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Analysis of Assessment of Power Grid Corp Asset Management Based on Set Pair Analysis Model

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Abstract:

The level of grid asset management should adapt to the reform with the change of Power Grid Corp's business environment and profit mode and profit pattern. Under the situation of state-owned assets reforming, Power Grid Corp, as an asset-intensive state-owned enterprise, needs a reasonable and scientific asset management method to reduce operating costs and improve management benefit. Based on the actual situation of the Power Grid Company, we improve the set pair analysis method by combining different weight methods. We use a power grid company as an example to verify the validity of set pair analysis in asset evaluation. Set pair analysis method has simple calculation, high data utilization rate, objective, direct, reliable and other advantages in asset evaluation. The improvement effect combined with the improved weight method is obvious, and the research is helpful to optimize the asset management, improve the operational efficiency of enterprises.

Keywords*: Set pair analysis, Asset management, Improved weight method.*

I. INTRODUCTION

The "13th Five-Year Plan" proposes supply-side structural reforms. Electricity is the basic industry for economic and social development. Electricity transformation and electrical market reform are two important measures to continue to deepen the energy supply side reform under the background of the "new era". Deepening reform is also an urgent need for state grid corporations to assume social responsibilities as a state-owned enterprise. The current "electricity reform" is constantly deepening in the direction of marketization. The current "electricity reform" market-oriented deepening. The marketization of electricity prices, as a solution, is of great significance to solving the problems of economic structural imbalance and the interests of all parties, caused by the distortion of electricity prices in the current structure of the domestic energy industry [1]. During the advancement of the "electricity reform" process, higher requirements are put on the asset management of power grid companies.

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State grid corporations are asset-intensive enterprises with numerous physical assets, which are the important resource for power production. The reform of "Three Intensifications and Five Systems" has promoted the intensive strategic transformation of state grid corporations. As the scale of assets continues to grow, the difficulty of managing physical assets has also increased. "Electricity Reform" proposes the reform of transmission and distribution prices. The electricity transmission and distribution of the state grid corporation is composed of permitted costs, permitted benefits, and permitted taxes. And the permitted costs and permitted benefits are closely related to the effective asset size. The formation of electricity prices in the future requires comprehensive consideration of all aspects, and the asset management of the state grid corporation plays an important role in verifying electricity prices [2]. Under the new situation, a scientific and effective method for evaluating the physical assets of the state grid corporation is of great significance for improving the company's physical asset management and allocation level, and enhancing economic benefits on the basis of ensuring the company's normal production and operation.

Efficient asset utilization can enhance the core competitiveness of the enterprise. The main work of the state grid corporation involves multiple links such as transformation, transmission, and distribution, whose physical assets are numerous and asset management is cumbersome and complicated. In the process of "electricity reform", asset management is an important basis for the revenue and cost accounting of the future state grid corporations, so the supporting and promoting role of asset management in terms of company operations has attracted the attention of many scholars and state grid corporations. Qi et al. [3] established an asset management evaluation standard system, proposed and optimized the principles of power grid asset management evaluation standards. Based on the new requirements of the country to deepen the reform and development of the power system, Zhou et al. [4], based on an in-depth analysis of the power grid companies' own technology and market characteristics, integrate the security management organically, efficiency management and full-cycle cost management in the asset management of the state grid corporation, summarizing and implementing new concepts and new methods of asset life cycle management. Roda I and Macchi M [5] suggested that asset management is carried out from the following two dimensions. One dimension is to start from the entire life cycle of the asset, including the beginning, middle and end of the life cycle; the other is to start from the asset management activity level, including the strategic layer, the tactical layer, and the operational layer. Liu et al. [6] put forward an evaluation index system for asset life cycle management suitable for power supply enterprises. Liu et al. [7] used grey correlation and ideal solutions to evaluate the comprehensive value of power grid companies. Summarizing the research results of many scholars, domestic physical asset comprehensive management evaluation has produced many research results, but most of them are static evaluations and lack dynamic research in recent years. Therefore, it is necessary to introduce dynamic evaluation into a comprehensive evaluation system of state grid physical assets and scientific comprehensive evaluation methods, which will help improve the risk management level and sustainable development ability of the state grid corporation.

