Research on Transmission and Transformation Engineering Cost System Based on BIM 3D Modelling Technology

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Abstract. Taking the concept of service-oriented design as the concept, the paper designs the digital platform architecture based on the integrated application ideas and technical methods of the IFC standard and the three-dimensional geospatial engineering cost information platform, and builds a 3DGIS+BIM digital power engineering cost based on the B/S network architecture, information platform. Combined with the application value of BIM technology in the field of engineering cost, the applicability of BIM technology in the management of transmission and transformation engineering cost is first analysed; then the BIM technology is studied layer by layer from the aspects of graphical calculation, three-dimensional design and full process management Promoting strategies for application of engineering cost management; Finally, from the perspective of policy guidance, industry standards, BIM platform construction, and training of BIM talents, the application guarantee mechanism of BIM technology in transmission and transformation project cost management is proposed, with a view to BIM technology in transmission and transformation projects Provide reference for application promotion in cost management.

Keywords: 3D BIM modelling, power transmission and transformation engineering, cost system, 3DGIS+BIM.

1. Introduction

BIM technology refers to technology based on building information modelling and building information model. Use the form of establishing an information model to more clearly reflect the relevant management data, and better control the main points in the relevant mathematical model. Power engineering includes power supply and power grid construction projects. When constructing the power grid, there are power stations, power supply and distribution lines, substations and other projects. The use of BIM technology for three-dimensional modelling of power engineering cost, so as to better control the cost of power engineering and improve the economic benefits of power engineering. The process of calculating the cost of power engineering projects in my country is mainly divided into two steps. The first step is the calculation of the engineering quantity, and the second step is the calculation of the engineering price based on the calculation results of the engineering quantity. The calculation of engineering quantity becomes the basis of engineering cost calculation, and also
becomes the key to the accuracy of engineering cost result calculation. Therefore, in the process of promoting BIM technology for the engineering cost industry, the primary task is to solve the calculation of the amount of power engineering projects.

This paper describes the application advantages of BIM technology in the cost of power engineering, discusses on the basis of case analysis, and draws conclusions with certain reference value. Take a power station project in Anhui Province as an example. The design scale of this power project is 2.4 million kW. Two 600,000 kW units, which were the first batch of domestically manufactured technology, were installed. They were put into operation in 1988 and 1993. The power station uses intelligent technology to improve operating efficiency and ensure power supply quality. In this power engineering design, in order to save engineering costs and reduce the cost of power engineering, BIM technology is applied [1].

2. Data learning theory of substation engineering cost

2.1. Data reprocessing
Not only is there a limited number of substation engineering samples, but the data classification of each engineering project is complex. The data collected from various companies may have errors, inconsistencies, redundancy, and underreporting. At the same time, the same type of project may be between different types of data. There will be a relationship. If the reported data is analysed and calculated, it will not only increase the calculation time of the computer, but also increase the calculation error. Therefore, the data must be pre-processed before analysis and calculation. Power transmission and transformation projects mainly include power transformation projects, overhead line projects, cable line projects, communication equipment projects and communication optical cable projects [2].

2.2. Clustering algorithm
Cluster analysis is a statistical method for analysing research indicators or sample classification problems. Cluster analysis belongs to unsupervised learning and does not require manual annotation of statistical data. The basis of cluster analysis classification is the characteristics of the statistical data sample itself, and the classification is based on the characteristics of the data itself or some similarity between the data. Cluster analysis can help to explore data with unknown structures or features, and the results can provide optimal sample sets for classification, reducing the empirical error and workload of manual labelling. Therefore, cluster analysis can be used as the starting point for a series of data analysis, and classification can provide some help for analysing the structure and characteristics of data.

In cluster analysis of a given data sample space \( X \), each data sample \( x_i \) \((x_i \in X, i = 1, 2, ..., n)\) has \( m \) parameters, and \( n \) is the number of samples in the data sample space. Each data sample \( x_i \) can be regarded as an \( m \)-dimensional data vector, \( x \cdot x_1^{(1)}, x_2^{(2)}, ..., x_m^{(m)} \)^T, where \( x_j^{(j)} \) is the \( j \) parameter of \( x_i \) \((J = 1, 2, ..., m)\).

2.2.1. Definition and calculation formula. A moving average refers to the moving average of the statistical data of the variables. The calculation formula of a moving average is:

\[
M_t^{(1)} = \frac{y_{t-1} + y_{t-2} + \cdots + y_{t-n+1}}{n}
\]  

(1)

In the formula: \( M_t^{(1)} \) represents the moving average of the \( t \) cycle; here \( n \) represents the number of moving cycles or the number of segmented data points. For example: take \( n = 5 \), then the moving average \( M_5^{(1)} = \frac{y_1 + y_2 + y_3 + y_4 + y_5}{5} \) of the 5th cycle.
Two special cases of n value: (1) n=1, then \( M^{[1]}_t = y_t \), that is, a moving average is equal to the original statistical data, this is the natural description line of the data point. (2) n=t, then \( M^{[1]}_t = \sum y_i / t = \bar{y} \), that is, a moving average equal to the average of all data represents a simple average.

