Research on Advantages and Difficulties of Implementing Full-cost Comprehensive Information System in Power Engineering

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Abstract. The article analyses the current status and existing problems of the current pricing model of electric power projects in our country, introduces the advantages of the full-cost comprehensive unit price method, and demonstrates that the implementation of the full-cost comprehensive unit price method for project pricing is simple, operability, and meets market needs. The market pricing principle is more conducive to the reasonable determination and effective control of the project cost. Finally, it expounds the difficulties that need to be studied to solve the current implementation of this model, and proposes corresponding countermeasures. At the same time, we applied the full-cost comprehensive unit price to actual cases, and demonstrated the effectiveness of the full-cost comprehensive unit price in power engineering management through modelling and simulation.

Key words: Electric power engineering pricing; full cost comprehensive unit price method; market pricing; engineering quantity list.

1. Introduction
At present, power engineering cost management has the following problems: First, in terms of settlement supervision and review, due to the current cost management system, the settlement adopts the "vertical itemized cost" method of engineering quantity billing, and the preliminary estimate adopts the "horizontal combined fee collection" method. "The fixed pricing method of ", due to inconsistent calibres, affects the operability of comparative analysis; second, in terms of technical and economic evaluation, due to the current pre-regulated budget table content restrictions, the budget document is difficult to intuitively reflect a single main transformer and a single interval [1]. Or the cost level of a certain plan is not conducive to the economic comparison and selection of plans; third, in terms of investment accuracy, according to the results of annual cost analysis, there are more cases where the final project budget is greater than 10% of the estimated balance rate, so how It is imminent to be able to reasonably control the cost level through the application of settlement big data in the preliminary technical and economic review stage, and avoid investment deviations caused by non-design factors such as improper application of quotas; fourth, in terms of quality and efficiency, in the case of tight time and heavy tasks, It is necessary to ensure and improve quality and efficiency; Fifth,
in terms of the quality of the cost team, technical and economic personnel rely excessively on cost software, and the improvement of professional quality is slow.

The purpose of this subject is to study a simple and efficient new method of cost calculation, to innovate and establish a new comparison channel of "all-round five ratios", to support the economic comparison and selection of schemes, to accurately control project investment, and to provide timely updated "standard reference prices in all aspects". quickly build a professional cost team, lay a solid foundation for lean engineering management and high-quality development of power grids, study a simple and efficient new method of cost calculation, introduce the concept of "full cost comprehensive unit price", and change "full cost comprehensive unit price" The system is directly applied to the cost control of power grid projects.

2. Analysis of the related functional requirements of the comprehensive unit price of the full cost

2.1. Establish a full-cost comprehensive unit price analysis system

Introduce the concept of "full cost and comprehensive unit price" for business such as technological transformation and infrastructure construction. According to the current "Regulations on Budget Preparation and Calculation" of various types of electricity, the key elements, key algorithms and corresponding fast calculation formulas of the "full cost comprehensive unit price" are determined. Establish the overall system and corresponding calculation indicators of the "full cost comprehensive unit price" method [2]. According to the Electric Power "Budget Preparation and Calculation Regulations", analyse the key elements and calculation methods of the installation, construction, and demolition processes involved in technological transformation, infrastructure construction, etc., to ensure accuracy and efficiency. The system supports quick formula setting and calculation functions. The system needs to establish the relationship between the various businesses on the basis of the export table of the current cost software, and complete the "full cost comprehensive unit price" system work with a reasonable business database, algorithm database, etc.

2.2. Realize the calculation of the comprehensive unit price

Realize the development of "full cost and comprehensive unit price" software module. Extract the current quota system involved in electrical equipment installation, construction, overhead lines, cables, communications, debugging and other categories, more than 200,000 basic data including fixed base price, labour, materials, and mechanical unit price, based on the "full cost comprehensive unit price "The system develops corresponding software modules to realize the function of "full cost and comprehensive unit price", so that the cost level of a single main transformer, a single interval or a certain program can be visualized, simple, clear and clear.

The system supports large data volume Excel analysis capabilities, can identify technical transformation, infrastructure related data formats, and supports data write-back. The system supports seamless connection with the big data analysis platform, and the calculation results can be quickly analysed and processed through the big data platform for visual display [3]. The system can run on the internal network of the State Grid, and calculate the response results according to the "full cost comprehensive unit price" algorithm and index calculation system by importing existing electrical equipment installation, construction, overhead lines, cables, communications, debugging and other types of information.