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Combining the improved set pair analysis method and the three weighting methods, this paper uses the physical asset management data of a power grid company to conduct dynamic analysis and evaluation, establish an evaluation index system, and propose a new power grid company asset evaluation method, whose feasibility is verified through the analysis of calculation examples. And the best evaluation method is given to provide technical support for enterprise operation practice and government policy formulation.

II. EVALUATION METHOD

The evaluation of the management of physical assets of state grid companies is a problem with both certainty and uncertainty. Set pair analysis is a comprehensive deterministic analysis and uncertainty analysis to solve the analysis method of comprehensive integration problems [8]. That is, to the evolution of the concept of collection, quantitatively describe the evaluation target from three dimensions of identity, opposition, and difference, and give the evaluation result through the connection with the description level. Set pair analysis has the advantages of simple calculation, high data utilization, objective, direct and reliable results in asset evaluation.

Set pair analysis and fuzzy mathematics are closely related but clearly distinguished. Set pair analysis is equivalent to the problem of membership in fuzzy mathematics， which is the focus of fuzzy mathematics. On the one hand, the difference degree and the opposite degree in the set pair analysis are regarded as the perfection of the same degree, and the target is evaluated and the judgment level is determined. On the other hand, set pair analysis has accuracy problems in the evaluation of the three dimensions of similarity, difference and converse, and there are detailed differences in each evaluation level. In order to improve the accuracy of the analysis, the following improvements are made:

First, establish the evaluation grade standard $L_d = \{l_{d1}, l_{d2}, \ldots, l_{dn}\}$ of each index, d represents the index level division, and each index data $X_y = \{x_{y1}, x_{y2}, \ldots, x_{yn}\}$ each year, y means the year, and constitute each basic unit of the set pair analysis. The formula for calculating the degree of connection is further improved:

$$\mu = a + bi + cj \tag{1}$$

Improved to

$$\mu = a + (b_1 + b_2)\, i + (c_1 + c_2)\, j \tag{2}$$

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Improve the method through accurate values. Taking the improved three-level index connection degree calculation as an example, the calculation formulas of cost index and economic index are shown in formulas (3) and (4) respectively.

$$\mu_3\left(l_{3k},x_{yk}\right)=\begin{cases}\dfrac{l_{3k}-l_{2k}}{l_{3k}-x_{yk}}+\dfrac{l_{2k}-l_{1k}}{l_{3k}-x_{yk}}i^{+}+\dfrac{l_{1k}-x_{yk}}{l_{3k}-x_{yk}}j^{+},[0,l_{1k}) \\ \dfrac{l_{3k}-l_{2k}}{l_{3k}-x_{yk}}+\dfrac{l_{2k}-x_{yk}}{l_{3k}-x_{yk}}i^{+},[l_{1k},l_{2k}) \\ 1,[l_{2k},l_{3k}) \\ \dfrac{l_{3k}-l_{2k}}{x_{yk}-l_{2k}}+\dfrac{x_{yk}-l_{3k}}{x_{yk}-l_{2k}}i^{-},[l_{3k},l_{4k}) \\ \dfrac{l_{3k}-l_{2k}}{x_{yk}-l_{2k}}+\dfrac{l_{4k}-l_{3k}}{x_{yk}-l_{2k}}i^{-}+\dfrac{x_{yk}-l_{4k}}{x_{yk}-l_{2k}}j^{-},[l_{4k},+\infty)\end{cases} \tag{3}$$

