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# Research on Intelligent Forecast Technology of Power Engineering Precision Cost

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***ABSTRACT.*** *In recent years, with the rapid development of energy and power technologies such as advanced power transmission and transformation, smart grid terminal energy electrification, and the continuous integration of modern information communication and digital technology, the functional form and operation mode of the power grid have undergone profound changes. Good grid function and operation mode require high-quality, accurate and punctual power grid construction as the foundation. Therefore, the construction of power grid engineering needs to gradually shift from "rough and inefficient" to "high quality and high efficiency", and increasingly strengthen the key nodes in the whole process of power grid construction. Management and control. Although various measures have been implemented in recent years to improve the control of power grid construction, there are still many problems.*

***KEYWORDS:*** *power cost, optimization research*

## 1. Purpose and significance

The engineering quantity in the budget stage of the power transmission and transformation project lacks accurate measurement methods, and the coordination of the time schedule of each stage is insufficient. The project budget refers to the technical and economic documents that pre-calculate and determine the total project cost of the construction project according to the specific content of the design documents at different design stages and the relevant quotas, indicators and fee collection standards during the construction process, including the design budget. , revision of budget estimates, construction drawing budget, construction budget, involving the entire cycle of construction. At the same time, the project budget is also the basis for quota picking, economic accounting, strengthening construction plan management, and facilitating operation plans. Therefore, the data source of the unified caliber, the precise calculation method and the good coordination between the various links are important conditions for ensuring the accuracy of the estimated budget and the completion of the project on schedule. However, most of the current

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budgetary data depends on design funding, and it does not accurately reflect the total investment of the project. There are also phenomena such as contract price, progress review, design change, and on-site visas, which are not uniform in terms of cost calculation and implementation. Seriously constrained the project management effect, which is not conducive to the completion of the project within the budget. The management technology of the implementation phase of power transmission and transformation projects is still not mature, and it is difficult to achieve effective real-time cooperation among multiple links. Project implementation refers to a series of work carried out from the survey and design, construction preparation, planning, construction, production preparation, completion and acceptance, and completion of the project. It is the substantive stage of project construction. Project implementation includes two phases of project planning execution and control, and any matters in the project implementation phase are linked to investment. Therefore, good dynamic cost control in the implementation stage is an important part of improving project investment management. At present, the on-site construction management technology of power transmission and transformation project is not mature enough. There is no organic combination of estimation, budgetary estimate, budget, engineering process cost and project settlement. There are disconnected problems in each link, project progress, material procurement, project contract, warehouse status and other data. It can't be associated with cost data in real time, so it can't realize dynamic cost analysis and smart contract performance approval settlement, which is not conducive to project quality improvement and efficiency [1-2].

Based on the analysis of the above problems, the development direction closely related to the research and application of the precision control technology of the power transmission and transformation engineering is mainly reflected in the following aspects:

In order to realize the unification of data caliber in power grid engineering, grid companies need to deeply integrate computer technology with power grid construction projects based on ubiquitous Internet of Things. The ubiquitous power Internet of Things is about all aspects of the power system, fully applying modern information technology such as mobile internet and artificial intelligence, and advanced communication technology to realize the interconnection of all things and human-computer interaction in all aspects of the power system. It has comprehensive state perception, efficient information processing and application. A smart service system with convenient and flexible features. Based on the system, the grid construction project can be mapped to the project management and management in a three-dimensional manner, realizing the real-time, comprehensive and objective response of the grid construction, and reducing the data loss and distortion caused by human intervention. At present, it is precisely because the various links in the power grid project rely on manpower to communicate in a timely and accurate manner. Therefore, it is necessary to promote the systematic interaction between the power grid project and the computer, and realize the digital connection between the cost and the multiple links in the power grid construction project.

During the digital construction of power grid engineering, a large number of “chimney” systems have been formed according to different business needs, and

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there is no unified data interaction specification and interface standard between systems. The "data island" effect between systems limits the digital construction of power grid engineering and also restricts the value mining of massive power grid engineering data. At present, the State Grid Corporation has proposed the ubiquitous power Internet of Things theory, which clarifies the importance of data sharing. Only by opening up all aspects of power grid construction can we realize the interconnection of all things and state holographic perception. In addition, Building Information Modeling (BIM) technology is widely used in other industries. It is to describe computer-aided design based on three-dimensional graphics, object-oriented, and architecture. It provides experience for grid engineering construction. With the support of the above technologies and theories, considering the complementary characteristics of engineering design and cost in terms of data association and business process, it is a trend to explore the intelligent sharing mechanism between the two. Therefore, with the three-dimensional design and BIM technology gradually applied in the field of power grid, the automatic calculation of grid cost based on the GIM standard of the State Grid and the dynamic analysis of the whole process cost can be realized.