2.2.2. Improve the formula. From the above calculations, we find that compared \( M^{[1]}_6 \) with \( M^{[1]}_5 \), only \( y_6 \) is added, and \( y_1 \) is removed, that is, only the two data at the beginning and the end have changed, and the data in the middle will change with the future. Therefore, for convenience of calculation, formula (1) can be improved. For the case of n=5, there is

\[
M^{[1]}_6 = \frac{y_6 + y_5 + y_4 + y_3 + y_2}{5} \\
= \frac{(y_1 + y_2 + y_3 + y_4 + y_5) + (y_6 - y_1)}{5} \\
= M^{[1]}_5 + \frac{y_6 - y_1}{5}
\]

(2)

For the general case:

\[
M^{[1]}_t = \frac{y_t + y_{t+1} + y_{t+2} + \ldots + y_{t+n-1}}{n} \\
= \frac{y_1 + y_2 + \ldots + y_{t+n-1} - y_1 - y_t}{n} \\
= M^{[1]}_{t-1} - \frac{y_{t+1} - y_{t+n+1}}{n}
\]

(3)

It can be seen that when calculated, only \( \frac{y_{t+1} - y_{t+n+1}}{n} \) needs to be calculated to obtain \( M^{[1]}_{t+1} \). This is an iterative formula, and the calculation process is an iterative process. When obtaining new data, it is easy to find a new moving average based on the original moving average. To build a prediction model, you also need to calculate the secondary moving average. The second moving average is to move the moving average \( M^{[1]}_t \) once again. The calculation formula of the second moving average is:

\[
M^{[2]}_t = \frac{M^{[1]}_t + M^{[1]}_{t-1} + M^{[1]}_{t-2} + \ldots + M^{[1]}_{t-n+1}}{n}
\]

(4)

In the formula: \( M^{[2]}_t \) represents the second moving average; \( M^{[1]}_t \) represents a moving average; n represents the number of moving cycles or the number of segmented data points. The calculation method of the second moving average is the same as the calculation method of the first moving average, and it is also improved to:

\[
M^{[2]}_{t+1} = M^{[2]}_t + \frac{M^{[1]}_t - M^{[1]}_{t-n}}{n}
\]

(5)

\[
M^{[2]}_{t+1} = M^{[2]}_t + \frac{M^{[1]}_t - M^{[1]}_{t-n+1}}{n}
\]

(6)
3. Application of BIM in cost estimation of substation projects

3.1. BIM technology and application overview
The theoretical basis of BIM technology mainly comes from the CIMS computer/modern integrated manufacturing system that integrates CAD (computer-aided technology) and CAM (computer-aided manufacturing) in the manufacturing industry. Relying on three-dimensional technology, BIM is a digital expression of engineering project entities and their engineering characteristics. BIM technology generally has coordination, simulation, optimization, visualization, parameterization and plotability. Figure 1 shows the BIM information sharing platform.

![BIM information sharing platform diagram](image)

Figure 1. BIM information sharing platform diagram

3.2. BIM-based data management of substation engineering cost

3.2.1. Decision-making stage. At this stage, the most suitable investment plan is selected through a series of channels. The application of BIM technology mainly includes: site selection of substations, comparison and selection of different transmission and transformation engineering technical schemes, etc. Comprehensive use of BIM cost-related database information, project technical parameters, and project economic value evaluation methods to dynamically predict the cost and benefit of the project at different stages to minimize project cost and maximize expected profit.

3.2.2. Design stage. The design stage is one of the most important stages in the cost control of the substation project. Including: preliminary scheme design, construction drawing design, etc. The design scheme optimizes the BIM information system, which can realize the 3D dynamic display of the design effect and simulate the effect of different design schemes.

3.2.3. Project implementation stage. According to the current State Grid Corporation's power transmission and transformation project management method, the project implementation phase mainly includes the bidding phase and the construction phase.

3.2.4. Completion acceptance stage. The transmission and transformation project in the completion acceptance stage compared with the traditional project cost management mode, the staff responsible
for the transmission and transformation project cost in the cost management process is extremely heavy, the task is very difficult. At the same time, due to the problems of manual intervention and personal experience, in the entire process, there are inevitable errors and omissions, which cannot ensure the efficiency and accuracy of the work, and cannot guarantee the settlement quality of the transmission and transformation project. The application of BIM technology-based transmission and transformation project model parameters and information integrity ensures the safety and accuracy of engineering information, and at the same time can improve work efficiency, saving a lot of time for each participant in the transmission and transformation project Energy, speed up settlement, and save investment costs of transmission and transformation projects [3].

