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Analysis on the Importance of the Factors Affecting the Comprehensive Capacity of Power Selling Companies Based on Weight Calculation

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***Abstract*—With the improvement of user status and the transformation of power demand, it is urgent to improve the comprehensive capacity of power selling companies in the power market. This paper first constructs an evaluation index system for the comprehensive capacity of power sales companies, analyzes the factors that affect the power sales companies by using the analytic hierarchy process, and simulates the possible changes in the importance of indicators over time, guiding the power sales companies to focus on key indicators and improve their comprehensive capacity.**

Keywords—power sales company, Comprehensive capability, Index system, weight calculation

I. INTRODUCTION

In the process of deepening the construction of power market, the diversification of power supply has also brought difficulties to users' choice. It is urgent to build a reasonable comprehensive capacity evaluation system for power selling companies, and based on the evaluation system to obtain the impact of different indicators on the comprehensive capacity of power selling companies, so as to provide guidance for improving the focus indicators of power selling companies and better serving users.

For the analysis of the financial benefit indicators of power selling companies, the literature [1] believes that power selling companies should not only fulfill their economic responsibilities, but also pay more attention to social responsibilities. Through the link between the responsibilities of various stakeholders, they should evaluate the performance of the multiple responsibilities of the power selling enterprises. Literature [2] introduces the performance evaluation method into the comprehensive evaluation of the financial performance of power selling enterprises, and combines the theory of China's economic situation to improve the comprehensiveness of the comprehensive evaluation results. Literature [3] emphasizes the quality of cash, profit, capital structure and assets in the process of evaluating the financial quality of power selling companies, and constructs the corresponding evaluation system. In the research of competitiveness indicators, the literature [4] has conducted an in-depth study of China's current reform policies, and proposed how to optimize itself in this policy context. The professional evaluation method was adopted for the evaluation, and a comprehensive study was conducted on the divided topics. Literature [5] has studied from the perspective of competition mode, and put forward a competitiveness evaluation system suitable for different power selling companies on the basis of combining the macro and micro environment. For the relevant indicators in the enterprise credit dimension, the literature [6] proposes to improve the fuzzy comprehensive evaluation model to evaluate the enterprise credit level. The model combines AHP and factor analysis to calculate the weight value. In terms of relevant indicators reflecting the quality of power supply service, the literature [7] regards the quality of power supply service as a service performance indicator from the perspective of power supply companies, mainly including evaluation indicators such as power supply reliability rate and voltage qualification rate. Literature [8] first analyzes the concept, type and connotation of power supply service of power selling companies, and constructs the power supply service quality evaluation system of power selling companies under the new power reform; Then, the lower evaluation system based on BP neural network and the unified adaptive evaluation based on TOPSIS are implemented to realize the comprehensive evaluation of power supply service quality.

Although the comprehensive capacity assessment of the power selling company has achieved preliminary results, the research focusing on the screening and identification of key

indicators affecting the company's ability is relatively rare, which restricts the company's attention to the determination of key indicators affecting the comprehensive capacity of the power selling company. Therefore, this paper establishes a method to identify the key indicators that affect the comprehensive capacity of power selling enterprises, providing support for the company to screen and improve the focus of key factors.

II. INFLUENTIAL FACTORS AND INDICATOR SYSTEM OF COMPREHENSIVE CAPACITY OF POWER SALES COMPANIES

From the dimensions of service ability, credit level, technical ability and marketing ability, the comprehensive ability of power selling companies is analyzed in detail. This is of strategic significance for power sales companies to master customer needs, risk control, technological self-reliance and long-term development.

TABLE I. COMPREHENSIVE CAPACITY EVALUATION INDEX SYSTEM OF POWER SALES COMPANY

Table Head	Table Column Head		
	Target layer	***Criterion layer***	***Factor layer***
Comprehensive Capacity Evaluation Index System of Power Sales Company	Comprehensive capacity of power selling company（A）	Service capacity（B1）	Customer satisfaction（C1）
			Business handling capacity（C2）
		Credit Level（B2）	Credit Record（C3）
			Compliance with trading rules（C4）
			Timeliness of contract settlement（C5）
		Technical capability（B3）	Technical integration capability（C6）
			Value added service development capability（C7）
			Rationality of electricity price setting（C8）
		Marketing capability（B4）	Risk control capability（C9）
			Demand side management capability（C10）

III. ANALYTIC HIERARCHY PROCESS

Analytic Hierarchy Process (AHP) is a hierarchical weight decision-making method, that is, quantitative analysis of qualitative problems is carried out by constructing a hierarchical structure. The steps are as follows.

(1) Establish hierarchical structure model

Analytic Hierarchy Process (AHP) is just to study the weight influence of the lowest level on the highest level. Various options in the lowest level can be sorted according to the weight. First, divide the structure model into target layer, criterion layer and scheme layer, and draw a hierarchy diagram.