2.3. System technical index requirements

The system adopts the J2EE technology platform, and the software is implemented as a Java Web application with a B/S architecture, which is centrally deployed on the application server, and the client uses a chrome browser for business processing. The database should be able to support large-scale enterprise-level applications, support multiple data backup methods, and provide complete data
recovery capabilities. The front-end development tools adopt object-oriented development languages, such as java, JavaScript, etc.

3. Comprehensive unit price model of full cost based on case-based reasoning

3.1. The basic principles of case-based reasoning
Based on the basic principles of case-based reasoning: It uses cases or accumulated experience as the basis for storing knowledge, and makes corresponding adjustments to the differences between the new and the old situations, so as to modify the original solutions to adapt to the new situation, that is, to obtain the solution of the new problem [4]. Form a new case. The CBR research method can alleviate the bottleneck problem of knowledge acquisition in the conventional knowledge system. It combines quantitative analysis with qualitative analysis, and has the characteristics of dynamic knowledge base and incremental learning.

3.2. Basic process
We can imagine how domain experts think when they encounter problems. First, the domain experts find out the characteristics and key parts of the current problem; then, based on these comparable parts, try to recall the most similar failure conditions that have been experienced in the past; then, compare the found failure conditions with the current problem. If they are completely consistent, then directly reuse the solution to the fault. If no fault condition is found that exactly matches the fault condition, then use the most similar fault condition as a template, and then adjust according to the current specific problem environment; finally, the solution process of the problem is in practice. Perform verification and record the problem handling process and verification results in case you encounter similar problems in the future [5]. The above-mentioned domain expert problem-solving process corresponds to the general process of CBR problem solving. The process model based on case-based reasoning is currently widely accepted is the proposed CBR cycle, which consists of four fundamental tasks: retrieval, reuse, correction and storage, referred to as 4R model. The basic workflow of case-based reasoning is shown in Figure 1.

3.3. Basic quotation model based on case-based reasoning
Regarding the problem to be solved as a new case, its scientific representation is the first step to realize case-based reasoning. Although selecting all the attributes of the case can fully and completely
represent the case, it will bring about the consequence that it takes up a lot of data storage space in the later system development stage, which adds a certain burden to the maintenance of the case library. Therefore, some effective characteristic factors must be selected to represent the case. These characteristic factors can not only describe the information of the case, but also reduce the redundancy of the case library to the greatest extent. Regarding the extraction of characteristic factors, commonly used methods include reduction methods based on rough set theory and correlation analysis methods. Taking into account the characteristics of the project itself, there are inconvenience factors in using the above two methods to reduce the feature factors [6]. Therefore, this article is based on the existing research literature and combined with engineering practice to extract the feature factors of the case. For foundation and foundation sub-projects, it can be expressed as shown in Figure 2:

![Figure 2. Description system of engineering characteristic factors of foundation and foundation division](image)

4. Design of full-cost comprehensive unit price system

4.1. Overall design

The system architecture has a great influence on the function, performance and development strategy of the system, so choosing a suitable system architecture is very important to the realization of the system. In order to enable the system to interact well between humans and machines, to be able to effectively integrate with the database, and to take into account the system’s access speed, security, scalability requirements and the actual needs of the enterprise, the system uses a client/server (Client/Server), referred to as C/S mode. C/S mode is a more popular system solution oriented to the actual business of enterprises. In the C/S system, it is composed of at least two parts: one is the client that sends the request, and the other is the server that provides services for the request. These two parts run independently and complete the corresponding work separately. The application logic of the system is distributed between the client and the server [7]. In this way, the system can provide faster and more effective application performance. For the C/S mode of bidding and quotation assistant decision-making system, the front-end client is used to provide users with various input interfaces, respond to users’ service requests, and process related business logic. The server is used to store various data, which is convenient for management and maintenance. The overall structure of the entire system is shown in Figure 3:
4.2. Implementation process of the auxiliary decision-making system

Combined with the theoretical basis of bid quotation based on case-based reasoning, the implementation process of the bid quotation assistant decision-making system is as follows: (1) Establish a corporate bid quotation case library as the basis for reasoning on the new proposed quotation project. (2) The user inputs the characteristic information of the project to be quoted to be matched. (3) Search the enterprise bidding quotation case database and find the case similar to the project to be matched. (4) Process the matching result and get the project quotation. (5) Combining the practice results of corporate bidding and quotation, the system administrator considers storing the new project quotation instance information in the case database. The above process can be represented by Figure 4:

4.3. Functional structure

According to the functions of the system, the established bidding quotation assistant decision-making system mainly consists of the following four modules: user management module, case reasoning module, case maintenance module and help module.