$$\mu_3\left(l_{3k},x_{yk}\right)=\begin{cases}\dfrac{l_{3k}-l_{2k}}{l_{3k}-x_{yk}}+\dfrac{l_{2k}-l_{1k}}{l_{3k}-x_{yk}}i^{-}+\dfrac{l_{1k}-x_{yk}}{l_{3k}-x_{yk}}j^{-},[0,l_{1k}) \\ \dfrac{l_{3k}-l_{2k}}{l_{3k}-x_{yk}}+\dfrac{l_{2k}-x_{yk}}{l_{3k}-x_{yk}}i^{-},[l_{1k},l_{2k}) \\ 1,[l_{2k},l_{3k}) \\ \dfrac{l_{3k}-l_{2k}}{x_{yk}-l_{2k}}+\dfrac{x_{yk}-l_{3k}}{x_{yk}-l_{2k}}i^{+},[l_{3k},l_{4k}) \\ \dfrac{l_{3k}-l_{2k}}{x_{yk}-l_{2k}}+\dfrac{l_{4k}-l_{3k}}{x_{yk}-l_{2k}}i^{+}+\dfrac{x_{yk}-l_{4k}}{x_{yk}-l_{2k}}j^{+},[l_{4k},+\infty)\end{cases} \tag{4}$$

In addition to improving the connection degree, the conventional set pair analysis method judges the average value of the connection degree of each index without considering the different degree of influence of different indexes on the whole. This adopts a weighted average fuzzy operator and operates according to the ordinary matrix algorithm to improve the limitations of the previous average calculation. According to the weight of different indicators, all indicators are balanced, and the weight, each indicator, and the degree of membership of the criterion layer are comprehensively considered. In this way, all the information of the evaluation system is displayed reasonably. Normalized weights are used in the process, and there is no upper limit on the degree of contact. The introduction of the weighting algorithm preserves the original information of the data to the greatest extent.

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III. IMPROVEMENT WEIGHT

The weight represents the importance of the influence of each indicator in the system on the overall evaluation level. Based on the analytic hierarchy process and the entropy method, the weight calculation method is improved.

The analytic hierarchy process is a commonly used research method in the multi-objective decision-making evaluation model [9], which aims to simulate the thinking method of artificially solving complex decisions. It is expressed in a mathematical way and then quantitatively solves the problem of multi-objective decision-making evaluation by quantifying various levels of indicators. The basic idea is to decompose complex problems into a progressive hierarchical structure, and then judge the relative importance of each two indicators separately according to the established ratio scale, and obtain a judgment matrix. After passing the consistency check, the index weights of each level are calculated, and then the weights of the total evaluation system are obtained. However, this progressive formula only considers the dominance of the lower-level indicators between the upper and lower levels, and the indicators at the same level are ideally considered to be independent of each other. This simplifies the calculation, but it is always limited, and the judgment matrix contains the interference of human factors, which affects the accuracy of the decision-making plan. Carry out a systematic analysis of the evaluation system established, and adopt an expert scoring system to carry out qualitative evaluation and quantitative analysis of each index, including the criterion level and the index level.

The entropy weight method is used in the multi-objective decision-making evaluation model. It is an objective weighting method [10]. After the original data of each indicator is collected, the entropy value can be obtained according to the distribution of the data of each indicator. The entropy value represents the relative fierce competition of each index, and the weight of each index is determined according to the entropy value, which can objectively reflect the information contained in the original data and improve the accuracy of comprehensive evaluation. The entropy method reflects the relationship between objective data. But when the original statistical data is limited or out of real-time, the weights reflected are inaccurate. If the original data of a relatively unimportant indicator differs greatly due to special reasons, it will get a larger weight. Similarly, if the difference in the original data of an important indicator is small, the weight will be too small.

Synthesize the limitations and respective characteristics of the two methods, and determine the index weight through subjective and objective combination. The improved weighting method comprehensively considers the combination of subjective judgment at the criterion level and objective data, and also considers the relative importance of each index at the index level under different criteria, and finally ensures the rationality of the weight assignment.

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3.1 Improved Entropy Method

(1) According to the established evaluation system, quantitatively obtain the evaluation index matrix X' of each index.

$$X' = \begin{bmatrix} x'_{11} & x'_{12} & \cdots & x'_{1n} \\ x'_{21} & x'_{22} & \cdots & \\ \vdots & \vdots & & \vdots \\ x'_{m1} & x'_{m2} & \cdots & x'_{mn} \end{bmatrix} \tag{5}$$

(2) Considering that each index unit is different, and there are cost-type and economic-type index data, it is difficult to directly use and compare, so it is necessary to process the index data to obtain the improved matrix X.