3.2.5. Operation and maintenance stage. In the operation and maintenance phase of the power transmission and transformation project, it is necessary to formulate an operation management and maintenance management plan that conforms to the construction situation to minimize the project cost of the power transmission and transformation project.

3.3. Design of BIM-based rapid cost estimation method for substation projects

This paper introduces the BIM technology into the cost estimation of the substation project, using the advantage of the BIM model to obtain engineering information. Because this article builds the civil engineering model of the substation project, the electrical information about the project still needs to apply a standard quota to obtain part of the project information; at the same time, combined with the characteristics of the project itself to determine such as voltage level, the number of main transformers, single capacity, etc. index. Organize the information as a verification sample of the prediction algorithm, and then predict the cost of the project. The route of substation project cost estimation method based on BIM technology is shown in Figure 2.

![BIM technology's cost estimation method for substation projects](image)

According to the plan, the static investment of the new substation project can be predicted, and the investment scale of the project can be initially understood. At the feasibility study stage of the substation project, the initial investment scale of the project can be understood, which is of great help to the design and construction of the project.

4. Construction of power transmission and transformation engineering design system based on BIM platform

4.1. System flow

The engineering design plan is as follows: the platform design foundation is BIM technology, on this basis, the BIM model is established, and the cost of the entire power project is calculated using the pricing software. In this electric power engineering design, CAD software is not applied, but replaced with BIM software, using BIM software technology to extract engineering quantities, and import the
extracted engineering quantities into engineering valuation software to complete the cost calculation. The construction of the BIM model in this scheme is the responsibility of the design unit. The design unit uses BIM design software, based on the BIM model family library, and designs the power engineering project with reference to the BIM standard. After the design work is completed, the design unit is responsible for handing over the designed project to the owner unit, and the owner unit will hand over the model to the established construction unit for application in the construction process according to the bidding situation. In this process, both the owner unit and the construction unit can use the BIM model of the project provided by the design unit to calculate the quantity and price of the project. Figure 3 shows the basic flow of the system [4].

**Figure 3.** The basic flow of the system

### 4.2. Construction of BIM model family library

Engineering project design work is the basis for project implementation, and the construction of the BIM model family library for power engineering provides electricity with support for engineering projects based on BIM-based design work. Through the source of the Revit family of buildings currently on the market, it can provide an idea for the construction of the BIM model standard component library of the power engineering industry. Because the standard component family contains very rich content, it is unrealistic to rely solely on one party to develop and improve it in the process of establishing the family. You can use multiple channels such as the development unit of the family, individuals and product suppliers. It's perfected [5].

### 4.3. Realization of power engineering pricing

Most BIM software has the function of automatic calculation. At the same time, this software can also export the calculated engineering amount according to a certain format. At present, the most commonly used by cost engineers is to import the engineering quantities extracted by BIM software into an Excel table for summary calculation. The advantage of this method is that it has strong practicability and ease of operation. The disadvantage is that when the cost calculation is carried out
by sending samples, the BIM modelling process must be ensured to be very standard, and various components must be clearly defined. Only in this way can the accuracy of the engineering quantity calculation be guaranteed. The pricing plan proposed in this article is to import the Revit export schedule into the Quamina pricing software. According to the format requirements of Quanlianda's engineering quantity schedule that needs to be imported into the Quamina power engineering valuation software, it is necessary for the substation project output by the Revit software. The format of the detailed list of engineering statistics is modified, and the final output is an Excel format detailed list that meets the requirements of Guanglianda Power Engineering Pricing Software. The research and development personnel of Guanglianda Company modified the way of reading the Excel file in its power engineering pricing software, so that it can automatically read the detailed project quantity list of the substation project exported by Revit software, and automatically apply the quota to realize the pricing work [6].

5. Conclusion
Under the BIM technology environment, the relevant information of transmission and transformation project cost management can be exchanged and shared horizontally and vertically, which can realize real-time monitoring, dynamic display and accurate analysis of project cost management. This paper systematically studies the application of BIM technology in transmission and transformation project cost management, separately discusses the applicability, application status and application promotion strategy of BIM technology in transmission and transformation project cost management, and at the same time, proposes BIM technology Suggestions for application in cost management of transmission and transformation projects. It should be pointed out that as an advanced engineering management technology, BIM technology is still required to be fully applied in the field of transmission and transformation engineering cost. The comprehensive application benefits of BIM technology in transmission and transformation project cost management, and exploring the application value of BIM technology in transmission and transformation project cost management in stages will be the focus of the next research.

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