(2) Build a hierarchy judgment matrix

After the establishment of the hierarchical structure model, it is necessary to judge the directivity between each layer and the weight between each element and factor of each layer, introduce the corresponding importance scale and build a judgment matrix. Assume that the dimension of judgment matrix A is n × n. In the consistent matrix method, the judgment matrix is:

$$\mathrm{A} = (\mathrm{a_{ij}})_{\mathrm{n\times n}} \tag{1}$$

In formula (1), n is the order of judgment matrix (number of elements); A_{ij} represents the comparison scale of the importance of the ith index relative to the jth index, and $a_{ij} > 0$, $a_{ij} = 1/a_{ji}$, A is a positive and reciprocal judgment matrix.

(3) Hierarchical Single Sorting and Consistency Test

After the judgment matrix is constructed, the hierarchical single sorting is carried out first. Use the assigned matrix constructed above to calculate the weight of the model, that is, normalize the maximum eigenvalue corresponding to the judgment matrix λ. The eigenvector W, $W = (w_1, w_2, \cdots, w_n)^T$, W of max is the ranking weight value of the relative importance of the factors at the same level to the factors at the next level. This process is called hierarchical single ranking. The solution process of eigenvector W is as follows:

Normalize column A vector of judgment matrix to $\bar{W}_{ij}$, and for $\bar{W}_{ij}$ is multiplied by rows to the nth power.

$$\bar{W}_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \tag{2}$$

$$\bar{W}_{ij} = \left(\prod_{i=1}^{n} \bar{W}_{ij}\right)^{\frac{1}{n}} \tag{3}$$

Set $\bar{W}_{ij}$normalization, get the eigenvector $W = (w_1, w_2, \cdots, w_n)^T$, calculate λ_{max}。

$$W_i = \frac{\bar{W}_{ij}}{\sum_{i=1}^{n} \bar{W}_{ij}} \tag{4}$$

$$\lambda_{max} = \sum_{i=1}^{n} \frac{AW_i}{nW_i} \tag{5}$$

Secondly, the consistency test is carried out, that is, the allowable range of matrix A inconsistency is determined, and the feature vector W passing the consistency test can be determined as the hierarchy weight.

$$\mathrm{RI} = \frac{\sum_{i=1}^{\mathrm{n}} \mathrm{CI_i}}{\mathrm{n}} \tag{6}$$

CI and CR are calculated as follows:

$$\mathrm{CI} = (\lambda\_\max - \mathrm{n})/(\mathrm{n}-1) \tag{7}$$

$$\mathrm{CR} = \mathrm{CI}/\mathrm{RI} \tag{8}$$

(4) Hierarchical Total Ranking and Consistency Test

The overall ranking of levels refers to the calculation of the overall ranking of all elements in a certain level for the highest level. The importance weight ratio of each element in the indicator level is obtained above. The weight ratio of each

element relative to the target level needs to be calculated by using the normalization method to perform the overall ranking of levels.

The consistency check is also required for the overall ranking of levels. The purpose is to master the ranking of each element weight of the target level, so as to provide a basis for selecting the best scheme. Assume that the consistency index of each factor of layer B to the factor a_j (j=1, 2,..., m) of layer A in the upper layer is CI_j, the random consistency refers to RI_j, and the consistency ratio of the total ranking of layers is calculated as follows:

$$CR = \frac{a_1 CI_1 + a_2 CI_2 + \cdots + a_m CI_m}{a_1 RI_1 + a_2 RI_2 + \cdots + a_m RI_m} \quad (9)$$

Use CR in the above formula to judge whether the calculated weight ratio of each element is available. If CR>0.10, the overall ranking of the hierarchy passes the consistency test; If CR<0.10, it is necessary to readjust the importance of elements in the matrix.

IV. CASE STUDY

(1) Determination of weight of criterion layer

For the determination of weight, a judgment matrix is first constructed, and then experts compare and score the index importance of the judgment matrix in pairs, and finally calculate the index weight. The corresponding maximum eigenvalue and eigenvector are calculated, and the consistency is checked.

TABLE II. COMPARISON JUDGMENT MATRIX A-B

A	B1	B2	B3	B4	Wi
B1	1	2	3	5	0.4609
B2	1/2	1	3	4	0.3104
B3	1/3	1/3	1	3	0.1561
B4	1/5	1/4	1/3	1	0.0726

(2) Determination of index layer weight

For the comparison judgment matrix B1-C of the weight of the index layer, calculate the corresponding maximum eigenvalue and eigenvector, and check the consistency.