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & \\ \vdots & \vdots & & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \tag{6}$$

Among them, the cost-type and economic-type index data are processed as follows:

$$\begin{cases} x_{ij} = \dfrac{x'_{\max,j} - x'_{ij}}{x'_{\max,j} - x'_{\min,j}} \\ x_{ij} = \dfrac{x'_{ij} - x'_{\min,j}}{x'_{\max,j} - x'_{\min,j}} \end{cases} \tag{7}$$

In the formula, x'max,j and x'min,j are the maximum and minimum values of the j-th index of the evaluation object, x'ij is the original value of the i-th index of the evaluation object, and xij is the standard value after processing.

(3) Obtain the characteristic proportion of the evaluation index, taking into account that part of the data is negative, and avoiding excessive entropy of some indexes and inaccurate weights, transform through the power coefficient transformation method, and then add 1 to the obtained data.

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$$r_{ij}=\frac{1+x_{ij}}{\sum_{i=1}^{m}1+x_{ij}},(i=1,2,\cdots,m,\ j=1,2,\cdots,n). \tag{8}$$

(4) Obtain the index entropy of the index

$$E_j=-\frac{\sum_{i=1}^{m}r_{ij}\ln r_{ij}}{\ln m} \tag{9}$$

(5) Get its index weight finally

$$w_j^{'}=\frac{1-E_j}{\sum_{j=1}^{n}1-E_j} \tag{10}$$

3.2 Improve the Solution Method of Comprehensive Weight

Suppose the system has a criterion layer and b index layer. The weight distribution of the criterion layer and the weight distribution $S=\{s_1, s_2, \ldots, s_b\}$ of the index layer are obtained by the $R=\{r_1, r_2, \ldots, r_b\}$ analytic hierarchy process, and the weight distribution obtained by the improved entropy weight method is $E=\{e_1, e_2, \ldots, e_b\}$.

Combining the right S and the right E, we get

$$C=\{c_1,c_2,\cdots,c_b\},\quad c_i=\frac{s_ie_i}{\sum_{i=1}^{b}s_ie_i} \tag{11}$$

Normalize the indicator layer under each criterion layer

$$\begin{cases} S_i=\left\{s_1^{'},s_2^{'},\cdots s_n^{'}\right\} \\ s_i^{'}=\dfrac{c_{ij}}{\sum_{j=1}^{k}c_{ij}},k=n_1,n_2,\cdots,n_a,i=1,2,\cdots,a. \end{cases} \tag{12}$$

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Article History: Received: 22 July 2021 Revised: 16 August 2021 Accepted: 05 September 2021 Publication: 31 October 2021

The weight distribution of the criterion layer weight distribution R is combined and normalized to obtain the weight distribution S_i

$$Q' = \left\{q'_{11}, q'_{12}, \cdots, q'_{an_a}\right\}, q'_{ij} = r_i s'_i \tag{13}$$

Re-form Q' into $Q' = \left\{q'_1, q'_2, \cdots, q'_b\right\}$, and then normalize it to:

$$\begin{cases} Q = \{q_1, q_2, \cdots, q_b\} \\ q_i = \dfrac{q_i}{\sum_{i=1}^{b} q_i} \quad ,i=1,2,\cdots b \end{cases} \tag{14}$$

IV. COMMENT CONTENT

On the basis of existing asset management related research [11, 12], this article combines the characteristics of power grid physical asset management to form an "investment-operation-maintenance" system perspective. Then combined with the connotation of asset life-cycle management, it is concluded that asset management evaluation should include five aspects: scale structure, health level, utilization efficiency, and retirement. Starting from the scientific, hierarchical, systematic, and data availability requirements of the construction of the evaluation index system, the establishment of a "criteria layer-indicator layer" evaluation framework is shown in Figure 1.

