Optimization Technology of Grid Transportation and Inspection Cost of Distribution Network Considering Complex Influence Factors

Xiaoyong Yang[1], Xiaoyan Yu[1](✉), Min Yu[1], Fuyan Liu[1], Hongzhi Hao[2], and Feng Wu[2]

[1] Economic and Technological Research Institute, State Grid Zhejiang Power Co. Ltd., Zhejiang 310000 Hangzhou, China
yuxy1209@163.com

[2] Zhejiang Dingsheng Construction Project Management Co., Ltd., Zhejiang 321017 Jinhua, China
{haohongzhi,wufeng}@cnzjds.com

Abstract. In this paper, combined with the construction of grid portraits, considering the differences between grids, and by sorting out the influencing factors of grid operation and maintenance costs, such as geographical location, operating environment, load density, economic level, safety and stability, a combined weight-based method is proposed. The cost optimization adjustment model corrects the grid operation and maintenance cost, realizes the fine evaluation and dynamic improvement of the operation and inspection standard cost level, and meets the needs of power grid operation management and cost refinement development under the new situation.

Keywords: Transportation And Inspection Cost · Combination Weight · Complex Elements · Optimization Technology

1 Introduction

In recent years, there has been rich research on grid planning and standard cost application in power grid enterprises. Based on the differentiation and classification of various functional areas. Document [1] puts forward improvement goals from multiple dimensions, and realizes accurate investment and project lean management of distribution network through grid decomposition and optimizing projects. Document [2] uses multi-grid technology and VAR model to establish a set of power grid engineering cost data information analysis methods. Document [3] systematically summarizes the best practices in the construction of standard cost system of power grid enterprises, in order to provide reference for other enterprises to carry out cost lean management. Document [5] proposes an algorithm for the differential allocation of job standard costs based on the decision-making and evaluation laboratory method and the combined weighting method, and realizes the differential allocation of job standard costs based on actual data. Document [4] divides the distribution network into multiple power supply grids to improve

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Table 1. Diagnosis and evaluation index system for the operation and development of power grid enterprises.

Order number	Level 1 indicators	Secondary indicators	Unit
1	geographic position	above sea level	rice
2	Java runtime environment Java	Equipment input life	year
3		mean temperature of air	degree Celsius
4	load density	load density	Mg / s2
5	Economic level	area GDP	100 million
6		Sales of electricity	Ten thousand kilowatt-hours
7	Security and stability	Average user fault outage time	hour
8		Equipment load rate	%

the granularity, and uses standard wiring to directly and independently supply power to each grid, thereby improving the fineness of distribution network planning and improving planning. Business synergy between management and project management, operation and maintenance management, and business expansion and access management.

To sum up, the current grid planning and the standard cost system construction and application research is rich, can provide some reference for the overall research ideas of this paper, but combined with the standard cost, so this paper has some innovation and necessity, can realize the scientific optimization of the standard cost system, and provide reference for the transportation cost system.

2 Identification of the Cost Influencing Factors of the Grid Transport and Inspection Standards

This paper identifies the influencing factors from five aspects: geographical location, operating environment, load density, economic level, and safety and stability, and constructs a set of influencing factors, as shown in Table 1.

3 Standard Cost Optimization and Adjusment Model

3.1 Model Construction Ideas

The operation cost of the standard inspection is affected by many factors. Building the standard cost parameter adjustment model to realize the standard cost calculation under the condition of related factors is helpful to improve the efficient and refined management level of the standard cost of power grid enterprises. The specific idea is shown in Fig. 1.

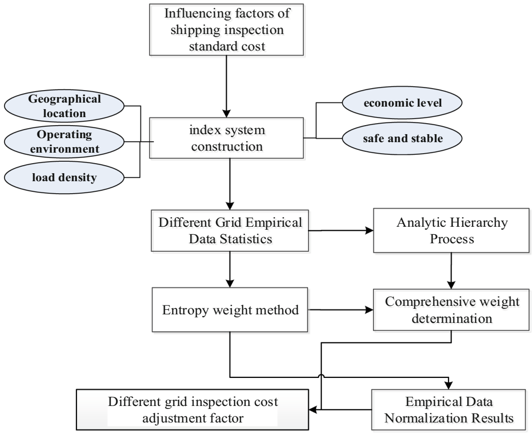

Fig. 1. Model flow chart.