According to the current situation of power grid power transmission and transformation engineering cost calculation, through the use of three-dimensional design results, the automatic calculation of engineering quantity and multi-dimensional statistics are realized, which solves the problem of design financing information dispersion and data unstructured, and reduces the difficulty of coordination among various professions; It avoids the repeated data modeling of grid engineering cost calculation work, changes the status quo of the cost of professional changes, saves the cost of calculation and cost calculation work, forms a new type of work management ideas, and uses the formed standard engineering data to ensure data. Consistency and timeliness of information transmission, in order to achieve automatic nesting, rapid group price and auxiliary comparison in cost calculation, improve work quality and improve work efficiency [3].

## 2. Domestic and foreign research

In recent years, project schedule and cost collaborative management has become a very important research topic in the field of engineering construction. Scholars at home and abroad have made many efforts to develop various models and methods for the integration of engineering project schedule and cost management, especially the Building Information Model (BIM) technology is the most eye-catching. At present, BIM technology is applied more and more widely in most developed countries, and has reached a certain level. Among them, more than 80% of the top 300 enterprises in the construction industry in the United States applied BIM technology in 2009. The main application body of domestic BIM is design unit and construction unit. The application items are mainly space modeling and collision detection. These applications only involve the tip of BIM. In May 2011, the "2011-2015 Construction Industry Informatization Development Outline" issued by the Ministry of Housing and Urban-Rural Development clearly stated that the

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research and application of BIM technology should be carried out during the construction phase, and the application of BIM technology from the design stage to the construction stage should be promoted to reduce the information. Attenuation in the process of transmission; research on the application of 4D project management information system based on BIM technology in the construction process of large and complex projects, and realize effective visual management of construction engineering. The "Eleventh Five-Year" National Science and Technology Support Program Key Project "Research on Key Technologies of Modern Architecture Design and Construction" has taken BIM as the key research direction, and has already had large projects such as "Water Cube" venue, Shanghai Center, World Expo, Shanghai Disneyland and so on. Successful application of BIM technology shows that the development of BIM in China is unstoppable [4-5].

State Grid Corporation attaches great importance to 3D related technology. In 2013, it issued the General Rules for 3D Modeling of Power Grid (Q/GDW 1795-2013), which laid the foundation for the application of 3D technology in power engineering. From the application analysis, many units have already had 3D digital design capabilities and have been applied in some projects. However, during the construction of the project, the construction drawings are also used for on-site management. The 3D design results generated during the design phase are not well applied in the project construction [6], and the whole process management of the power engineering construction mainly relies on experience and enterprises. The management system and related professional control, 3D design results did not play its due value in the whole life cycle of power grid engineering. It is necessary to further carry out the work of three-dimensional cost management of power grid engineering, effectively improve the management level and work efficiency of power grid construction, and effectively strengthen the overall process control and control of the project construction site.

The research on the status quo and development trend of domestic and international research level of engineering cost will be analyzed from two aspects of practice and theoretical research. In practice, the development level of information technology in the construction industry in developed countries is relatively high. More than 50% of projects in the United States use BIM technology. The main application method is to form the building information model through the design stage, output the IFC common format for inter-platform model docking, and import it into the cost software to directly compile the project cost file, such as AUTODESK's QTO software [7]. However, due to the different calculation rules and pricing rules adopted by foreign countries, foreign related software is seriously unacceptable in China and cannot be fully used.

Internationally, the cost of an engineering project is usually based on an analysis of the project structure and the project schedule. Through a breakdown of the project structure, a comprehensive and detailed description of the project, combined with the schedule of these activities to determine the resources required for each activity (manual, various materials, production or functional facilities, construction

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equipment), the lowest level project The estimated cost of the unit is aggregated to determine the total cost of the project. There are three main modes in the field of construction project cost management: the material measurement system represented by the United Kingdom and Hong Kong, the cost engineering management system represented by the United States, and the engineering accumulation system represented by Japan.The United Kingdom is a country with a long history and a complete system of project cost management. The government promulgates a unified project quantity rule and regularly publishes various price indices. The project cost is calculated according to these rules. The price is calculated by the information price and market price provided by the consulting company. There is no uniform quota standard applicable. Project prices are finally formed through free quotes and competition. An important feature of UK engineering pricing is the use of quantity surveyors, whether it is government engineering or private engineering, whether it is a traditional management model or a non-traditional model.At present, the application of 3D design results of power grid engineering in the cost stage is limited to the output of some professional engineering quantities. The final cost production needs to be completed manually by experienced technicians. The technical and economic majors generally rely on the design of the financing form to complete most of the lifting work. Among them, the professional engineering quantity of the substation civil engineering is difficult to calculate and the calculation amount is large, mainly relying on the manual calculation of the engineering quantity. After the engineering quantity statistics, technicians are required to manually enter the engineering quantity in the cost and inventory software, and take the list and quota items according to the construction practices and engineering related information in the engineering drawings.