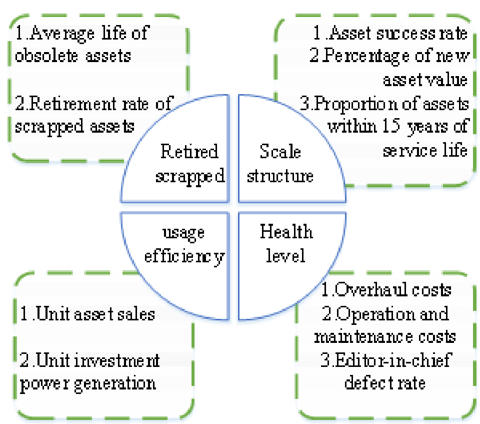

Fig 1: Asset management evaluation system

(1) Scale structure. The net asset value ratio, which is the ratio of the total net value of physical

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assets to the original value of total assets at the end of the year, represents the overall average growth rate of the company's assets at the value level. An important reference. The proportion of the value of new assets, the ratio of the value of new assets that year to the average asset value of the enterprise reflects the value structure of the company's assets, and is a cost-based indicator. The proportion of assets within 15 years of service age, that is, the proportion of the original value of assets within 15 years of service age, reflects the healthy level of the age structure of corporate assets, and is an economic indicator.

(2) Health level. The main transformer undertakes the main tasks of power transmission and distribution, which starts from the availability of statistical data and selects the defect rate of the main variable as the evaluation index of the health level. The main transformer defect rate is the ratio of the number of defective equipment in the main transformer to the total number of main transformers, which reflects the overall health of the main transformer.

(3) Utilization efficiency. The electricity sales per unit of assets is the calculation of the electricity sales of grid assets per unit value, which reflects the overall asset utilization efficiency of the enterprise. The increase/decrease of unit investment electricity represents the ratio of the new electricity sales each year (which can be negative) to the value of the new physical assets each year, reflecting the impact of the power grid company on the operating efficiency of the new physical assets that year.

(4) Retirement. The average life of scrapped assets is the ratio of the total actual service life of scrapped assets to the number of scrapped assets each year. This indicator mainly includes transmission lines, substation equipment, and distribution lines and equipment. These, as the main physical asset tools for the normal production and operation of power grid companies, reflect the company's scrap asset management situation. The retiring rate of scrapped assets is the ratio of the total net value of retired and retired assets in the current period to its total original value. It is a cost-based data indicator, that is, the higher the retiring rate of scrapped assets in the current period, the lower the asset utilization rate.

V. EXAMPLE ANALYSIS

This paper takes the five-year physical asset management status of a power grid company as an example to study, select its asset management status from 2013 to 2017, compare the evaluation results obtained by the analytic hierarchy process and the entropy weight method, and verify the effectiveness of the improved evaluation method.

The third part establishes a comprehensive evaluation index system with the help of analytic hierarchy process. The judgment matrix is obtained by consulting 6 experts and scoring each indicator. Then perform the following consistency test: when $CR<0.1$, the results of the questionnaire are within

Forest Chemicals Review
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ISSN: 1520-0191
September-October 2021 Page No. 1119-1132
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the allowable degree of inconsistency. At this time, the eigenvector of the scoring result matrix can be used as the weight vector to obtain the weight of the index.

TABLE I. Expert scoring results

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Expert 1	0.070	0.011	0.019	0.078	0.155	0.311	0.075	0.226	0.018	0.037
Expert 2	0.364	0.060	0.148	0.037	0.005	0.012	0.084	0.017	0.219	0.055
Expert 3	0.075	0.011	0.029	0.026	0.074	0.139	0.444	0.148	0.043	0.011
Expert 4	0.047	0.047	0.016	0.061	0.149	0.368	0.052	0.206	0.045	0.009
Expert 5	0.066	0.007	0.017	0.169	0.056	0.056	0.144	0.433	0.045	0.006
Expert 6	0.084	0.018	0.032	0.021	0.071	0.177	0.397	0.132	0.059	0.010

