Automatic analysis model of power grid infrastructure project cost level

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Abstract. Under the development of large-scale power grid investment, precise investment management has important guiding significance for improving power grid investment control and efficiency. In this paper, combined with the current situation of power grid infrastructure project cost management and pricing, using the ABC prediction method, through the analysis of cost price mode and characteristics, the cost theory and method innovation and application are carried out. This method is innovative and verified by experiments.

1. Introduction
In recent years, the investment projects of power transmission and transformation projects are increasing year by year, and the scale of power construction is also expanding. This can be used in UAV route selection [1] and other fields [2]. There is a certain difference between the project investment estimation and the actual project cost, which is not conducive to the accurate control of the cost, resulting in a relatively high-cost balance rate. Besides, the power grid infrastructure project has a long duration, which is affected by many factors such as topography [3], geology [4], meteorology [5], transportation conditions [6], etc With the development of the environment, enterprise management requirements, new technology and new technology, the level of power grid construction cost fluctuates greatly. How to strengthen the project cost controllable and under control has certain challenges, and the cost level is difficult to be accurately controlled. The reasonable level of power grid investment cost is an important support and analysis basis for enterprise investment planning, and an important tool and support platform for enterprises to strengthen investment control. Therefore, how to determine the project investment estimation scientifically [7] and reasonably, combine with the application of big data mining, optimize the cost prediction method, establish the scientific cost prediction concept, is of great significance to the power grid enterprises to reasonably plan the investment and improve the utilization efficiency of their funds [8].

For this reason, we advanced the cost forecast analysis of the grid infrastructure project based on the intelligent prediction algorithm, mainly based on the historical engineering data information of the cost, engineering technology and design index information, expert experience information, relying on the intelligence and the advanced nature of the cost forecasting theory and method and the prediction technology, and carried out the cost prediction and evaluation of the pre-construction management of the project. With the continuous accumulation of Engineering historical database, the intelligent means
of cost prediction are more and more abundant. The accuracy of cost level prediction based on intelligent prediction algorithm is higher and higher, which can provide decision support for cost determination and cost control management of power grid infrastructure projects, and provide a reference for investment planning, investment analysis, and investment decision-making.

2. Method

2.1. Automatic cost analysis model based on Intelligent Prediction Theory
Prediction theory is a theory that uses scientific judgment and measurement methods to predict the possible changes in future events. The scientific prediction method requires that according to the history and reality, the comprehensive information, the qualitative and quantitative analysis method should be used to reveal the development and change law of objective things, and point out the relationship between things, the way and result of future development.

The automatic cost analysis model based on intelligent prediction theory should first construct a historical engineering database, which should be combined with the whole process management data of relevant historical project cost, relevant standards of cost industry, laws and regulations, as well as expert experience information and engineering technology information as the basic data input layer. Then, it uses system dynamics, fishbone diagram, and other methods to identify and analyze the influencing factors of different types of projects, and classifies and scientifically measures the influencing factors, selects the main influencing factors affecting the project cost, analyzes the causes of the changes of the factors, explores their potential laws, and predicts the change trend of the key influencing factors. On this basis, combined with a variety of forecasts Model and prediction method, the automatic analysis model of cost level is constructed, and the accuracy and applicability of the model are verified by simulation and training combined with the prediction results.

Based on the intelligent prediction algorithm, the cost forecast analysis of the power grid infrastructure projects is based on the cost historical engineering data information, engineering technology and design index information, expert experience information, and based on the intelligence and the advanced nature of the cost forecasting theory and method and the prediction technology, the cost prediction and evaluation of the construction project's pre-management is carried out. With the continuous accumulation of Engineering historical database, the intelligent means of cost prediction are more and more abundant. The accuracy of cost level prediction based on intelligent prediction algorithm is higher and higher, which can provide decision support for cost determination and cost control management of power grid infrastructure projects, and provide a reference for investment planning, investment analysis, and investment decision-making.

2.2. Identification and analysis of cost influencing factors
The identification of influencing factors is mainly based on the main technical parameters of power grid infrastructure projects and the idea of decomposition and integration. According to the basic factors included and the suggestions of experts, the basic factors affecting the unit price of nodes are determined. The attribute structure of the deterministic influencing factors is summarized layer by layer, and the tree network topology diagram between elements and costs, factors and factors is constructed. Finally, the correlation analysis of factors is carried out to obtain the improved factor correlation topological diagram, and the content system construction of cost influencing factors identification is completed.

Through the identification of influencing factors, we can find out which factors may affect the cost of power transmission and transformation project, and lay a foundation for the classification and measurement of influencing factors.

2.3. Classification of cost influencing factors
The classification of influencing factors is the further analysis of the influencing factors of power transmission and transformation project cost after the factor identification. Because the classification
directly according to the nature of the factors, such as the classification according to the different stages, different parts, and different participants of the project construction, is often completed in the stage of factor identification. The method of factor classification is to find the rules and excavate the relationship between the factors with the help of mathematical models and data.

The ABC classification method can be used to analyze the factors affecting the cost of power transmission and transformation projects by calculating the cumulative proportion of the factors. The proportion here refers to the proportion of the cost of this factor. The classification steps are as follows:

1) The factors to be analyzed are arranged in descending order of proportion.
2) The cumulative proportion of factors is calculated in sequence.
3) Judge the importance of factors according to the cumulative proportion. The factors with the cumulative proportion of 70% - 80% are the main factors (class a factors); the factors with the cumulative proportion of 80% - 90% are the secondary factors (class B factors) after removing the class factors; some factors with the remaining proportion of about 10% are general (class C factors).

