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Research on Risk Control of Energy Management Companies Based on DEMATEL-ISM

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ABSTRACT: *China is committed to achieving "carbon peak" by 2030 and "carbon neutral" by 2060, and the energy management sector is an integral part of achieving this goal. In order to further explore the risk mechanism of energy management companies and improve the risk control level of energy companies, this paper established a risk factor index system of energy management companies including four aspects and 23 factors based on the risk control theory. Then, using DEMATEL-ISM model, the relationship matrix of factors and the model of factor level interpretation are constructed. Finally, the risk index system of energy management company includes 11 cause risk factors and 12 result risk factors. The factory-level interpretation model consists of seven layers. Based on the above research results, this paper puts forward targeted risk control measures, which serve as the theoretical basis for the risk control decisions of energy management enterprises.*

KEYWORDS - *Carbon Neutral, Carbon Peak, DEMATEL-ISM, Energy Management Companies, Risk Control*

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I. INTRODUCTION

On September 22, 2020, Chinese President Xi Jinping made an important speech at the general debate of the 75th session of the United Nations General Assembly, stating that "China will strive to achieve" carbon peak "by 2030 and achieve carbon neutrality by 2060 [1]. At present, China's energy consumption structure is still dominated by coal. In 2019, coal consumption accounts for 57.7% of China's energy consumption structure. At present, China is less than 10 years away from achieving the carbon peak goal and only 30 years away from achieving the carbon neutral goal, which shows that China has a tight time frame to achieve this goal, and the pressure is huge. In order to promote the green transformation of the development mode and achieve the goal of carbon neutrality at an early date, the participation of energy management enterprises, the key subject, is needed. China encourages the vigorous development of green economy, which is clearly proposed in the Fourteenth Five-Year Plan and the Outline of the 2035 Vision Goals: "The principle of energy priority should be upheld and energy management promoted." It can be seen that the development of energy management industry has become a major breakthrough to promote the green transformation of development mode and help achieve the goal of carbon peak and carbon neutral. Energy management company is a professional company that provides energy management such as usage diagnosis, energy project design and financing transformation for energy-using enterprises [2]. It provides professional energy management for industry, transportation, construction and other energy-consuming industries, helping to achieve the goal of "carbon peak" and "carbon neutral". However, China's energy management industry is faced with risks from capital, talent, management and other aspects due to industrial characteristics, mode, incomplete energy management awareness, discontinuous policy support, and other reasons, which further limits the development of energy management industry. Therefore, through identifying and analyzing the risk factors of energy management companies, we find out which are the key risk factors restricting the development of energy management companies and take targeted measures to help the development of energy management companies. This is of great significance to the development of the energy management industry, and thus contributes to energy management and emission reduction and the realization of the goals of "carbon peak" and "carbon neutral".

The problem of energy management is imminent. Many scholars have studied the risk evaluation of energy management companies. Fang Jun constructed the risk evaluation model of energy contract management project by using the analytic hierarchy process and fuzzy comprehensive evaluation method [3]. Li Qiangnian et al. used structural equation model (SEM) to study the risks of energy management renovation projects of existing public buildings [4]. Guo Ziyan et al. used the fuzzy comprehensive evaluation method to evaluate the investment risks of energy-management renovation projects of existing buildings in energy management companies [5]. Li Mei et al. analyzed the development problems of energy management companies under the existing contract energy management model, and put forward countermeasures and suggestions [6]. Duan

Xiaoping used the principal-agent theory, information asymmetry theory and financing risk sharing and transfer theory to make an in-depth analysis of the causes of financing risks in China's energy management industry, and put forward countermeasures and suggestions [7]. Yang Xuefeng et al. used the fuzzy comprehensive evaluation method to evaluate the risk of contract energy management [8]. However, the existing studies are mainly limited to the identification of risk factors of a specific project or energy management enterprises, without the correlation and hierarchical analysis among risk factors of energy management companies, without finding out the key influencing factors, and then putting forward more targeted risk control suggestions.

To sum up, this paper will identify the risk factors faced by energy companies and establish a risk index system through literature research. By using the DEMATEL-ISM model, the risk factors of energy companies will be deeply analyzed based on the clear hierarchical relationship between ISM model and the importance of factors defined by DEMATEL model. This paper establishes a multi-level structure model of risk factors for energy management companies, analyzes the correlation between the factors, finds out the key risk factors, and puts forward targeted suggestions and measures, which is a reliable objective basis for the risk control of energy management companies.