3.2 Calculation Method of Combined Weight

(1) Basic principles and steps of hierarchical analysis method.

The main principles of Analytic Hierarchy Process (AHP) are as follows:

First, construct pairwise comparison judgment matrix is constructed on importance scaling theory A:

$$A = \left(a_{ij}\right)_{n \times n} (i, j = 1, 2, \cdots, n) \tag{1}$$

The judgment matrix A is then normalized, and the calculation formula is:

$$\overline{a}_{ij} = a_{ij} / \sum_{k=1}^{n} a_{kj} \, (i, j = 1, 2, \cdots, n) \tag{2}$$

The calculation formula of the weights is:

$$w_i = \overline{w}_i / \sum_{i=1}^{n} \overline{w}_i \, (i = 1, 2, \cdots, n) \tag{3}$$

Finally, judge the consistency, if through the consistency test, the results are valid.Do not to adjust the results.

(2) Basic principles and steps of entropy weight Method.

The calculation steps of the entropy weight method are as follows:

1) Set n evaluation indicators to evaluate m plans to be selected.
   x_{ik}: Estimation of the evaluation index i of the option k to be selected. x_i^*: The ideal value of the evaluation index i. The value of x_i^* varies depending on the characteristics of the evaluation indicators. For profit indicators, the larger x_i^* is, the better; for loss indicators (inverse indicators), the smaller x_i^* is, the better (it can also be converted to a positive indicator first).

2) Define the proximity D_{ik} of x_{ik} to x_i^*:

$$D_{ik} = \begin{cases} \frac{x_{ik}}{x_i^*} & x_i^* = \max\{x_{ik}\} \\ \frac{x_{ik}}{x_i^*} & x_i^* = \min\{x_{ik}\} \end{cases} \tag{4}$$

3) D_{ik} normalization processing:

$$d_{ik} = D_{ik} \Bigg/ \sqrt{\sum_{i=1}^{n} \sum_{k=1}^{m} D_{ik}^2} \tag{5}$$

4) Overall entropy: The entropy E of the m unselected schemes is evaluated with n evaluation indexes is:

$$E = -\sum_{i=1}^{n} \sum_{k=1}^{m} d_{ik} \ln d_{ik} \tag{6}$$

5) Overall entropy when the index is independent of the scheme:
If the relative importance of the evaluation index is irrelevant to the scheme to be selected, the entropy is calculated by the following formula:

$$E = -\sum_{i=1}^{n} d_{ik} \ln d_i \tag{7}$$

In formula:

$$d_i = \sum_{k=1}^{n} d_{ik} \tag{8}$$

In this way, the uncertainty of the relative importance of the evaluation index I to the selection scheme decision evaluation can be determined by the following conditional entropy.

6) Conditional entropy of the evaluation index i

$$E_i = -\sum_{k=1}^{m} \frac{d_{ik}}{d_i} \ln \frac{d_{ik}}{d_i}$$

From the extreme value of entropy, $\frac{d_{ik}}{d_i}$(k = 1 ~ m), namely $d_{i1} \approx d_{i2} \approx ... \approx d_{ik}$, the closer the equality, the greater the conditional entropy, and the greater the uncertainty that the evaluation index treats the evaluation decision.

7) We can normalize the above formula to obtain the entropy value of the importance of the evaluation decision for characterizing the evaluation index i.

$$e(d_i) = -\frac{1}{\ln m} \sum_{k=1}^{m} \frac{d_{ik}}{d_i} \ln \frac{d_{ik}}{d_i} \tag{9}$$

8) Combination of the weight calculation process.
This paper adopts the method of combining entropy weight method and hierarchical analysis method to determine the weight of each index. The comprehensive weight is the weighted average of the objective weight. The determination of the comprehensive weight can fully reflect the scientific nature of the index weight setting and provide support for the accuracy of decision-making.