Therefore, according to the expert score, the weight of each indicator is S, and the weight distribution of the criterion layer is R:

$$S = [0.118, 0.026, 0.044, 0.065, 0.085, 0.177, 0.199, 0.194, 0.072, 0.021]$$
$$R = [0.187, 0.328, 0.393, 0.093]$$

The entropy method gives the weight of the index to be:

$$E = [0.259, 0.069, 0.083, 0.073, 0.074, 0.094, 0.102, 0.066, 0.099, 0.081]$$

Through the improved comprehensive weight solution method, the final weight of each index is obtained as:

$$Q = [0.159, 0.009, 0.019, 0.056, 0.074, 0.197, 0.241, 0.152, 0.075, 0.018]$$

TABLE II. Asset management index classification

Grade	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
I	48%	10	95	38000	140000	0.5%	44000	9000	15	15
II	46%	13	94	40000	150000	0.6%	42000	3000	14	20
III	43%	20	93	50000	180000	1.2%	39000	-3000	13	25
IV	40%	30	88	60000	210000	2.4%	36000	-9000	12	35
V	37%	40	83	80000	240000	3.6%	33000	-15000	11	50

Select the relevant asset management data collected by the power grid company, and establish the evaluation levels I to V for each index based on TABLE II, with I being the relatively optimal level.

Forest Chemicals Review
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Calculate the connection degree matrix of each index of asset management status each year. Here only the results of the connection degree in 2017 are listed here.

$$R_{2017} = \begin{bmatrix} 0.256+0.384i^- +0.360j^- & 0.516+0.484i^- & 1 & 0.940+0.060i^+ & 0.921+0.075i^+ +0.004j^+ \\ 0.741+0.222i^- +0.037j^- & 0.857+0.143i^- & 1 & 0.606+0.394i^+ & 0.377+0.377i^+ +0.246j^+ \\ 0.146+0.146i^- +0.708j^- & 0.171+0.829i^- & 1 & 0.969+0.031i^+ & 0.941+0.057i^+ +0.002j^+ \\ 0.632+0.033i^- +0.335j^- & 0.090+0.451i^- +0.459j^- & 0.496+0.496i^- +0.008j^- & 0.984+0.016i^- & 1 \\ 0.916+0.065i^- +0.019j^- & 0.776+0.224i^- & 1 & 0.525+0.475i^+ & 0.344+0.344i^+ +0.312j^+ \\ 0.806+0.161i^- +0.033j^- & 0.833+0.167i^- & 1 & 0.674+0.326i^+ & 0.403+0.403i^+ +0.194j^+ \\ 0.223+0.334i^- +0.443j^- & 0.430+0.430i^- +0.140i^- & 0.754+0.246i^- & 1 & 0.942+0.058i^+ \\ 0.438+0.438i^- +0.124j^- & 0.781+0.219i^- & 1 & 0.582+0.418i^+ & 0.327+0.392i^+ +0.281j^+ \\ 0.935+0.065i^- & 1 & 0.518+0.482i^+ & 0.341+0.341i^+ +0.318j^+ & 0.790+0.072i^+ +0.138j^+ \\ 0.883+0.117i^- & 1 & 0.624+0.376i^+ & 0.555+0.278i^+ +0.167i^+ & 0.454+0.303i^+ +0.243j^+ \end{bmatrix}$$

The connection degree characterizes the amount of the degree to which the evaluation index is biased toward the level of superiority. The connection degree matrix of each index is embodied as the degree of equivalence that tends to each evaluation level, using MATLAB software to program and perform composite operations (where "。" is a fuzzy operator, see Equation 15). C1, C2, and C3 are the combined results of the 2017 analytic hierarchy process, entropy weight method and improved weight method respectively.

$$C = W \circ R_{2017} = [\sum_{i=1}^{n} w_n \circ c_{im} + \sum_{i=1}^{n} w_n \circ b_{1,im} i^- + \sum_{i=1}^{n} w_n \circ b_{2,i} i^+ + \sum_{i=1}^{n} w_n \circ c_{1,im} j^- + \sum_{i=1}^{n} w_n \circ c_{2,im} j^+] \tag{15}$$

$$C_1 = [0.533 + 0.249i^- + 0.219j^-, 0.640 + 0.303i^- + 0.058j^-, 0.877 + 0.081i^- + 0.043j^- + 0.001j^+, 0.745+0.229i^+ +0.026j^+, 0.643+0.012i^- +0.209i^+ +0.137j^+]$$