II. IDENTIFICATION OF RISK FACTORS FOR ENERGY MANAGEMENT COMPANIES

Based on the literature research method, the risk factors of energy management companies are summarized into project factors, customer factors, internal factors and external factors, including a total of 23 risk factor indicators, which constitute the risk factor index system of energy management companies in this study. Project factors include the following six factors: Project financing status (B_1)[12], Technology advancement and maturity (B_2)[15], Project construction status (B_3)[2], Energy saving forecast and audit (B_4)[6], Return on investment status (B_5)[2], Capital return status (B_6)[13]. Customer factors include the following three factors: Capital return status (B_7)[12], Customer operating stability (B_8)[3], Customer dispute Status (B_9)[3]. Internal factors include the following five factors: Internal operation management (B_{10})[10], Enterprise resource allocation status (B_{11})[14], Corporate brand Effect (B_{12})[11], Enterprise market development ability (B_{13})[6], Contract management ability (B_{14})[6]. External factors include the following nine factors: (B_{15})[9], Fiscal subsidy (B_{16})[12], Transaction costs (B_{17})[7], Information symmetry condition (B_{18})[3], Energy management evaluation and management system (B_{19})[11], Market demand potential (B_{20})[16], Market structure (B_{21})[17], Market competition risk (B_{22})[14], Energy price changes (B_{23})[3].

III. DEMATEL-ISM MODEL CONSTRUCTION

3.1 Model definition

DEMATEL method is a kind of tool using graph theory and matrix of the factor analysis method, through the logical relationship between various factors in the system with a direct impact on matrix, calculates the degree of each factor's influence on other factors as well as by the effect of each factor is obtained at the center of the degree and reason degree. ISM reveals the hierarchical structure of factors by analyzing factors and the direct binary relations between factors. The DEMATEL-ISM model combines the two, providing both a correlation between each factor and a clear hierarchy.

3.2 Steps of model construction

3.2.1 Construct the Direct Impact Matrix

Through a large number of literature research, the risk index system was determined, and the degree of correlation influence among risk factors was determined by the way of expert rating to form a direct influence matrix D.

$$D = \left[d_{ij} \right]_{n \times n} \tag{1}$$

3.2.2 Calculation of comprehensive impact matrix

(1) Normalization directly affects the matrix

Normalization directly affects the matrix E.

$$E = \left[E_{ij} \right]_{n \times n} = \frac{D}{\max \sum_{j=1}^{n} D_{ij}} \tag{2}$$

(2) Calculate the comprehensive impact matrix T.

$$T = \left[T_{ij} \right]_{n \times n} = E \left(I - E \right)^{-1} \tag{3}$$

I is the identity matrix.

3.2.3 Calculate influence degree p, affected degree p, centrality degree m and reason degree n.

$$p_i = \sum_{j=1}^{n} T_{ij}, 1 \le i \le n \tag{4}$$

$$q_i = \sum_{i=1}^{n} T_{ji}, 1 \le j \le n \tag{5}$$

$$m_i = p_i + q_i, 1 \le i \le n \tag{6}$$

$$n_i = p_i - q_i, 1 \le i \le n \tag{7}$$

3.2.4 Calculation of reachable matrix

(1) Calculate the overall impact matrix

$$H = \left[h_{ij} \right]_{n \times n} = I + T \tag{8}$$

(2) Determine the threshold value λ

$$\lambda = \alpha + \beta \tag{9}$$

α and β are respectively the mean value and standard deviation of the comprehensive matrix T, and the different values of divisor correspond to different logical relations of influencing factors [4]. The divisor and standard deviation of the comprehensive matrix T mean are selected to reduce the subjectivity of the threshold selection by experts.

(3) Establish a standardized reachable matrix

$$K = \left[K_{ij} \right]_{n \times n}, k_{ij} = \begin{cases} 1, h_{ij} \ge \lambda \\ 0, h_{ij} < \lambda \end{cases} \tag{10}$$

3.2.5 Determinate reachable set and antecedent set

The reachable set U(Bi), the antecedent set V(Bi) and the common set W(Bi)=U(Bi)∩V(Bi) are obtained by the hierarchical processing of the reachable matrix.

3.2.6 Calculation of factor sets at each layer of the structural model

$$W\left(Bi\right) = U\left(Bi\right) \cap V\left(Bi\right) \tag{11}$$

If a factor satisfies formula (11), the corresponding row and column of the factor will be deleted in the matrix K, and the previous step will be repeated until all elements in the reachable matrix K are deleted, so as to obtain the factor set of each layer and establish the factor recursive hierarchy [18].

IV. ESTABLISHMENT AND ANALYSIS OF A COMPREHENSIVE RISK FACTOR MODEL FOR ENERGY MANAGEMENT COMPANIES BASED ON DEMATEL-ISM MODEL

According to Formula (1) - (7), use Matlab to calculate the influence degree, affected degree, centrality degree and reason degree. After that, draw the graph in which the horizontal axis is centrality and the vertical axis is causality, as shown in Figure 1.

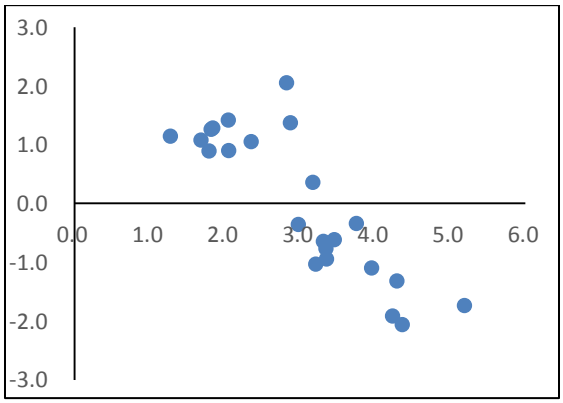

Figure 1. Causal diagram of influencing factors.

