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Research on the application of BIM technology in engineering project auditing

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Abstract. Engineering project auditing is a core process to ensure the rational use of funds in engineering projects. With the development of information technology, the construction industry is undergoing a digital transformation. The application of BIM technology in engineering projects has significantly improved the efficiency and effectiveness of engineering project auditing. This paper delves into the application and innovation of BIM technology in engineering project auditing. First, it provides an overview of the basic concepts of BIM technology and its current application status in the engineering field. Next, the paper analyzes the problems and challenges faced by engineering project auditing and elaborates on the opportunities and advantages of applying BIM technology in this field. Finally, the paper proposes application scenarios for BIM technology in engineering project auditing, aiming to promote the development and innovation of BIM technology in the field of engineering project auditing.

Keywords: BIM technology, engineering project auditing, application, innovation, scenarios

1. Introduction

BIM enables information sharing throughout the entire project lifecycle, offering significant advantages and value in reducing audit risks, improving audit quality, and enhancing communication efficiency in auditing [1]. Currently, the development of BIM technology is still insufficient, especially in the field of engineering project auditing, where its widespread adoption is far from meeting the practical needs of auditing. Therefore, deepening the application and innovative research of BIM in engineering project auditing is of significant practical importance.

2. Overview of BIM technology

BIM, or Building Information Modeling, is a digital model-based technology that integrates multiple dimensions of information, including structural components, material properties, investment, cost, time, and more. By modeling engineering projects, BIM provides support for the design, construction, and operation and maintenance of buildings. As an advanced digital tool, BIM technology is widely used in the construction and engineering fields, including architectural design, construction process management, and post-delivery operation and maintenance.

2.1. Architectural design

During the architectural design phase, BIM technology can assist architects in building performance simulation, component clash detection, and construction plan selection. BIM technology can simulate lighting, heat transfer, and construction cost calculations for the architectural design model. These simulations are not limited to the physical structure of the building but also include functional expansion and cost control, helping designers better assess design outcomes and select the most satisfactory design plan. Through the comparison and analysis of multiple design options, optimal configurations can be achieved. By examining the scientific and rational connections between components in the architectural design plan, potential construction conflicts and accidents can be avoided. Additionally, by simulating the building's usage scenarios, architectural performance and sustainability designs can be optimized, improving energy utilization efficiency and overall effectiveness.

2.2. Construction process management

BIM technology is primarily used for construction simulation, schedule management, and material tracking. During the early stages of a project, BIM models can perform clash detection and analysis of building components, allowing for timely corrections to poor designs, simulating and predicting the construction process, reducing construction errors and changes, avoiding waste, and lowering project costs. At the same time, the BIM platform supports online collaboration among multiple users, allowing various stakeholders (such as owners, designers, contractors, etc.) to work on the same model and collaboratively manage the project schedule, improving work efficiency and coordination. Furthermore, during the construction phase, BIM technology provides an instant communication platform for all stakeholders, enabling them to share and improve construction data, track material usage, and perform refined management to reduce unnecessary losses caused by information asymmetry.

2.3. Post-project delivery operation and maintenance

After the completion and delivery of an engineering project, BIM technology can be used for building facilities management, energy consumption analysis, and maintenance planning. BIM technology integrates all relevant information of building facilities into a single model, allowing maintenance personnel to intuitively understand the facility layout, operational status, and historical records through the 3D model, providing accurate data support for operation and maintenance tasks. The comprehensive integration and visualization features of BIM technology enable maintenance personnel to quickly locate issues, develop maintenance plans, and track the execution of these plans, thus improving the accuracy and efficiency of maintenance work. BIM technology can also integrate various sensor data to monitor performance indicators of facilities in real time (e.g., temperature, humidity, energy consumption), simulate hidden components, and through data analysis, help the maintenance team gain deeper insights into the facility's operational status, identify potential issues, and provide a basis for facility performance and safety assessments, ultimately enhancing the reliability and lifespan of the equipment.

In the field of engineering technology, BIM, with its powerful 3D modeling capabilities and integrated application of information technology, enables comprehensive and efficient management of engineering projects from decision-making and design, through construction process management, to post-delivery operation and maintenance.

3. Problems and challenges in engineering project auditing

Engineering project auditing refers to the process of reviewing and evaluating an engineering project from decision-making and implementation to completion and acceptance, to ensure its legality, compliance, and rationality. Common types of engineering project auditing include cost auditing, bidding and contract auditing, and economic responsibility auditing. The main objectives of engineering project auditing are to control project costs, prevent resource waste, ensure timely project completion, and create economic benefits [2].

Currently, the engineering project auditing process faces a series of problems and challenges.

