Research on Diagnosis and Evaluation of Power Grid Enterprise Management Development Based on Combined Weight TOPSIS Theory

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Abstract: At present, the operation and management of power grid enterprises is facing a complicated situation. Facing the new market-oriented reform situation and development trend, power grid companies must strengthen the awareness of input and output efficiency, fully integrate the key factors that determine investment and cost allocation and the evaluation results of enterprise production and operation, and do a good job in production and operation and grid development. This paper takes the county companies in the S area as the empirical analysis object, proposes a power grid management development evaluation index system, and combines the analytic hierarchy process(AHP) and the entropy weight method(EWM) to determine the weight, uses the TOPSIS theory to comprehensively evaluate the actual situation of the county companies, and through comparative analysis, The rationality of the indicator system and evaluation method is verified, and it can provide support and reference for further improving the level of fine investment management.

1. Introduction
In recent years, due to changes in the external environment, the macro-economy has continued to decline. Meeting the needs of power development, optimizing the investment strategy of power grid companies, and improving the lean level of power grid investment management have become a vital part of the investment projects of power grid companies. Diagnosing and evaluating the business development of power grid companies can effectively clarify the operating status of different companies, which can provide support and guarantee for standardizing investment behavior, improving investment efficiency, and further clarifying the principles of power grid investment and project arrangements.

In recent years, research on comprehensive evaluation of power grid enterprises has been abundant. Literature [1] constructs a high-quality development evaluation framework system for power grids. It designs an evaluation index system from five levels: equipment, technology, management, service, and operation. Evaluation rules can provide methodological support for the evaluation of high-quality development of power grids. Literature [2] analyzes the development level of regional power grids, economy and society, and establishes a regional power grid development diagnosis system through relevant indicators. Taking the SQ area as an example, it deeply analyzes the local power grid development level, establishes a suitable diagnosis system, and applies fuzzy-AHP to obtain the diagnosis result. By referring to the process of the power grid company in the investment allocation, a
distribution network investment iterative allocation model combining historical investment results is proposed.

Literature [3] establishes an evaluation index system based on 37 main indicators of four categories that have been issued by power grid enterprises, and uses AHP and fuzzy evaluation principle to evaluate whether power grid companies implement integrated planning management is reasonable and effective. Literature [4] applies a set of table results of county-level power supply enterprise production and operation statistics and a comprehensive information platform for grid planning to establish an indicator system for grid development and production and operation analysis, focusing on empirical research on 98 county-level power supply companies in Shandong. Using data mining and comprehensive evaluation, the internal index data and external index are clustered respectively, the classification results are observed and the difference analysis is performed. Literature [5] subdivided the grid development indicators into three secondary indicators of power supply capacity, grid structure and intelligence, subdivided production and operation into three secondary indicators of operating performance, asset quality and power supply services, proposed power grid development and production and operation evaluation index system and evaluation methods which are based on Delphi-AHP model, and made empirical application analysis. Literature [6] constructed an evaluation index system for the sustainable development ability of power grid enterprises under the new normal, and used the expert scoring method and AHP method to evaluate the index system.

2. Construction of Diagnosis and Evaluation Index System for the Development of Power Grid Enterprises

2.1. Principles of constructing indicator system

The operating conditions of power grid companies are affected by many factors, including not only the company’s past profits and losses, but also the company’s future development. The selection of indicators will affect the establishment of the final model. Therefore, this article will fully consider all aspects of the development of power grid companies and draw on the research experience of domestic and foreign experts and scholars to formulate the following basic principles for selecting indicators: Comprehensive principle, Systematic principle, Scientific principles, Guiding principles, The principle of balancing qualitative and quantitative.

2.2. Index system construction

This paper constructs a set of index evaluation system to fully reflect the characteristics and advantages of local power grid development and production and operation, and evaluate the future development potential and direction of the enterprises.

Table 1. Diagnosis and evaluation index system of power grid enterprise operation development and original statistics

| Serial number | Evaluation index unit | A   | B   | C   | D   | IS  | F   | G   | H   |
|---------------|-----------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| 1             | Capacity ratio        |     |     |     |     |     |     |     |     |
|               | Distribution transformer capacity per household |     |     |     |     |     |     |     |     |
| 2             | KVA / household       | 5.95| 7.27| 3.73| 4.95| 5.57| 3.68| 3.62| 5.41|
| 3             | Route N-1 pass rate % | 92.42| 100 | 98.3| 69.46| 67.46| 90.19| 85 | 86.8 |
| 4             | Main transformer N-1 pass rate % | 92.23| 100 | 100 | 100 | 100 | 92.86| 94.12| 100 |
| 5             | Operating life of main year | 6.75 | 5.21 | 8.91 | 8.6 | 7.93 | 7 | 5.49 | 5.89 |
### Table 1: Key Performance Indicators

|   | Indicator                                      | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 |
|---|------------------------------------------------|--------|--------|--------|--------|--------|--------|
|   | Line operating life                           | 9.74   | 10.42  | 9.22   | 9.44   | 10.81  | 6.47   |
| 6 | Power supply reliability rate                 | 99.91  | 99.91  | 99.98  | 99.89  | 99.9   | 99.93  |
| 7 | Power failure time                            | 3.31   | 3.69   | 3.8    | 2.2    | 3.71   | 4.61   |
| 8 | Comprehensive voltage qualification rate       | 99.96  | 99.98  | 99.97  | 99.93  | 99.95  | 99.97  |
| 9 | Total profit per unit of electricity sales     | 345.34 | 315.62 | 282.59 | 380.16 | 362.15 | 316.44 |
|10 | Overall labor productivity                     | 171.49 | 204.88 | 95.63  | 142.29 | 151.71 | 112.99 |
|11 | Unit investment increase power supply          | 1.66   | 2.4    | 1.04   | 1.02   | 1.14   | 1.7    |
|12 | Unit investment increase supply load           | 0.56   | 0.34   | 1.06   | 0.25   | 0.44   | 0.73   |
|13 | Casualties                                     | 0      | 0      | 0      | 0      | 0      | 0      |
|14 | 95598 service satisfaction rates               | 99.71  | 99.56  | 99.53  | 99.46  | 99.48  | 99.43  |