4 Empirical Analysis

According to the construction results of the index system, 8 grids from different regions are selected as empirical analysis objects, so as to make scientific and reasonable adjustment and optimization for the standard cost system of transportation and inspection. The original data are shown as follows.

The comprehensive weight is calculated by hierarchical analysis method and entropy weight method to obtain the following results:

Combined with the above methods, the comprehensive state level of operation and maintenance cost in different regions is obtained. The specific results are shown in the table below.

Based on the identification of multi-attribute elements, the adjustment coefficient calculation model is constructed, and the adjustment coefficient of different grids is obtained through the change of the main factors, so as to realize the dynamic adjustment and optimization of the maintenance standard cost.

Table 2. Original Statistics Table.

Order number	Evaluation index index	Unit	A	B	C	D	E	F	G	H
1	above sea level	rice	257	198	298	283	234	187	165	150
2	Equipment input life	year	9.8	7.2	8.3	10.2	7.9	8.8	8.6	7.7
3	mean temperature of air	degree Celsius	18.9	20.3	21.5	18.4	19.9	20.6	17.4	16.8
4	load density	Mg / s2	0.60	0.59	0.60	0.45	0.51	0.46	0.56	0.58
5	area GDP	100 million	10.23	12.99	9.13	10.96	12.86	10.76	12.15	13.91
6	Sales of electricity	Ten thousand kilowatt-hours	325.3	487.7	345.2	382.8	411.8	441.8	503.2	392.7
7	Average user fault outage time	hour	3.5	3.9	4.2	3.8	3.9	5.1	4.6	3.4
8	Equipment load rate	%	25.4	26.6	27.2	19.6	21.7	22.9	31.1	24.8

Table 3. Comprehensive weight calculation results.

Order number	Evaluation index index	Objective, weight	Subjective weight	Comprehensive weight
1	above sea level	0.34	0.04	0.13
2	Equipment input life	0.08	0.18	0.15
3	mean temperature of air	0.04	0.08	0.07
4	load density	0.08	0.12	0.11
5	area GDP	0.11	0.12	0.12
6	Sales of electricity	0.13	0.16	0.15
7	Average user fault outage time	0.11	0.12	0.11
8	Equipment load rate	0.11	0.18	0.16

Table 4. Calculation Results Table.

Area	Above sea level	Equipment input life	Mean temperature of air	Load density	area GDP	Sales of electricity	Average user fault outage time	Equipment load rate	Adjustment coefficient
A	0.11	0.14	0.06	0.11	0.09	0.10	0.08	0.13	1.00
B	0.09	0.11	0.07	0.11	0.11	0.15	0.08	0.14	1.03
C	0.13	0.12	0.07	0.11	0.08	0.10	0.09	0.14	1.03
D	0.12	0.15	0.06	0.08	0.09	0.11	0.08	0.10	0.98
E	0.10	0.12	0.06	0.09	0.11	0.12	0.08	0.11	0.98
F	0.08	0.13	0.07	0.08	0.09	0.13	0.11	0.12	0.99
G	0.07	0.13	0.06	0.10	0.10	0.15	0.10	0.16	1.06
H	0.07	0.11	0.05	0.11	0.12	0.12	0.07	0.13	0.94

5 Conclusion

This paper combines the characteristics of grid multi-attribute identification and transportation cost input, identifies the influence factors affecting the transportation cost from different aspects, and combines the relevant concepts of combination weight, and determines the standard cost adjustment parameters considering the impact of comprehensive factors according to the evaluation results. Combined with empirical analysis, verifying the applicability and guiding significance of the model, it can realize the scientific adjustment of the cost level of operation and inspection standard under different scenarios, and help to improve the efficient and refined management level of power grid operation and inspection cost.

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