The user management module is the basic function of the system, which mainly realizes the maintenance of users and their permissions. The operators of the bidding quotation assistant decision-making system include two types of system administrators and ordinary users, and they correspond to...
different operation rights. The operation authority of ordinary users is mainly to view the case library, operate the whole process of case-based reasoning, and get the quotation of the project to be quoted. In addition to the rights of ordinary users, the system administrator can also manage users and manage the case library, such as adding, editing and deleting cases in the case library.

The case reasoning module is the core of the entire system. It is divided into three sub-modules, sub-items, measure items and other items according to the components of the unit project quotation. Each sub-module corresponds to the three parts of case retrieval, case reuse and quotation calculation. The case retrieval submodule mainly returns the matching results of the case, the case reuse submodule returns the resource consumption of the new case list items, and the quotation calculation submodule realizes the calculation of the preliminary quotation of the project.

The case maintenance module is mainly operated and implemented by the system administrator, and the realized function is the maintenance of cases, including case addition, case modification and deletion. Since case-based reasoning is an incremental learning method, new cases should be added to the case library after each system operation, so that the coverage and accuracy of the case library can also be improved. In order to ensure that the cases in the case library have more reference value, all the cases stored in the case library must be carefully compared and analysed with the actual consumption and actual settlement cost of the project, and find out the consumption and expenses calculated at the time of quotation and the actual expenses incurred the difference between and the reasons for it, and then make appropriate modifications to the case [8]. With the gradual increase in the number of cases in the case database, some technologies and construction methods have been eliminated, or some cases have lost their representativeness, these cases should be deleted in time. To realize the modification and deletion functions of the case, the query of the case must be completed first, so ordinary users can browse and view the case on the relevant interface.

The help module is to provide relevant help for users to smoothly complete system operations. The functional structure diagram of the bidding quotation assistant decision-making system is shown in Figure 5:

![Functional structure diagram of the bidding quotation assistant decision-making system](image)

**Figure 5.** The functional structure diagram of the bidding quotation assistant decision-making system

5. **Fuzzy evaluation of comprehensive unit price of full cost**

Case-based reasoning decomposition decomposes the original vibration signal into a series of single-component signals with effective instantaneous frequency and a residual signal according to different frequency components. The single-component signal is called the intrinsic mode function (IMF) component. Each IMF component only contains the local characteristic signal of the same time scale
in the original signal. In order to verify that the obtained single-component signal is an IMF component, it is usually judged according to the following two conditions:

(1) Within the length of the signal sequence, the number of extreme points and the number of zero-crossing points are equal or the difference does not exceed one at most. (2) For any moment, the mean value of the signal local envelope is zero.

The specific steps of case-based reasoning decomposition and decomposition of the original signal are as follows:

(2) Assuming that the original signal is \( x(t) \), first find out all the maximum and minimum points in \( x(t) \), and fit the upper and lower envelopes \( E_1(t) \) and \( E_2(t) \) of \( x(t) \) by cubic spline interpolation. Calculate the mean value \( m(t) = (E_1(t) + E_2(t))/2 \) of the upper and lower envelopes, and subtract the mean value from the original signal to get the first signal component:

\[
h_1(t) = x(t) - m_1(t)
\]

(3) Determine whether \( h_1(t) \) is IMF according to the basic conditions of IMF. If the conditions are not met, repeat the above operation and condition judgment process with \( h_1(t) \) as the signal to be decomposed until the signal components that meet the conditions are obtained, which is the first IMF component or the stop condition of the iterative operation is reached.

(4) Mark the first IMF component obtained as \( c_1 \), and subtract the \( c_1 \) component from the original signal to obtain the new signal \( r_1(t) = x(t) - c_1 \), \( r_1(t) \) to be decomposed, and go through the first two steps again:

\[
r_2(t) = r_1(t) - c_2(t), \ldots, r_m(t) = r_{m-1}(t) - c_m(t)
\]

Perform multiple iterations until the signal to be decomposed does not meet the decomposition conditions of case-based reasoning, and the signal is the residual signal component. After the decomposition process of case-based reasoning, the original signal can be expressed as:

\[
x(t) = \sum_{k=1}^{m} c_k(t) + r_m(t)
\]

In the formula, \( c_k(t) \) is each IMF component, \( r_m(t) \) is the residual component. From the decomposition process of the vibration signal, it can be seen that the order in which the IMF components are decomposed corresponds to the frequency components of the components, that is, the IMF components decomposed first contain the high-frequency components in the signal and contain obvious and important features. information.

