using raw materials and parts. The low purchase price is an important condition for choosing supplier. But the supplier with the lowest price is not the most appropriate necessary, which the product quality and delivery time cannot reach to requirements. Owing to the geographical position is too far, higher transportation costs can make the total cost increased. The lowest total cost is an important factor on selecting supplier.

The coal-fired cost is referred to the summation of the prices of thermal power enterprise purchasing coal, transportation expenses and miscellaneous fees, including direct cost and indirect cost. Coal plays a main role in power cost of coal power enterprise, so the cost purchasing coal is directly related to profitability and market competitiveness of them. Therefore, the purchase cost is the important basis of selecting supplier.

(2) Quality factor

Quality is one of the most basic indexes to measure suppliers. But quality could not the better as much as possible. Supplier need to be able to provide finished goods that are suitable for enterprise. The product of the poor quality and the low price, although the purchase cost is low, which can increase the total cost of enterprise. As the unqualified product often influence the production continuity and the product quality in the process of putting in use, which will be reflected in the total cost eventually.

For thermal power enterprise, ensuring secure continuous production, we still must keep economy of the unit operation. From the point of view of production, quality of raw materials directly determines the economy of the unit operation. So combining with the power enterprise, we should choose three indexes to evaluate quality of the supplier's supply which are the low position calorific capacity, volatility share, coal qualified rate. The low position calorific capacity refers to the biggest calorific value of unit fuel deducting calorific value of water vapor after vaporization, which expresses the thermal efficiency of combustion. Volatility share is that the coal sample is isolated the air heating under the specified conditions, the organic matter in the coal being heated to decompose a part of smaller molecular liquid and gaseous products occupies the percentage of the coal sample quality, which be called the volatility share production rate , namely, volatility share. Coal qualified rate is the ratio of the passing rate of the total coal produced.

(3) Arrival factor

The arrival should be considered two aspects of delivery on time and prescriptive number. Therefore, evaluating delivery level of coal enterprise supplier could be evaluated by on-time delivery rate, coal-fired surplus tons rate and order completion rate. On-time delivery rate is the percentage of the delivered actual batch on time in delivery batch of order confirmation, reflecting on-time delivery performance of supplier in prescribed time. Coal-fired surplus tons rate refers to the percentage of the quantity of fuel surplus tons in the actual amount of fuel inspection. The order completion rate reflects the performance of supplier's satisfaction with Customer purchasing demand.

(4) Service factor

Good service of supplier plays an important role, which will structure the new partner partnership between thermal power enterprise and coal supplier. It is the platform to make trust each other. Service of coal supplier for thermal power enterprise mainly lies in the claims rate of coal-fired loss tonnage and customer satisfaction. The former is the ratio of comparing with the reclaimed loss tonnage quantity of thermal power company to suppliers and the total amount of the loss tonnage. The latter is the satisfaction of the customer to the supplier.

(5) Environment factor

Supply chain partner selection and evaluation is to establish a win-win partnership. Cooperation and environmental influence is an important key to the success, so it is necessary to evaluate external environment and cooperative relations for enterprise. Here environmental factor including the natural and geographical environment, political and legal environment and economic and technological environment. Natural and geographical environment mainly inspects the address location of the supplier, climate, natural resources and transportation and so on. Political and legal environment is an important aspect of the investment environment, which is directly related to the security of the investment. It mainly investigates from the political system, political stability, the government's attitude to foreign investment and legal framework. The quality of the economic and technological environment constraints of a national, regional supplier development.

(6) Other factors

We can also consider many other factors in the selection and evaluation of coal supplier, such as the history effectiveness, the production facilities of supplier, technical capabilities, financial condition, management and organization, maintenance services, Image of the attitude, communication systems for suppliers and buyers, business expectations. In short, through the combination of the characteristics of the coal supplier, according to the construction principle of the evaluation index system, the establishment of the thermal power enterprises' coal supplier selection and evaluation index system is shown in Table 1.