$$C_2 = [0.535+0.222i^- +0.243j^-, 0.625+0.328i^- +0.478j^-, 0.860+0.061i^- +0.078i^+ +0.001j^-, 0.759+0.196i^+ +0.045j^+, 0.712+0.006i^- +0.171i^+ +0.111j^+]$$

$$C_3 = [0.518+0.254i^- +0.227j^-, 0.635+0.306i^- +0.059j^-, 0.870+0.087i^- +0.043i^+, 0.765 + 0.208i^+ + 0.027j^+, 0.673 + 0.014i^- + 0.192i^+ + 0.122j^+]$$

Calculating the five-level set pairing based on the 2017 data, the probability distributions of the asset management status for the first to fifth levels in 2017 are 1.82%, 8.61%, 62.51%, 22.65%, and 4.10%, respectively. In terms of the established asset evaluation level, the evaluation result in 2017 was Level III. In the same way, the 2013-2016 data are processed, TABLE Ⅳ.

Forest Chemicals Review
www.forestchemicalsreview.com
ISSN: 1520-0191
September-October 2021 Page No. 1119-1132
Article History: Received: 22 July 2021 Revised: 16 August 2021 Accepted: 05 September 2021 Publication: 31 October 2021

TABLE III. Evaluation result of connection degree

	Shi(L1)	Shi(L2)	Shi(L3)	Shi(L4)	Shi(L5)	Evaluation grade
2017	2.282	10.763	78.181	28.330	5.516	III
2016	2.527	40.435	93.210	56.230	5.322	III
2015	2.433	7.133	139.670	49.610	11.134	III
2014	2.699	2.880	7.425	2.910	5.836	III
2013	3.284	2.434	2.100	1.888	4.084	V

TABLE IV. Comparison of evaluation results

	Analytic Hierarchy Process	Entropy method	Improved synthesis method
2017	IV	III	III
2016	III	III	III
2015	III	IV	III
2014	III	III	III
2013	V	V	V

Analyze the evaluation results obtained in TABLE III and TABLE IV:

(1) Through the analysis of the evaluation results, compared with the analytic hierarchy process and the entropy method, the results of the improved set pair analysis in 2013, 2014 and 2016 are basically the same, but the results in 2015 and 2017 have improved, which shows that improvements can effectively optimize the evaluation results. At the same time, compared with the improved set pair analysis combined with the analytic hierarchy process and the entropy weight method, it also verifies the feasibility of the improved set pair analysis evaluation method.

(2) In 2017, the comprehensive evaluation was level III, and the weight obtained by the analytic hierarchy process was the level IV evaluation result. Seven of the 10 evaluation indicators analyzed in that year were level IV. Based on the actual conditions of each indicator, the six indicators belong to the three-level evaluation standard, and the objective evaluation weight obtained by the entropy weight method is also the third level. Therefore, the improved comprehensive method in this paper is more reasonable for the company's asset management evaluation. The 2015 evaluation result is three levels, which is consistent with the results of the analytic hierarchy process, and the objective evaluation result of the entropy method is four levels. Analyzing the indicators of the year, the five indicators are distributed above the second level, and the evaluation results of the improved method are more

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reasonable. In summary, the improved method has a certain degree of improvement compared to the previous two methods.

(3) The results of the dynamic analysis of the company's asset management status showed that the situation in 2013 was not optimistic, and there was a relative improvement in the following four years, but the evaluation results were not very good. Among them, in 2017, the asset retirement and decommissioning criteria level was greatly improved; in 2016, the asset value scale criteria level was relatively increased, and other aspects were improved to a certain extent. However, the asset management status in the past four years has not improved much, and the evaluation results are all three levels. The state grid corporation should strengthen all aspects of asset management.

VI. SUMMARY AND OUTLOOK

This paper proposes to apply the improved set pair analysis method to the asset management evaluation method, combining qualitative and quantitative, subjective and objective improvement weights, and analyze the calculation examples on the given evaluation index system. The results are compared and analyzed to get an improved evaluation effect, which verifies the effectiveness and practicability of the evaluation method, provides support for the asset management evaluation work of state grid corporations, and is worthy of popularization and application.