In summary, the current research on grid engineering cost focuses on existing problems, management improvement measures, and development of power grid engineering cost systems. There is a lack of digital analysis of the design-cost-site process that considers intelligent data sharing. However, with the rapid development of the Internet of Things and modern intelligent information technology, the deep integration of computer technology and existing social development has become the future development direction. As an important part of promoting power transmission, power grid construction integrates it with computer technology. Based on ubiquitous Internet of Things, power grid construction from design-cost-site full-process intelligent data sharing and three-dimensional design and real-time complete mapping between sites is not only The effective means of improving quality and efficiency of power grid projects is also in line with the development direction of China's future power grid.

## 3. Leading theory

### *3.1. WBS coding system*

State Grid Co., Ltd. WBS coding system to meet the project design, project budget, project procurement, engineering accounting, project settlement and other

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business needs as the overall design principles, while considering the business management status of each unit, and strive to ensure the integrity of the function, On the basis of rationality and effectiveness, it fully satisfies the actual business management needs of each unit and ensures the application effect. And based on the "State Grid Co., Ltd. WBS Architecture Code Specification (Trial)" (State Grid Information [2011] No. 209), refer to "State Grid Co., Ltd. Project Classification and Coding Specifications (Trial)" (State Grid Information [2010]) No. 1336), according to the "Grid Engineering Construction Budgeting and Calculation Regulations (2013 Edition)" (Guoneng Electric Power [2013] No. 289), "On the trial of ±800kV UHV DC project budget fixed quota and converter station, grounding Circular on the Division of Construction Project Budget Projects (DC Project [2015] No. 55), analyzes and draws on the experience of the WBS coding system related to the project types applicable to each unit, and forms the standard WBS architecture of the State Grid.

### *3.2. State Grid Co., Ltd. Material Coding System*

Material coding is an important part of system data management in ERP system of State Grid Co., Ltd. It runs through all links and functional modules of ERP's entire logistics information system. The material code is a symbol that identifies and processes the material by human or computer according to the equipment, material properties, and following certain rules. With the development of information technology, material coding has become an important means for people to understand, unify and exchange information. Each material code represents a specific device and material, which can be stored, read, modified and retrieved by the computer. It also facilitates the classification of equipment materials, data statistics, cost calculation, report generation and identification.

At present, the material code of State Grid Co., Ltd. is uniformly maintained by the State Grid Headquarters. The Data Standards Group of State Grid Co., Ltd. has established a standard material classification and coding scheme to determine the classification, characteristics and characteristic values of grid enterprises, thus ensuring the material coding system nationwide. Consistent within.

### *3.3.State Grid Co., Ltd. Standard Process Achievement System*

The standard process achievement system is the in-depth study of the power grid construction process since 2005 by the Ministry of Infrastructure of the State Grid Corporation. It summarizes the construction management experience, unifies the construction process requirements, standardizes the construction process behavior, improves the construction process level, and promotes the construction technology level and engineering. Formed by the improvement of construction quality. Each process in the standard process system has a corresponding process number and its number is unique.

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### *3.4. Data mining technology*

Data mining is the extraction of information that is hidden from the prior art, but is potentially useful, from a large number of incomplete, noisy, fuzzy, random, and practical application data. The process of knowledge. With the rapid development of information technology, the amount of data accumulated by people has increased dramatically. It is imperative to extract useful knowledge from massive data in tb. Data mining is a data processing technology developed to meet this need. It is a key step in knowledge discovery in database.

The tasks of data mining are mainly correlation analysis, cluster analysis, classification, prediction, time series mode and deviation analysis.

### *3.5. Zhejiang Digital Power Grid*

Since 2017, the Ministry of Infrastructure of the State Grid Corporation has required digital design and digital construction management and control requirements in some projects, and vigorously advocated the provincial companies to carry out digital technology pilot work. With engineering data as the core and Internet + thought as the guide, comprehensive use of new generation technologies such as large, cloud, material and migration has carried out research work on digital design, construction, supervision and handover of engineering. The digital engineering management system of power grid engineering with the concept of three-dimensional digital construction, GIM three-dimensional model as the carrier and data-driven management as the core is proposed.

Digital transmission and transformation three-dimensional design, digital construction of power grid construction site, digital training of power grid engineering construction, digital power grid, through the whole process of design and construction of pilot projects such as 220 kV Longxing transformer and 110 kV long bridge transformer in Zhejiang Digital Power Grid A series of application researches on digital construction of engineering construction and digital service of power grid engineering have built a digital production, collection and application system throughout the whole process of Zhejiang power grid construction, realizing the visualization and digital management of power grid construction, and improving engineering safety and quality. The efficiency and level of technical management have improved the enthusiasm, initiative and business capability level of employees' participation in power grid construction, and improved the owner's satisfaction with construction progress and quality. It laid the foundation for the extended application of digital results in the whole life cycle. It has provided strong support for the national grid company's digital construction strategy.