Table 1. Evaluation Index System of Coal Supplier of Thermal Power Enterprise

The Target Layer	First-Level Indicator	Second-Level Indicator
Thermal Power Enterprise in Supplier Selection and Evaluation Index System	Cost	The Standard Coal Price of Entering the Factory C1
		The Low Position Calorific Capacity C2
	Quality	Volatility Share C3
		Coal Qualified Rate C4
	Arrival	On-Time Delivery Rate C5
		Coal-Fired Surplus Tons Rate C6
		Order Completion Rate C7
	Service	The Claims Rate of Coal-Fired Loss Tonnage C8
		Customer Satisfaction C9
	Environment	Natural and Geographical Environment C10
		Political and Legal Environment C11
		Economic and Technological Environment C12

3. Determine the Index Weight Based on AHP Method

The complex problem is decomposed into various component factors by AHP method. These factors are divided into groups according to the domination relationship, and form the hierarchical structure. The relative importance of various factors is determined in the hierarchy

by pairwise comparisons way. Then we integrate the judgment of the relevant personnel to determine the total ranking of the relative importance of alternative program. The whole process reflects the decomposition - judgment - combination of thinking pattern. The steps of AHP method determining the weight are as follows [7, 8].

(1) Establish the evaluation system of hierarchical structure

In accordance with the different goals and achieving functional differences, the system is divided into the hierarchical structure. This article starts from the influencing factors of the supplier selection and evaluation about thermal power enterprises and the evaluation index is divided into three layers: The first layer is the main factor layer, which is the subject of study. The second layer has five first-level indicators, under which have their own second-level indicators.

(2) Structure judgment matrix

After establishing the multi-level hierarchical structure system, through the pairwise comparisons in the elements of layers, using the 1-9 scale value expresses the importance degree between the elements, constructing the judgment matrix to determine the relative importance of certain factor of the next layer to the previous layer, which is shown in Table 2:

Table 2. Judgment Matrix

u_{11}	u_{12}	···	u_{1m}
u_{21}	u_{22}	···	u_{2m}
···	···	···	···
u_{m1}	u_{m2}	···	u_{mm}

(3) Seek the normalized relative importance vector W of various elements relative to certain element of the upper layer

Here with the square root method

$$V_i = \left(\prod u_i\right)^{\frac{1}{n}},$$

$$W_i = \frac{V_i}{\sum_i V_i}$$

Here $W = (w_1, w_2, \cdots, w_m)$ is the weight of solving index

(4) Consistency test

Calculate the consistency index $C.I.$

$$C.I. = \frac{\lambda_{\max} - n}{n-1}, \text{ Among } \lambda_{\max} = \frac{1}{n}\sum_{i=1}^{n}\frac{(AW)_i}{W_i}$$

Calculate the consistency ratio : $C.R. = \frac{C.I}{R.I.}$,

In the formula: $R.I.$ is the corresponding average random consistency index.

If $C.R. < 0.1$ shows the calculation of the weight is reasonable, you can use.

4. The Basic Principle of Extension Method

4.1. The Basic Concept of Extenics

The extenics is founded by Chinese scholars Cai wen in 1980, which is an emerging discipline. It is the rules and methods to research solutions to the complex and contradictory problems from the qualitative and quantitative perspective with the formal tools. It reflects the content and relationship of the quality and quantity of the comprehensive evaluation in a very intuitive way. It provides a new methodology system to solve the contradictions in the real world for people to understand and analyze real world from a new perspective. The extenics has been more widely used in the product portfolio, evaluation of the ecological environment, highway construction.

The extenics is disciplines of the theory and method, which studies and solves contradictory problems. Based on the primitive theory, extension theory, extension logic, through the establishment of the primitive, extension set and correlation function, It studies not only the qualitative change process of things but the quantitative change process as well. It provides the quantitative, formal and logical theoretical basis for people studying and solving contradictory problems [9].

The basic idea of extensive comprehensive evaluation is that according to the accumulated data in the supplier management, the pros and cons of the evaluation object is divided into several grades. The data ranges of various grades are given by the database or expert advice, then the index of the evaluation object is brought into the set of various grades to make multi-index assessment. Assessment results are compared by the comprehensive correlation degree of it and the set of various grades. The greater the comprehensive correlation degree is, the better the conform degree of the evaluation object and the grade set is [10].