TABLE III. COMPARISON JUDGMENT MATRIX B1-C

B1	C1	C2	Wi
C1	1	1/2	0.5
C2	2	1	0.5
The second order matrix has complete consistency, and the judgment matrix passes the consistency test			

Similarly, comparative judgment matrices B2-C, B3-C, and B4-C of indicator layer weights are constructed to calculate the corresponding maximum eigenvalue and eigenvector, and the consistency is checked:

TABLE IV. COMPARISON JUDGMENT MATRIX B2-C

B2	C3	C4	C5	Wi
C3	1	2	3	0.5247
C4	1/2	1	3	0.3338
C5	1/3	1/3	1	0.1415
λ max=3.054， CI=0.027， RI=0.52， CR=0.052<0.10 the judgment matrix passes the consistency test				

TABLE V. COMPARISON JUDGMENT MATRIX B3-C

B3	C6	C7	C8	Wi
C6	1	3	4	0.6079
C7	1/3	1	3	0.2721
C8	1/4	1/3	1	0.12
λ max=3.074， CI=0.037， RI=0.52， CR=0.071<0.10 the judgment matrix passes the consistency test				

TABLE VI. COMPARISON JUDGMENT MATRIX B4-C

B4	C9	C10	Wi
C9	1	2	0.6667
C10	1/2	1	0.3333
The second order matrix has complete consistency, and the judgment matrix passes the consistency test			

(3) Determination of composite weight

After calculating the weight vector of each level, the weight of the indicator layer relative to the target layer can be calculated, and the composite weight of the indicator system can be obtained to complete the overall ranking of the levels.

TABLE VII. INDEX WEIGHT

Target layer	criterion layer	Cweight layer 权重	factor layer	fweight	Composite weight
Comprehensive capacity of power selling company（A）	Service capacity（B1）	0.4609	Customer satisfaction（C1）	0.5	0.2305
			Business handling capacity（C2）	0.5	0.2305
	Credit Level（B2）	0.3104	Credit Record（C3）	0.5247	0.1629
			Compliance with trading rules（C4）	0.3338	0.1036
			Timeliness of contract settlement（C5）	0.1415	0.0439
	Technical capabilit	0.1561	Technical integration capability（C6）	0.6079	0.0949

	y（B3）		Value added service development capability（C7）	0.2721	0.0425
			Rationality of electricity price setting（C8）	0.12	0.0187
	Marketing capability（B4）	0.0726	Risk control capability（C9）	0.6667	0.0484
			Demand side management capability（C10）	0.3333	0.0242

(4) As time goes by, the importance of indicators changes. The following table shows the simulation calculation results of a new round of weights in the future.

TABLE VIII. INDEX WEIGHT

Target layer	criterion layer	Cweight layer 权重	factor layer	fweight	Composite weight
Comprehensive capacity of power selling company（A）	Service capacity（B1）	0.3799	Customer satisfaction（C1）	0.5	0.18995
			Business handling capacity（C2）	0.5	0.18995
	Credit Level（B2）	0.3104	Credit Record（C3）	0.4839	0.150203
			Compliance with trading rules（C4）	0.3027	0.093958
			Timeliness of contract settlement（C5）	0.2134	0.066239
	Technical capability（B3）	0.1872	Technical integration capability（C6）	0.5666	0.106068
			Value added service development capability（C7）	0.3101	0.058051
			Rationality of electricity price setting（C8）	0.1233	0.023082
	Marketing capability（B4）	0.1225	Risk control capability（C9）	0.6712	0.082222
			Demand side management capability（C10）	0.3288	0.040278

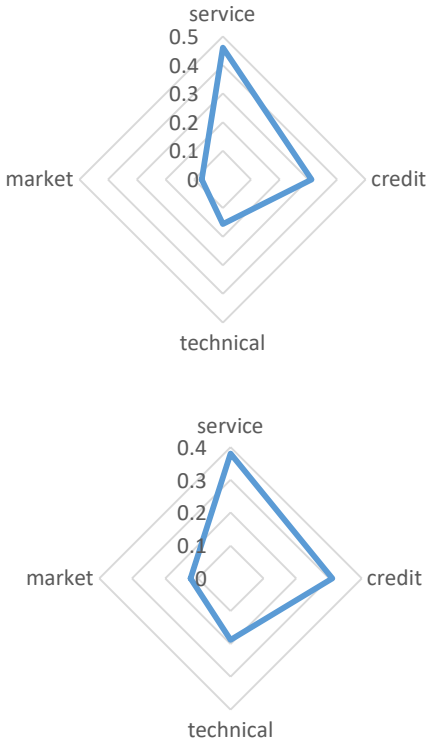

Fig. 1. Index Importance Radar Chart Comparison

At the same time, the left radar chart shows the importance of the four dimensions under the benchmark situation, and the right radar chart shows the importance of each dimension after simulating the passage of time.

V. CONCLUSION

According to the calculation results, service capability is an important dimension. Therefore, power sales companies need to pay attention to customer satisfaction and business processing capacity.

At the same time, according to the radar chart, it can be found that under the benchmark scenario, the service capacity has a greater impact on the comprehensive capacity of the power selling company, which is a dimension that the power selling

company needs to focus on. However, the market, credit and technology dimensions are relatively low, and there is still some room for development in the future. Over time and to a certain extent, with the credit dimension unchanged, both technology and market have expanded to a certain extent. However, there is no doubt that some service levels need to be sacrificed in exchange for the development of technology and market. However, on the whole, the service level, on the premise of ensuring user satisfaction, has a certain space for sacrifice, which can be in exchange for market efficiency and technical improvement.

This paper uses the analytic hierarchy process to study the importance of the factors that affect the comprehensive capacity of electricity selling enterprises. It provides a scientific and feasible method for power selling enterprises to judge the importance of different indicators.

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