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### *3.6. Digital construction management practice of power transmission and transformation engineering*

In order to promote the pace of digital construction of power grids, State Grid follows the working principles of "scientific research support, standards first, pilot construction, and accelerated advancement". Complete the research and preparation of relevant standard documents, and select the pilot application of the power transmission substation project, including: "One station, one line, one tube gallery", UHV Sutong GIL pipe gallery project, Zaozhuang 1000kV substation, 750kV Bozhou substation, 500kV Jimei Substation, 500kV Nanchang East Substation, 220kV Sanyingmen Substation, 220kV Mauluoxi Substation, etc., realized the practical application of 3D digital construction management in engineering. Among them, the UHV Sutong GIL pipe gallery project provides a practical basis for the study of the cost management intelligent control technology based on the ubiquitous Internet of Things.

### *3.7. Data model information based on technical business*

In the power grid project, based on the different cost models of budget estimates, budgets, and engineering quantity lists, it is necessary to comprehensively analyze the power quota and historical engineering, and comb all the engineering information into tabularized. Attributes. There are many single projects involved in the construction of power grid projects. In the process of sorting out the cost information, how to not miss the projects of individual projects is a difficult point in the data information.

## 4. Data model

In order to further improve the lean management and precision investment level of the power grid, promote the realization of the strategic goal of building a world-class energy Internet enterprise, deepen the integration of power grid construction and computer technology, and research on the intelligent cost control technology of power transmission and transformation engineering based on ubiquitous Internet of Things. The intelligent control system for power transmission and transformation projects has become an effective means. However, at present, domestic research on this aspect is concentrated on the cost control of a certain link. There is no organic combination of power transmission and transformation project estimation, budgetary estimate, budget, engineering process cost, and project settlement, and there is a disconnect between various links, which restricts the construction of power grid. development of. In order to solve this problem, the project is based on the whole process of control theory, technical and economic theory, computer technology and grid construction related requirements, respectively, from the following parts:

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Study on real-time dynamic calculation technology of engineering cost in construction process of power transmission and transformation project:

A) Dynamic analysis based on the 3D design handover result model, engineering progress confirmation process and management method. 1) According to the full coverage of the business, the digital design results are quickly analyzed, and the system effectively displays these three basic indicators to clarify the effect of the digital design results and the construction process. 2) Based on the communication effect, find the similarities and differences between the digital results and the actual scene, and realize the progress of the project.

B) Combining the results of digitalization of cost, research on the implementation of design and cost change based on 3D design model. 1) Analyze the impact of design changes on the cost of power grid construction projects, and clarify the three-dimensional design-automatic cost compilation-interaction process between design changes; 2) aim to reduce project risk, analyze design change management, and realize flexible processing of design changes; Combine cost, on-site risk and design change management, analyze possible changes in site construction progress, and optimize construction schedule.

C) Open the data of the estimation, budget, budget, engineering process cost and project settlement of the power transmission and transformation project, study the model algorithm applicable to the completion settlement, and realize the automatic calculation of the completion settlement.

1) Build a data docking standard specification, find the logical relationship between estimation, budgetary estimate, budget, engineering process cost, and project settlement data, and clarify the connection control method of data and business process at each stage. 2) Analyze the dynamic changes of the data of the power transmission and transformation engineering estimation, budgetary estimate, budget, engineering process cost and project settlement; 3)Based on the engineering quantity intelligent statistical data, analyze the actual cost and design change generated by the construction process The cost of the research is based on the 3D design results of the completion settlement automatic calculation technology.

Establish a data model for automatic calculation of engineering quantity, automatic calculation of material consumption, automatic calculation of project settlement, and automatic calculation of output value after power transmission and transformation project

1)Automatic calculation of engineering quantity: Firstly, comprehensively sort out the calculation rules of the cost of power transmission and transformation engineering, and study the automatic calculation of engineering quantity; 2) Automatic calculation of material consumption: calculation of material cost, calculation rules and parameter conditions, automatic calculation of material consumption The model algorithm realizes automatic calculation of material consumption; 3)automatic calculation of project settlement: firstly, based on the budgetary file, the engineering quantity of the actual cost of the engineering-related model is clarified; secondly, the relationship between the model information and the

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progress data is analyzed, and the construction based on the integrated data analysis is constructed. Model; Finally, based on the engineering quantity intelligent statistical data, analyze the actual cost and construction cost incurred in the construction process, and study the automatic calculation technology based on engineering settlement. 4) The automatic calculation of the output value is completed: the calculation value and the parameter conditions are completed by combing the output value, and the automatic calculation technology is completed based on the actual completed engineering quantity.

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