Taking the 110kV line project as an example, the paper observes that its body engineering consists of foundation engineering, tower engineering, grounding engineering, stringing engineering, accessory engineering, and auxiliary engineering. According to the sample data to calculate the proportion of the cost, using the ABC classification method for analysis. As shown in Table 1.

| No. | Category         | Cost ratio | Proportion of accumulated expenses |
|-----|------------------|------------|------------------------------------|
| 1   | Foundation工程  | 30.00%     | 30.00%                             |
| 2   | Tower工程        | 40.01%     | 70.01%                             |
| 3   | Stringing工程   | 22.10%     | 92.11%                             |
| 4   | Accessory工程   | 7.37%      | 99.48%                             |
| 5   | Auxiliary工程   | 0.42%      | 99.90%                             |
| 6   | Grounding工程   | 0.10%      | 100%                               |

According to the ABC classification method, foundation engineering and tower engineering are class factors; stringing engineering is class B factors; accessory engineering, auxiliary engineering, and grounding engineering are class C factors. The case is simple, in practice, the cost can be further subdivided, and the conclusion is more detailed. It can be seen from the case that ABC classification is easy to understand and operate, and can help managers to distinguish the "key majority" and "minor minority" so that managers can not only focus on the key issues for management, but also take into account the general problems, thus improving economic benefits.

3. Test
The measurement of influencing factors is based on sample data to analyze the closeness of factors and the influence of factors on cost. Through the correlation coefficient, we can analyze the relationship between the factors; through the principal component analysis, we can reduce the dimension of a group of closely related factors; through the sensitivity coefficient, path coefficient, and grey correlation degree, we can analyze the influence degree of influence factors on the cost of power transmission and transformation project. In practical application, these methods are often combined to play their respective advantages.

The main purpose of correlation analysis is to study the relationship between variables, such as height and weight, wire and tower material, main transformer capacity, and power distribution device. In statistical analysis, correlation generally refers to "linear correlation", and its compactness is expressed by correlation coefficient $r$. The correlation coefficient is usually recorded as $-1$ to $+1$. The closer the absolute value is to 1, the closer the relationship between variables is. If the absolute value is equal to 1, it means that the two variables are completely related. If the value of a variable is known, the value of variable B can be obtained. If the correlation coefficient is positive, it means that when a
variable increases, B variable increases at the same time, and the two are positive correlation; otherwise, it indicates that variable b decreases with the increase of a variable, and the two are negatively correlated.

Correlation analysis can be realized by SPSS software. Select the command of "analysis" - "correlation" - bivariate "and select the calculation method of correlation coefficient in the dialog box to obtain the correlation coefficient between variables and the significance of the hypothesis test.

Through the correlation analysis of the influencing factors of power transmission and transformation project cost, it is helpful for researchers to quantitatively judge whether the correlation coefficient between factors is positive correlation, negative correlation, or uncorrelation with the help of objective data. It requires that the samples should be as sufficient as possible and the appropriate calculation method should be selected. But correlation analysis can only help people have a general understanding of the relationship between factors, so it is often used as an auxiliary method, combined with regression analysis, principal component analysis, and so on.

Taking 220kV substation project as an example, as shown in Table 2, based on 10 sample data, the Pearson correlation coefficient between the number of main transformers, the number of high-voltage side outgoing lines, the number of high-voltage circuit breakers, the filling volume (unit: m3) and the unit project cost (unit: yuan / kVA) are calculated.

| No. | Number of main transformers | Number of outgoing lines at high voltage side | Number of high voltage side circuit breakers | Filling volume (unit: m3) | Unit project cost (unit: yuan / kVA) |
|-----|-----------------------------|---------------------------------------------|---------------------------------------------|--------------------------|-----------------------------------|
| 1   | 2                           | 6                                           | 9                                           | 2000                     | 244.05                           |
| 2   | 2                           | 4                                           | 7                                           | 2991                     | 175.00                           |
| 3   | 1                           | 4                                           | 6                                           | 3123                     | 268.61                           |
| 4   | 1                           | 4                                           | 6                                           | 15376                    | 278.14                           |
| 5   | 2                           | 2                                           | 7                                           | 6813                     | 134.32                           |
| 6   | 2                           | 4                                           | 7                                           | 8939                     | 204.97                           |
| 7   | 2                           | 4                                           | 7                                           | 15377                    | 215.76                           |
| 8   | 1                           | 2                                           | 3                                           | 0                        | 291.96                           |
| 9   | 1                           | 2                                           | 3                                           | 55239                    | 463.28                           |
| 10  | 1                           | 4                                           | 2                                           | 8590                     | 321.65                           |

Input the data into SPSS and run to get the Pearson correlation coefficient table. The correlation coefficient and significance of any two factors are given in the table.

4. Conclusion
This paper puts forward the analysis method of power transmission and transformation project cost index, studies the correlation between the cost index and the macroeconomic index, and uses the cost index to predict the cost, which can provide the analysis basis for reasonably grasping the fluctuation trend and mechanism of the cost. Finally, combined with the composition of the project investment, the cost difference between the reference period and the prediction period is calculated by studying the changes of the construction cost index and the installation cost index, and the cost automatic analysis model based on the decomposition and prediction of the cost index is constructed. The scientific determination of the cost level is realized based on the difference between the prediction analysis of the cost index and the actual cost.

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