4.2. The Step of the Extension Analysis Method Evaluating Supplier

The basic steps are as follows [11-13]:

(1) Determine the classical domain

The extenics is the rules and methods to research solutions to the complex and contradictory problems from the qualitative and quantitative perspective with the formal tools. It reflects the comprehensive evaluation level of studying the object by establishing the evaluation model of multi-index parameters. The extenics brings in the matter-element to integrate of quality and quantity, which is the triples based on things, features and the value of things on features, and recorded as $R=(N,C,V)$. The extension method has been widely used in many areas.

The evaluation indexes of the coal-fired supplier is $(C_1,C_2,\cdots,C_m)$.The supplier's level is divided into n grades, so the classical domain is

$$R_{oj}=\begin{bmatrix} N_{oj} & C_1 & V_{oj1} \\ & C_2 & V_{oj2} \\ & \vdots & \vdots \\ & C_m & V_{j1} \end{bmatrix}=\begin{bmatrix} N_{oj} & C_1 & \langle a_{oj1},\ b_{oj1}\rangle \\ & C_2 & \langle a_{oj2},\ b_{oj2}\rangle \\ & \vdots & \vdots \\ & C_m & \langle a_{ojm},\ b_{ojm}\rangle \end{bmatrix},\ j=1,2,\cdots,\ \mathrm{n}$$

In the formula, N_{oj} is the j-th evaluation grade in the division. j = 1, 2, 3, 4 expressing grade of the evaluated coal-fired supplier is "excellent, good, normal, poor". $v_{ojk}=<a_{ojk},\ b_{ojk}>$（k=1, 2, …, m）expresses value range of the k evaluation index c_k, when the supplier' rating is the j-th grade.

(2) Determine the section domain

The matter-element model formed by the allowed range of value for product comprehensive evaluation index is called the section domain, which is recorded as

$$R_p = \begin{bmatrix} N_p & C_1 & V_{p1} \\ & C_2 & V_{p2} \\ & \vdots & \vdots \\ & C_m & V_{pm} \end{bmatrix} = \begin{bmatrix} N_p & C_1 & \langle a_{p1},\ b_{p1} \rangle \\ & C_2 & \langle a_{p2},\ b_{p2} \rangle \\ & \vdots & \vdots \\ & C_m & \langle a_{pm},\ b_{pm} \rangle \end{bmatrix}$$

In the formula: R_p represents the section domain of the matter-element model of the coal supplier's comprehensive evaluation; N_p represents all levels of supplier: $v_{ojk} =< a_{ojk},\ b_{ojk} >$ represents the allowed value range of the index C_k in N_p.

(3) Determine the matter-element to be evaluated

For the supplier to be evaluated, the obtained data is expressed by the matter-element model to be evaluated, which is as follows:

$$R = \begin{bmatrix} N & C_1 & V_1 \\ & C_2 & V_2 \\ & \vdots & \vdots \\ & C_m & V_m \end{bmatrix}$$

In the formula: N is the suppliers to be evaluated; V_k is the k-th index evaluation value of the supplier to be evaluated

(4) Determine the correlation degree of the supplier to be evaluated about various evaluation grades

The correlation degree is the measure of the relationship between things, between factors. That is, it is according to similar degree of continuous or discrete series of curves of things or factors to determine the size of its associated degree. If the shape of two curves is similar, the correlation degree is large; on the contrary, the correlation degree is small. The correlation degree of the supplier to be evaluated for the different evaluation grade are as follows:

$$K_j(x_i) = \begin{cases} \dfrac{\rho(x_i,\ x_{oji})}{\rho(x_i,\ x_{pi}) - \rho(x_i,\ x_{oji})} & x_i \in x_{oji} \\ -\dfrac{\rho(x_i,\ x_{oji})}{|x_{oji}|} & x_i \notin x_{oji} \end{cases} \quad (1)$$

In the formula: $\rho(x_i,\ x_{oji})$ is the distance of point and Interval x_{oji}.

$$\rho(x_i,\ x_{oji}) = \left| x_i - \frac{1}{2}(a_{oji} + b_{oji}) \right| - \frac{1}{2}(b_{oji} - a_{oji}),\ (\text{i=1, 2, 3, …, n}) \quad (2)$$

(5) Determine the correlation degree of the suppliers to be evaluated about level j

The weight vector of various features is $a_1,\ a_2, \cdots,\ a_m$, which makes the correlation degree and weight coefficients as the comprehensive correlation degree:

$$K_j(p_k)=\sum_{i=1}^{m} a_i K_i(x_i) \quad (3)$$

$K_j(p_k)$ is the correlation degree of enterprise to be evaluated p_k about the j-th grade of the supplier.