Although case-based reasoning decomposition is a time-frequency analysis method with good results, it also has the following shortcomings:

End effect: In the case-based reasoning decomposition process, the upper and lower envelopes of the original signal generally need to be calculated multiple times by cubic spline interpolation, and the end points and extreme points of the signal are not necessarily the same data point as a result, it is impossible to use its endpoints for calculations, resulting in a dispersion phenomenon at the endpoints during the envelope curve fitting process, resulting in fitting errors. This kind of error will continue to accumulate with the iteration of the algorithm process, and eventually cause the calculation result to be far from the true value, making it impossible to use the result for subsequent diagnosis processes.

Modal aliasing: When there are step signal frequency components caused by abnormal states such as signal discontinuity, noise, and pulse interference in the original signal, there may be frequency
components of different time scales in the IMF components decomposed by case-based reasoning. As a result, case-based reasoning decomposition cannot accurately separate the IMF components of different frequency components, and thus cannot reflect the true characteristics of the original signal. In the decomposition process, this algorithm superimposes the Gaussian white noise signal with uniform spectrum distribution on the decomposed signal many times, smoothest the intermittent signal components in the decomposed signal, suppresses modal aliasing, and achieves the signal components of different time scales from the original signal. The purpose of accurate separation. As one of the important characteristics of Gaussian white noise, the mean value is zero, which can ensure that after multiple averaging calculations, the additional noise components will cancel each other to a certain extent, avoiding the noise signal from causing serious interference to the decomposition result. The algorithm flow of the basic principle of case-based reasoning decomposition is similar to that of case-based reasoning decomposition, and the specific flow is shown in Figure 6.

Figure 6. Flow chart of case-based reasoning decomposition algorithm

6. Experimental verification analysis
This paper studies the possibility P and loss D of material price fluctuation risk. Through the questionnaire survey, the probability of the occurrence of the risk and the size of the loss caused after the occurrence of the risk are obtained. Finally, the two aspects are combined to quantify the final result, which provides a basis for determining the comprehensive unit price risk cost. Analyse the results of the questionnaire survey, assign values to quantify the probability of occurrence of the price risk of the main materials in the masonry project and the amount of loss caused, see Table 1.

| Serial number | Risk factors     | Pi  | Di  | PiDi | Sort |
|---------------|------------------|-----|-----|------|------|
| 1             | Block price risk | 4.12| 4.18| 19.38| 3    |
| 2             | Cement price risk| 6.3 | 6.46| 44.88| 1    |
| 3             | Sand price risk  | 6.22| 6.2 | 44.06| 2    |
| 4             | Water price risk | 2.56| 3.06| 10.7 | 4    |

The simulation signal is used to verify the effect of case-based reasoning decomposition in suppressing modal aliasing. Set the simulation signal as:

\[ x(t) = x_1(t) + x_2(t) + n(t) \] (4)
Among them, \( x_1(t) = \sin(100\pi t + \pi/2) \), \( x_2(t) = \sin(20\pi t) \) and \( n(t) \) are intermittent noise signals. The time-domain waveforms of the components of the mixed signal \( x(t) \) are shown in 7.

![Time-domain waveform diagram of the mixed signal and its components](image)

**Figure 7.** Time-domain waveform diagram of the mixed signal and its components

The result of case-based reasoning decomposition of mixed signal is shown in Figure 7. Since intermittent noise signal components are superimposed in the mixed signal, after case-based reasoning decomposition, it can be clearly seen that there must be frequency components with extremely different time scales in IMF1 to IMF4 components, and there is modal aliasing. Realize the decomposition goal of case-based reasoning decomposition algorithm.

7. Conclusion
The full-cost comprehensive unit price method is simple, which can improve the efficiency of cost preparation. It conforms to the market pricing principle, and the unit price composition meets the actual needs of the market. Integrating with international pricing rules is conducive to the internationalization of construction enterprises. The risk allocation is more reasonable, which is conducive to the reasonable determination and effective control of the project cost. It is beneficial to improve the management level of construction enterprises and enhance their competitiveness. Conducive to the standardized operation of the construction market. The full-cost comprehensive unit price method can effectively solve the current problems of Chinese current pricing model.

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