In terms of the importance of the weight analysis to the overall comprehensive evaluation, subjective analysis and objective analysis are utilization efficiency and scale structure, respectively, and utilization efficiency is the most important in improving analysis methods. According to the analysis of the calculation example, the improved evaluation method is perfect for the aforementioned single weight gain. The improved evaluation method is more in line with the actual situation for the evaluation of the assets of the power grid company. On the basis of traditional set pair analysis, this method improves the analysis of the two dimensions of opposition and difference, which is more accurate and scientific, but limited to the availability of data, the selection of evaluation system indicators needs to be further refined.

In the process of "electricity reform", the asset management of state grid corporations is very important, and it is closely related to the approval of power supply and distribution prices and the vital interests of power companies. In view of the current problems in the evaluation of physical assets of the power grid, it is necessary to conduct in-depth research on two aspects in the follow-up. On the one hand, the relationship between indicators needs to be studied in depth with the help of other disciplines to confirm the relationship qualitatively and quantitatively to form a systematic and complete indicator system. On the other hand, in the case of horizontal comparison, different power companies take into account factors such as regions, economic development, and lagging development, and the evaluation system and indicator calculation standards have certain limitations.

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REFERENCES

[1] Yiyuan Ding. Impact of Transmission and Distribution Price Reform on Assets and Management of Power Grid Enterprises. Institute of Management Science and Industrial Engineering.Proceedings of 2019 9th International Conference on Social Science and Education Research (SSER 2019). Institute of Management Science and Industrial Engineering: International Society of Computer Science and Electronic Technology (Computer Science and Electronic Technology International Society), 2019:6.
[2] Ronghua Wang, Ying Du, Quanfeng Gou, Jie Yang, Wouwei You, Dongwei Li. Investment efficiency and benefit evaluation of provincial power grid planning considering the reform of transmission and distribution prices. Electric Power Construction, 2020, 41(11): 135- 144.
[3] Lizhong Qi, Huafeng Qi, Yinghua Chen. Construction and optimization of power grid asset management evaluation standard system. Standard Science, 2018(03): 114-119.
[4] Pin Zhou, Weiwei Tao. Research on the Implementation of Asset Life Cycle Management in Power Grid Enterprises. Journal of Science & Technology Economics, 2019, 27(11): 189-190.
[5] Roda, I. & Macchi, M. Studying the funding principles for integrating Asset Management in Operations: an empirical research in production companies. IFAC-PapersOnline, 2016, 49(28): 1-6
[6] Zhongchao Liu, Zihai Hu. Building an index system based on asset life cycle management. China Equipment Engineering, 2018(03): 41-42.
[7] Lu Liu, Hongzhi Liu. Comprehensive value evaluation of power grid physical assets based on grey correlation and TOPSIS model. Shandong Electric Power Technology, 2018, 45(01): 8-13.
[8] Keqin Zhao, Aili Xuan. Set Pair Theory——A New Method and Application of Uncertainty Theory. Systems Engineering, 1996, 14(1):18-23, 72.
[9] Li Lei et al. Evaluation Model of Cable Insulation Life Based on Improved Fuzzy Analytic Hierarchy Process. Mathematical Problems in Engineering, 2021, 2021.
[10] Danlong Zhu, Guohui Fu, Bo Wei, Fuquan Li, Mingrui Zhao, Yajing Gao. Research on Benchmarking Model of Power Grid Infrastructure Management Based on Entropy Weight Method. Science and Engineering Research Center.Proceedings of 2019 International Conference on Modeling, Simulation, Optimization and Numerical Techniques(SMONT 2019).Science and Engineering Research Center:Science and Engineering Research Center, 2019:3.
[11] Peidong Li, Menglin Hong, Sang Shang. Grid physical assets evaluation index system. Electric Power Construction, 2014, 35(08): 145-150.
[12] Yihang.Song, Yuan Leng, Qiang Fu. Research on Transmission and Distribution Price Reform and Financial Operation Linkage Transmission Mechanism. Contemporary Economics, 2016(27):122-123.