(6) Rating

The size of the correlation degree expresses the things accord with the degree of the grade of standard things. The higher its value is, the higher the coincidence degree is.

$K_{jp}=\max\{K_j(p_k)\}$ expresses the comprehensive evaluation results of the suppliers to be evaluated belong to the jp grade.

5. Example Analysis

There are four coal-fired thermal power plant suppliers, and we use A, B, C, D to represent the four coal mines. Thermal power plant did a detailed investigation of the four suppliers, and they organize procurement, production, quality control experts to evaluate the qualitative indicators of the supplier [14-18]. The specific data are shown in Table 3:

Table 3. The Supplier Rating Index (Raw Data)

First-Level Indicator	Second-Level Indicator		A	B	C	D
Cost	The Standard Coal Price of Entering the Factory	C1	1000	988	990	976
Quality	The Low Position Calorific Capacity	C2	5326	5582	5443	5558
	Volatility Share	C3	30.28	25.12	24.55	27.15
Arrival	Coal Qualified Rate（%）	C4	88	95	97	98
	On-Time Delivery Rate（%）	C5	98	94	96	92
	Coal-Fired Surplus Tons Rate（%）	C6	1.8	1.2	2.1	1.7
Service	Order Completion Rate（%）	C7	87	99	93	85
	The Claims Rate of Coal-Fired Loss Tonnage（%）	C8	105	100	112	102
	Customer Satisfaction（%）	C9	98	97	98	99
Environment	Natural and geographical environment	C10	0.6335	0.9385	0.9801	0.7919
	Political and legal environment	C11	0.6958	0.9880	0.9446	0.7919
	Economic and technological environment	C12	0.9145	0.9760	0.9536	0.5781

According to the preceding established model, the four options A, B, C, D will be evaluated.

5.1. Determine the Weight of Each Index with AHP Method

Carry on pairwise comparison to various indexes, using the analytic hierarchy process (AHP) to determine the weights of the indicators to construct the judgment matrix. The importance of Indexes use a questionnaire to determine their respective importance.

Due to cost factor of the first layer index is the standard coal Price of entering the factory, the subjective and objective weight relative to the upper index all is 1. Therefore, we calculate the second layer index weight from the index C_2. The scoring of the indicators and their relative weights are shown in Table 4.

Similarly（C_2 C_3 C_4）=（0.53 0.31 0.16），（C_5 C_6 C_7）=（0.49 0.20 0.31），（C_8 C_9）=（0.75 0.25），（C_{10} C_{11} C_{12}）=（0.16 0.30 0.54）

The final weight vector can be obtained according to above mentioned the first-level weight and the second-level weight

Table 4. Judgment Matrix and Weight of the First-Level Index

F_1	Cost	Quality	Arrival	Service	Environ-ment	V	W	Consistency Test
Cost	1	2	3	2	2	1.89	0.33	
Quality	1/2	1	1/2	1/2	1/2	0.66	0.12	$\lambda_{\max} = 5.4$
Arrival	1/3	2	1	1/2	3	1	0.17	$C.I. = 0.1$
Service	1/2	2	2	1	2	1.32	0.23	$C.R. = 0.089 < 0.1$
Environ-ment	1/2	2	1/3	1/2	1	0.83	0.15	