And then according to the steps in 3.2.6, the factor hierarchy chart is obtained (Figure 2).

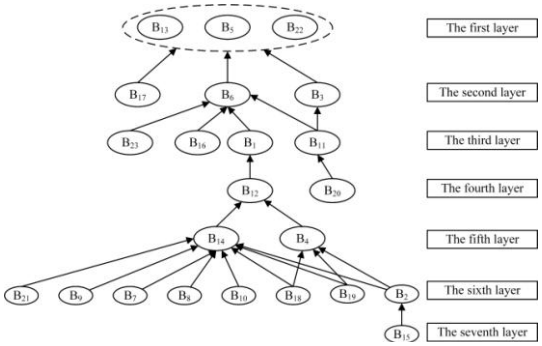

Figure 2. The factor recursive hierarchy.

V. ANALYSIS OF RESULTS

5.1 Factor causality analysis

Risk factors with positive cause degree are the cause set, while risk factors with negative cause degree are the result set[18]. The descending order of reasons is B_{15}, B_{21}, B_{18}, B_9, B_7, B_{23}, B_8, B_{19}, B_{20}, B_2, B_{10}, B_{17}, B_{12}, B_4, B_{14}, B_3, B_1, B_{11}, B_{13}, B_{22}, B_6, B_5.

Among them, there are 11 causative factors, namely B_{15}, B_{21}, B_{18}, B_9, B_7, B_{23}, B_8, B_{19}, B_{20}, B_{16} and B_2. Among them, B_{15}, B_{21} and B_{18} have a greater impact on other outcome factors and the risk control of energy management companies.

Results There are 12 factors, including B_{10}, B_{17}, B_{12}, B_4, B_{14}, B_3, B_1, B_{11}, B_{13}, B_{22}, B_6 and B_5, which are influenced by causative factors and directly affects the risk control effect.

5.2 Factor centrality analysis

Centrality is the position of the factor in the evaluation system and reflects the size of its role. Sort from highest to lowest: B_{22}, B_5, B_{13}, B_6, B_{11}, B_{10}, B_{12}, B_3, B_{14}, B_4, B_1, B_2, B_{17}, B_{18}, B_{15}, B_{19}, B_{20}, B_{21}, B_9, B_7, B_{16}, B_8, B_{23}.The top eleven in the ranking of centrality are all result sets, which mainly involve companies operation management and market development competition, and are controllable factors of the enterprise itself. Technical level ranks first in the list of reasons. It can be seen that paying attention to technological innovation is beneficial to risk control of energy management companies.

5.3 Structural analysis of factors

As shown in figure 2 energy management company risk level interpretation model, the factors of first layer are B_{13}, B_5 and B_{22}, which directly affect the results of risk control. However, the company cannot take measures against them directly. Instead, it can improve the situation at this level by controlling deeper risk factors.

The second to fifth layers are mainly internal factors of the enterprise, which are the best factors for the enterprise to track and monitor. These factors not only bear the influence of the sixth and the seventh layer factors, but also transfer this effect to the first layer direct factors, and then affect the enterprise risk control.

The seventh layer is B_{15} policy support. Policy, as a systemic risk, has a huge impact on the development of the industry and is the fundamental reason that affects the risk control of energy management enterprises.

VI. SUGGESTIONS

The seventh layer policy may bring positive or negative effects, so energy management companies should reasonably evaluate the future policy trend and take corresponding measures to hedge risks. At the same time, equity concentration significantly weakens the positive effect of economic policy uncertainty [19], and enterprises can enhance the positive effect of policy uncertainty by limiting equity concentration.

The factors of the sixth layer are mainly external factors. For example, the company is often unable to directly track and monitor customer risks, but it can control risks by paying attention to customer operating conditions and credit investigation, project feasibility research, contract management and other aspects before signing the contract.

The second to the fifth layer's factors are the most direct and necessary factors for enterprises to track, monitor and adjust.

The factors of the first layer, the most direct manifestation of enterprise risk, are influenced by the factors from the second to the fifth layers. Therefore, the control of the first layer of risk factors needs the help of the second to the fifth layer of risk control but can't directly take measures in this layer.

VII. CONCLUSION

In order to achieve "carbon peak" and "carbon neutral", the participation of energy management enterprises is necessary, and it is in urgent need of scientific theory to guide practical activities. However, previous studies on energy-saving services have focused on how to improve energy efficiency in terms of technology and energy utilization structure but paid less attention to how to take actions from the management side. This paper establishes a risk factor index system for energy companies through literature research. By constructing DEMATEL-ISM model, the correlation and hierarchical relationship of risk factors of energy management companies are analyzed, and the corresponding risk control measures are put forward, which can be used as the reference suggestions for the risk control decision-making of energy management companies. As for the limitations of this paper, the selection of risk factor indicators is limited in this paper, which cannot fully cover possible risk factors.

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