First, the decentralized storage of engineering information leads to low audit efficiency. The entire lifecycle of an engineering project involves multiple stages, and project information is often stored in a decentralized manner. The formats or data ports of the information provided by various project participants may differ, making it difficult for auditors to accurately and promptly access information and integrate data, thereby hindering effective audit checks and reducing auditing efficiency. The decentralized storage of engineering information causes a disconnect between audit data. There is a lack of effective integration between existing information systems, resulting in the inability to smoothly transfer and integrate information across different systems. This low level of integration not only affects data completeness but also increases the workload of auditors, as they need to spend more time verifying and organizing information and data from different systems. For example, the separation of project management systems and tax accounting systems may lead to errors in cost accounting.

Secondly, the audit effectiveness is poor due to the lack of widespread data collection tools. As engineering projects, especially large-scale projects, continue to expand in size and complexity, traditional auditing tools are no longer sufficient to meet the requirements of modern engineering project audits. According to surveys, in the region where the author is located, most engineering project information tools have not been widely adopted. Engineering project auditing has not yet incorporated modern information technology methods and still relies on traditional practices. Auditors, when performing on-site inspections, list the required data as table items and send them to the audited entities for manual completion. After collecting the forms, auditors manually compare and analyze data discrepancies and review paper-based project documents for any suspected areas. This manual or semi-automated data collection method not only affects audit efficiency but also increases the risk of human error. The outdated data collection tools limit the depth and breadth of the audit work. If the engineering project is large in scale or has many sub-projects, auditors can only use a sampling method for the audit, making it impossible to cover all project details. This results in audit conclusions that may have significant discrepancies.

Furthermore, the lack of real-time monitoring and early warning mechanisms makes it difficult to effectively manage project risks. In current engineering project audits, traditional audit methods tend to focus on post-event checks and assessments, making it difficult to detect potential risks during the project execution phase. The lag in auditing not only increases the likelihood of risks occurring but can also lead to a series of cascading problems, such as cost overruns and schedule delays. The introduction of BIM technology offers the possibility of real-time monitoring and early warning for engineering project audits. Through BIM modeling, auditors can dynamically track project progress, including changes in work quantities, fluctuations in material prices, etc. Once abnormal situations are detected, the early warning mechanism can be triggered immediately, alerting relevant parties to take necessary intervention measures. This allows for effective risk management and cost control of the project. The application of such real-time monitoring and early warning mechanisms will undoubtedly enhance the efficiency and accuracy of engineering project audits, providing strong guarantees for the smooth progression of engineering projects.

Therefore, exploring the innovative application of BIM technology in engineering project auditing has become an inevitable trend for the development and digital transformation of engineering audits.

4. Engineering project auditing based on BIM technology

BIM technology brings significant advantages to the digital application of engineering project auditing. First, BIM provides a multidimensional information model that allows the entire lifecycle of an engineering project to be stored in data form rather than paper documents. Auditors can use BIM technology to inspect project design plans, dynamically simulate the construction process, and review contract agreements, design change requests, visas, settlement reports, and other data. Meanwhile, the BIM information platform can reflect the design, construction, and operational status of the project in real time, providing comprehensive data support for auditing tasks. Second, the visualization feature of BIM technology makes complex engineering project information easier to understand and communicate. Auditors can leverage the platform's functionalities to monitor and control the entire project lifecycle, changing the traditional post-event auditing model. This breaks down the barriers of information asymmetry that occur at specific audit points, helping to identify potential issues and inconsistencies. Additionally, BIM's simulation capabilities can predict potential risks in the project, offering forward-looking analytical tools for engineering project auditing. Finally, the collaborative work platform of BIM enhances information sharing and communication across different project participants, improving the efficiency and quality of auditing work.

BIM technology brings significant innovative advantages to the application of engineering project auditing. The author hopes that using BIM technology to conduct project audits can expand the scope of application scenarios:

4.1. Engineering cost auditing

Engineering cost auditing is a crucial aspect of engineering project management. In engineering cost auditing, auditors can use the BIM model to quickly extract and analyze the budget data from the design phase, generating detailed reports on project costs. This significantly enhances the accuracy and completeness of budget audits.

In the early stages of a project, the design unit is responsible not only for architectural design but also for the design estimate and construction drawing budget. When the design estimate is complex, the auditing process becomes more challenging. Engineering project auditors can utilize BIM technology to assist by carefully comparing key information from the design estimate—such as pricing rules, tax rates, and material costs—with standard values and market prices in the database, thereby verifying the rationality and accuracy of the budget preparation. Additionally, using the modeling and calculation features of the BIM platform, auditors can automatically generate accurate project quantities simply by inputting design drawings and relevant parameters, effectively verifying the accuracy of the design estimate and construction drawing budget.

Under traditional auditing methods, auditors are required to perform audits based on 2D drawings during the design phase. This not only consumes a significant amount of time for quantity verification but may also result in issues such as missed quantities or double-counted items, which severely affect audit quality and efficiency [3].