5.2. Select the Coal Supplier with Extension Analysis Method

(1) Determine the classical domain and section domain

Coal supplier's rating can be divided into "excellent, good, normal, poor". The classic matter-element of various grades are as follows:

$$R_o = \begin{bmatrix} N & N_{01} & N_{02} & N_{03} & N_{04} \\ C_1 & (970,978) & (978,986) & (986,994) & (994,1002) \\ C_2 & (5330,5600) & (5050,5330) & (4775,5050) & (4500,4775) \\ C_3 & (24,26) & (26,28) & (28,30) & (30,32) \\ C_4 & (96,99) & (93,96) & (90,93) & (87,90) \\ C_5 & (97,99) & (95,97) & (93,95) & (91,93) \\ C_6 & (1.9,2.2) & (1.6,1.9) & (1.3,1.6) & (1.0,1.3) \\ C_7 & (95,100) & (90,95) & (85,90) & (80,85) \\ C_8 & (110,113) & (107,110) & (104,107) & (101,104) \\ C_9 & (98.5,99.5) & (97.5,98.5) & (96.5,97.5) & (95.5,96.5) \\ C_{10} & (0.9,1.0) & (0.8,0.9) & (0.7,0.8) & (0.6,0.7) \\ C_{11} & (0.9,1.0) & (0.8,0.9) & (0.7,0.8) & (0.6,0.7) \\ C_{12} & (0.9,1.0) & (0.8,0.9) & (0.7,0.8) & (0.6,0.7) \end{bmatrix}$$

Section domain matter-element and matter-element to be evaluated are:

$$R_p = \begin{bmatrix} N_p & C_1 & (970,1002) \\ & C_2 & (4500,5600) \\ & C_3 & (24,32) \\ & C_4 & (87,99) \\ & C_5 & (91,99) \\ & C_6 & (1.0,2.2) \\ & C_7 & (80,100) \\ & C_8 & (101,113) \\ & C_9 & (95.5,99.5) \\ & C_{10} & (0.6,1.0) \\ & C_{11} & (0.6,1.0) \\ & C_{12} & (0.6,1.0) \end{bmatrix}$$

$$R_A = \begin{bmatrix} N & C_1 & 1000 \\ & C_2 & 5326 \\ & C_3 & 30.28 \\ & C_4 & 88 \\ & C_5 & 98 \\ & C_6 & 1.8 \\ & C_7 & 87 \\ & C_8 & 105 \\ & C_9 & 98 \\ & C_{10} & 0.6335 \\ & C_{11} & 0.6958 \\ & C_{12} & 0.9145 \end{bmatrix}, \quad R_B = \begin{bmatrix} N & C_1 & 988 \\ & C_2 & 5582 \\ & C_3 & 25.12 \\ & C_4 & 95 \\ & C_5 & 94 \\ & C_6 & 1.2 \\ & C_7 & 99 \\ & C_8 & 100 \\ & C_9 & 97 \\ & C_{10} & 0.9385 \\ & C_{11} & 0.9880 \\ & C_{12} & 0.9760 \end{bmatrix}$$

$$R_C = \begin{bmatrix} N & C_1 & 990 \\ & C_2 & 5443 \\ & C_3 & 24.55 \\ & C_4 & 97 \\ & C_5 & 96 \\ & C_6 & 2.1 \\ & C_7 & 93 \\ & C_8 & 112 \\ & C_9 & 98 \\ & C_{10} & 0.9801 \\ & C_{11} & 0.9446 \\ & C_{12} & 0.9536 \end{bmatrix}, \quad R_D = \begin{bmatrix} N & C_1 & 976 \\ & C_2 & 5558 \\ & C_3 & 27.15 \\ & C_4 & 98 \\ & C_5 & 92 \\ & C_6 & 1.7 \\ & C_7 & 85 \\ & C_8 & 102 \\ & C_9 & 99 \\ & C_{10} & 0.7919 \\ & C_{11} & 0.7919 \\ & C_{12} & 0.5781 \end{bmatrix}$$

(2) Determine the correlation degree

Calculate the correlation matrix of the correlation degree according to (1), (2) type:

$$K_{A_j}(x_i)=\begin{bmatrix} -0.92 & -0.875 & -0.75 & 0.25 \\ -0.014 & 0.015 & -0.502 & -0.62 \\ -0.71 & -0.57 & -0.14 & 0.194 \\ -0.89 & -0.83 & -0.67 & 0.33 \\ 0.5 & -0.5 & -0.75 & -0.83 \\ -0.2 & -0.2 & -0.33 & -0.56 \\ -0.53 & -0.3 & 0.4 & -0.22 \\ -0.56 & -0.33 & 0.33 & -0.33 \\ -0.25 & 0.5 & -0.25 & -0.5 \\ -0.87 & -0.833 & -2.02 & 0.335 \\ -1.7 & -0.521 & -0.042 & 0.046 \\ 0.2 & -0.145 & -0.573 & -0.715 \end{bmatrix} \quad K_{Bj}(x_i)=\begin{bmatrix} -0.42 & 0.125 & 0.17 & 0.4 \\ 0.13 & -0.93 & -0.97 & -0.98 \\ 3.7 & -0.44 & -0.72 & -0.81 \\ -0.2 & 0.33 & -0.33 & -0.56 \\ -0.5 & -0.25 & 0.5 & -0.25 \\ -0.78 & -0.67 & -0.33 & 1 \\ 0.4 & -0.8 & -0.9 & -0.93 \\ -1.1 & -1.17 & -1.33 & 0.67 \\ -0.5 & -0.25 & 0.5 & -0.25 \\ 1.67 & -0.57 & -0.6925 & -0.795 \\ 0.24 & -0.88 & -0.94 & -0.96 \\ 0.48 & -0.76 & -0.88 & -0.92 \end{bmatrix}$$

$$K_{Cj}(x_i)=\begin{bmatrix} -0.5 & -0.25 & 0.5 & 0.2 \\ 2.74 & -0.42 & -0.72 & -0.81 \\ 0.55 & -0.725 & -0.8625 & -0.91 \\ 1 & -0.33 & -0.67 & -0.78 \\ -0.25 & 0.5 & -0.25 & -0.5 \\ 0.67 & -0.67 & -0.83 & -0.89 \\ -0.22 & 0.4 & -0.3 & -0.53 \\ 0.67 & -0.67 & -0.83 & -0.89 \\ -0.25 & 0.5 & -0.25 & -0.5 \\ 0.398 & -0.801 & -0.9005 & -0.93 \\ 4.12 & -0.446 & -0.723 & -0.815 \\ 0.928 & -0.536 & -0.768 & -0.85 \end{bmatrix} \quad K_{Dj}(x_i)=\begin{bmatrix} 0.5 & -0.25 & -0.625 & -0.57 \\ 0.31 & -0.84 & -0.92 & -0.95 \\ -0.27 & 0.37 & -0.2125 & -0.475 \\ 0.67 & -0.67 & -0.83 & -0.89 \\ -0.83 & -0.75 & -0.5 & 1 \\ -0.29 & 0.25 & -0.17 & -0.44 \\ -0.67 & -0.5 & 0 & 0 \\ -0.89 & -0.83 & -0.67 & 0.67 \\ 1 & -0.5 & -0.75 & -0.83 \\ -0.36 & -0.0405 & 0.044 & -0.32 \\ -0.36 & -0.0405 & 0.044 & -0.32 \\ -1.073 & -1.1095 & -0.1 & -0.438 \end{bmatrix}.$$

(3) Grade evaluation

Calculate the joint correlation degree and carry on the rank evaluation according to the obtained weight vector A

Using formula (3) to calculate

$$K_{Aj}(p_k)=\sum_{i=1}^{m} a_i K_{Aj}(x_i)=(-0.687,-0.616,-0.520,-0.119),$$

$$K_{Bj}(p_k)=\sum_{i=1}^{m} a_i K_{Bj}(x_i)=(-0.207,-0.388,-0.444,-0.139),$$

$$K_{Cj}(p_k)=\sum_{i=1}^{m} a_i K_{Cj}(x_i)=(0.583,-0.329,-0.380,-0.579),$$

$$K_{Dj}(p_k)=\sum_{i=1}^{m} a_i K_{Dj}(x_i)=(-0.019,-0.596,-0.642,-0.358)。$$

It can be seen, $MaxK_j(x_i)=0.583$, so the program C is the best, the program A is worst, Which shows that the thermal power plant should first choose program C namely to choose the C coal mine in the choice of coal-fired supplier.