### 3. Construction of diagnostic evaluation model for power grid operation and development

#### 3.1. Combination weight calculation method

1. **Basic principles and steps of AHP**
   - The Analytic Hierarchy Process (AHP) firstly decomposes the decision-making problem in detail and divides it into different target levels, each of which represents an important part of the decision-making problem. Then, according to the rating criteria and evaluation specifications, combined with the method of solving the judgment matrix.

2. **Basic principles and steps of entropy method**
   - Generally speaking, if the information entropy of an indicator is smaller, it indicates that the degree of variation of the indicator’s value is greater, the more information provided, the greater the role it can play in the comprehensive evaluation, and the greater its weight. On the contrary, the larger the information entropy of an indicator, the smaller the degree of variation of the indicator’s value, the less the amount of information provided, the smaller the role it plays in the comprehensive evaluation, and the smaller its weight.

3. **Combination weight calculation process**
   - The comprehensive weight is the weighted average of the subjective and objective weights. The determination of the comprehensive weight can fully reflect the scientific nature of the indicator weight setting, to provide support to ensure the accuracy of decision-making.
3.2. Basic principles of TOPSIS theory

TOPSIS method is a multi-attribute decision-making method, which determines the comprehensive evaluation value of the evaluated object by calculating the relative distance between the index vector of each evaluation object and the positive ideal solution and the negative ideal solution. Sorting is based on the relative distance between the index vector of the evaluation object and the positive ideal solution and the negative ideal solution. If the evaluation object is close to the positive ideal solution and farthest away from the negative ideal solution, it is the best; otherwise, it is not optimal.

4. Empirical analysis

Selecting 8 county-level power supply enterprises under the power company in S area as the research objects, combined with statistical analysis of data, the following results are calculated.

Construct the original matrix p according to the above data table. Perform normalization and normalization of the original matrix to obtain the normalized data matrix L.

The comprehensive weight is calculated by the analytic hierarchy process and entropy weight method, and the following results are obtained:

| Serial number | Evaluation index                                      | Weights |
|---------------|------------------------------------------------------|---------|
| 1             | Capacity ratio                                       | 0.05    |
| 2             | Distribution transformer capacity per household       | 0.03    |
| 3             | Route N-1 pass rate                                  | 0.03    |
| 4             | Main transformer N-1 pass rate                       | 0.03    |
| 5             | Operating life of main (distribution) transformer     | 0.04    |
| 6             | Line operating life                                  | 0.06    |
| 7             | Power supply reliability rate                        | 0.08    |
| 8             | Power failure time                                   | 0.08    |
| 9             | Comprehensive voltage qualification rate             | 0.05    |
| 10            | Total profit per unit of electricity sales           | 0.15    |
| 11            | Overall labor productivity                           | 0.06    |
| 12            | Unit investment increase power supply                | 0.1     |
| 13            | Unit investment increase supply load                 | 0.1     |
| 14            | Casualties                                           | 0.08    |
| 15            | 95598 service satisfaction rates                     | 0.06    |

According to The above announcement to get the positive ideal distance and negative ideal distance as shown in the table below:

| company name | A       | B       | C       | D       | IS      | F       | G       | H       |
|--------------|---------|---------|---------|---------|---------|---------|---------|---------|
| Nyaya want to distance | 0.0173  | 0.0204  | 0.0205  | 0.0235  | 0.0215  | 0.0255  | 0.0252  | 0.0214  |
| Negative ideal distance | 0.0189  | 0.0214  | 0.0229  | 0.0233  | 0.0172  | 0.0158  | 0.0159  | 0.0228  |

Calculate the final evaluation result according to the relative proximity.
Table 4 Calculation of relative proximity

| project | A    | B    | C    | D    | IS   | F    | G    | H    |
|---------|------|------|------|------|------|------|------|------|
| Relative proximity | 0.5214 | 0.5124 | 0.5274 | 0.4975 | 0.4438 | 0.3814 | 0.3879 | 0.5166 |

According to the principle of the method, sort according to the values of proximity. Greater the degree of proximity values, more excellent the programs; smaller the degree of proximity values, the worse programs. The area with largest relative proximity value are the area with the best operating and development benefits. So area C is the area with the best management and development benefits.

5. Conclusion
In this paper, based on the combined weight TOPSIS theory, diagnostic evaluation model for grid operation and development is proposed. By assessment of power grid enterprises grid structure, the grid performance indicators, business indicators, assess the real status of each company's business and growth potential. Therefore, scientifically carrying out research on the status of the operation and development of power grid enterprises has positive guiding significance and practical value for improving the efficiency of power grid operation, optimizing resource allocation and improving the level of refined investment management.

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