BIM technology, by integrating digital information, helps auditors better understand the design estimates and construction drawing budgets during the design phase, accurately calculate project quantities, and avoid errors that may arise in traditional manual calculations. Furthermore, the visualization feature of BIM models aids auditors in understanding the project details more effectively and identifying potential design flaws or budget overruns.

4.2. Bidding and contract auditing

Bidding and contract auditing primarily focuses on the authenticity and legality of the bidding process, as well as the review of bidding documents and contract terms. BIM technology can assist engineering project auditors in improving efficiency during the audit of the bidding process, the qualifications of the contracting parties, and the consistency of contract terms.

Auditors can use the BIM platform to verify the authenticity and legality of the entire bidding process, examine whether the preparation of the tender documents complies with regulations, check whether the qualifications of the bidders meet the required standards, analyze whether the pricing in all tender documents is reasonable and truthful, and review the relationships between the bidders to detect possible collusion, bid-rigging, or other unethical practices. The online bid evaluation in a BIM environment enhances transparency and improves the credibility of the evaluation process.

During contract auditing, auditors can use BIM modeling to clearly understand the project’s scope of work, quality standards, and schedule requirements, enabling them to assess whether the tender documents and contract terms align with the actual project conditions. Additionally, based on the BIM model, auditors can perform online checks to verify the qualifications of the contracting parties and conduct a detailed review of the tender documents and contract terms to ensure consistency with the bidding requirements.

4.3. Construction process auditing

In construction process auditing, BIM technology provides a new perspective and tools for engineering cost auditing. Through BIM modeling, auditors can track the progress of the project in real-time, accurately calculate the quantities for each phase of the construction, and compare these with the project budget, enabling them to identify and correct cost deviations in a timely manner. The three-dimensional visualization feature of BIM allows auditors to visually review construction processes and site layouts, assess the rationality of construction plans, and evaluate their impact on costs. When design changes occur, the BIM model can quickly update quantity data and cost information, allowing auditors to immediately perform a review, verify the implementation of contract terms, manage changes and claims, and avoid audit risks caused by delayed information. Additionally, BIM technology enables the integration of multiple data sources, facilitating information sharing and collaborative work, which improves communication during the auditing process.

By inputting all meeting documents, site inspection photos, materials and equipment acceptance reports, change orders, improvement suggestions from supervisors, and other relevant data into the BIM system, and continuously updating and enhancing the data storage, auditors can ensure the depth and breadth of the audit. This fully leverages BIM's advantages in comprehensive project auditing [4].

Therefore, the application of BIM technology in construction process auditing not only enhances the timeliness and accuracy of the audit but also provides data and platform support for effective communication among all project participants and the formation of valid audit conclusions.

4.4. Final settlement auditing

The core of final settlement auditing lies in verifying construction quantities, reviewing material usage and price differences, and auditing the application of change orders to construction quotas.

BIM technology, through its three-dimensional visual model, records the progress of the engineering project and all changes throughout its lifecycle, providing auditors with an intuitive and comprehensive view of project data. When applying BIM models in engineering audits, auditors no longer need to repeatedly examine design drawings to understand the detailed information of the project. Instead, they can observe relevant information through the three-dimensional model and stay updated on changes in design and cost variations [5]. Compared to traditional final settlement auditing, auditors can directly process large amounts of data automatically using the BIM model, enabling quick and accurate checks of engineering components, calculation rules, and project changes, thus avoiding errors from manual calculations. Moreover, the BIM model can continuously update project information, allowing auditors to stay informed with the latest data on quantities, ensuring the timeliness of audit results. This also reduces the risk of data manipulation and helps effectively prevent fraudulent activities. In terms of material usage and price differences, BIM technology can track the quantities and price information of each material in detail. Auditors can quickly compare actual material usage with the estimated quantities and the market prices with contract prices via the model, allowing them to accurately assess the reasonableness of material costs. Furthermore, BIM technology assists auditors in evaluating the application of change orders to construction quotas. By comparing the BIM models before and after changes, auditors can clearly identify the content of the changes and their impact on the project costs, providing strong support for audit efficiency and accuracy.

5. Conclusion

The application of BIM technology in engineering project auditing has significantly enhanced audit efficiency and accuracy, bringing more possibilities to the digital application of project auditing. Through BIM models, auditors can intuitively grasp project information, track project progress in real time, accurately calculate quantities, and promptly identify potential risks. The visualization features and coordination capabilities of BIM not only enhance the timeliness and reliability of auditing work but also provide platform support for effective communication among all project participants.

When conducting engineering cost auditing, bidding and contract auditing, construction process auditing, and final settlement auditing based on BIM technology, there are significant advantages compared to traditional auditing methods. As BIM technology continues to mature and spread, its application prospects in the field of engineering project auditing will become even broader, contributing to better cost control and improved project investment efficiency.

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