6. Conclusion

In this paper, the AHP method and the extension analysis methods are used in the coal-fired supplier selection of thermal power plant, and establishing an objective and comprehensive evaluation index system of coal-fired supplier. The AHP method and the extension analysis methods have their own advantages and characteristics. Two methods can compensate for their respective shortcomings to have a comprehensive, effective, scientific evaluation. Judgment matrix in AHP method to determine the weight can make the decision maker's thought process be mathematical, systematic. Basis for decision making is easy to be accepted. The extension analysis method is a comprehensive evaluation method, which evaluates the correlation grade of the things from multiple influencing factors. It uses the fuzzy definition to replace the artificial stipulation the boundary. It also uses fuzzy matter-element transformation, the structural changes to transform incompatible contradictions to compatibility issues. This is to restore things in the analysis process to facilitate the solution of the model. During mathematical modeling, we take full account of the vagueness of the things, so narrowing the differences in the model and the actual situation. It solves the contradiction between complexity and accuracy in the evaluation process of things. The combination of two methods, not only to solve the weight determination question of the multi-factor, the multiple index thing, and can effectively solve the comprehensive evaluation problem. Through treatment of concrete examples, the steps are clear and simple, the method is easy to master, and results is reasonable and credible, which is of extremely good value.

References

[1] Wu Jiang. Thermal Power Loss Causes and Protection of Coal Supply. *Journal of China Power Enterprise Management*. 2008; 13(7): 21-23.
[2] Cai Wen. *Matter-Element Analysis*. Guangdong: Guangdong Higher Education Press. 1987.
[3] Wu Hong-gang. Study on Evaluation Index System Of Coal Enterprise Provider. *Journal of China Coal*. 2009; 35(12): 37-39.
[4] He Yong-bing. Analysis of Factors Affecting the Cost of Thermal Power Plant Coal. *Journal of China Electric Power Education*. 2009; 32(7): 261-262.
[5] Li Bu-feng, Jiang Yong. A Study on Application of ABC in Supplier Evaluation. *Journal of Industrial Engineering and Management*. 2002; 21(1): 49-52.
[6] Gao Yuan. Study on the Purchase Tactics of Thermal Power Enterprises Based on the Synthetical Forecast Analysis. PhD Thesis. Wuhan University; 2005.
[7] Saaty TL. A Note on the AHP and Expected Value Theory. *Socio-Economic Planning Sciences*. 1986; 6(20): 397-398.
[8] Saaty TL. Rank from Comparisons and from Ratings in the Analytic Hierarchy/Network Processes. *European Journal of Operational Research*. 2006; 168(2): 557-570.
[9] Cai Wen. *Matter-Element Model and Application*. Beijing: Science and Technology Literature Press. 1994.
[10] Cai Wen. *Extension Engineering Method*. Beijing: Science Press. 2000.
[11] Ma Shi-xiao, Sun Yan. The Risk Assessment of the Engineering Project Based on Matter-Element Analysis Model. *Journal of Shenyang Jianzhu University (Social Science)*. 2012; 14(2): 157-160.
[12] Shao Yan-ying, Zheng De-feng. Study on Groundwater Environmental Health Assessment Model Based on Entropy Weight and Fuzzy Matter-element. *Journal of Water Resources and Power*. 2011; 29(12): 32-34.
[13] Lin Zheng-kui. Research on Information System Risk Assessment Based on Matter-element Analysis Method. *Journal of Mathematics in Practice and Theory*. 2012; 42(7): 80-86.
[14] Meng Ying, Zhang Qiang. Extensive Method of Supplier Selection in Coal Group. *Journal of Operations Research And Management Science*. 2006; 15(6): 145-150.
[15] Zhou Xiu-hong, Yang Sheng-qiang. Extension Comprehensive Evaluation on Mining Technology Condition. *Journal of Safety in Coal Mines*. 2012; 43(3): 147-150.

[16] Yang Zhan-she. Evaluation on Land Acquisition Successful Degree Based on Extension Theory. *Journal of Anhui Agricultural Sciences*. 2012; 40(12): 7442-7444.
[17] Huahuan Lei, Lilan Liu, Tao Yu. The Application of Multiple Attribute Decision in LED Commerce Platform. *Journal of TELKOMNIKA*. 2013; 11(4): 126-134.
[18] Hongqiang Gu, Cheng Zhang, Quan Shi. Equipment Maintenance Support Capability Evaluation Using Cloud Barycenter Evaluation Method*. Journal of TELKOMNIKA*. 2013; 11(2): 324-335.