

Research on Digital Transformation of Construction Engineering Cost Based on BIM Technology

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ABSTRACT

This study discusses the application of BIM technology in the digital transformation of construction engineering cost. In view of the difficulties in cost management, such as complexity, time and space influence, human factors and irregular construction organization design, it emphasizes the importance of improving professional ability, strengthening drawing review and ensuring timely update of design changes. BIM technology provides accurate bill of quantities and cost estimation through three-dimensional parametric modeling, enhances the accuracy and dynamics of cost management, optimizes information flow and collaborative work, and reduces communication errors and repetitive work. BIM technology plays an important role in design deepening, bill of quantities compilation, resource procurement, quality and safety control, schedule management and financial settlement, etc. It can automatically extract drawing information and reduce human error. The proposed solution is based on Guang Lianda software, supplemented by Revit/BIM5D, which realizes seamless data docking and real-time update, and improves the efficiency and accuracy of project management. The maturity and application of BIM technology indicates a more efficient and economical future for the construction industry.

KEYWORDS

Digital Transformation; Building Information Model (BIM) Technology; Full Cycle Cost Management

In the digital transformation of construction industry, BIM technology is very important to improve the efficiency, accuracy and dynamics of project cost management. BIM provides accurate bill of quantities and cost estimation through three-dimensional parametric modeling, and optimizes project information flow and collaborative work. This paper analyzes the application of BIM in overcoming difficulties in cost management, including design scheme deepening, bill of quantities compilation, resource procurement, quality and safety control, schedule management and financial settlement, supporting settlement audit and quality assurance maintenance, improving project efficiency and quality, and promoting the sustainable development of the industry.

1 Difficulties in project cost management and technical characteristics of BIM under the background of digitalization

1.1 Analysis of difficulties in project cost management

Complexity of sub-projects: In the digital transformation of the construction industry, project cost management faces challenges such as complexity, time and space influence, human factors and irregular construction organization design. Human factors, including missing items in the list, deviation of engineering quantity and inaccurate description of the project list, require improving the professional ability of compilers, strengthening drawing review, ensuring timely updating of design changes, enhancing coordination among disciplines and accurately recording construction changes.

Affected by time and space: Time and space factors affect cost control, including design changes, prolonged construction period, fluctuation of material prices, rising labor costs, market competition, changes in policies and regulations, supply and demand of resources and environmental protection policies. Managers need to comprehensively consider these factors and take effective measures to control costs.

The human factors in the early and late stages have a significant impact: The human factors in the early design stage have a significant impact on cost control, including insufficient cost control in the design stage, designers' lack of consideration of economic factors, imperfect cost management system and underestimation of the importance of the design stage. It is very important to improve the economic consciousness of design, optimize the design scheme, enhance the scientific design and implement the quota design system to accurately control the project cost, help reduce rework and change, ensure the rationality of the scheme and effectively reduce the project cost.

Unscientific and standardized construction organization design: The nonstandard construction organization design leads to unclear construction scheme, unreasonable resource allocation, difficult schedule management, increased safety risks, waste of materials and quality problems, inaccurate calculation of engineering quantities and omissions in the preparation of project list, increased difficulty in settlement audit and high cost of quality assurance and repair in the later period. Managers need to take meticulous management measures to optimize cost control.

Digital tools can not be effectively linked in the whole project cost: In the digital transformation, the key challenge of project cost management is the fault of digital tools in the whole project cycle, which affects the consistency of cost management. Specifically, the engineering quantity and cost data generated by BIM software cannot be effectively transferred to the subsequent stage; The optimization ability of BIM collaborative platform in the bidding stage is limited by insufficient integration of change information; The efficiency improvement of digital tools in the contract management stage is limited by the untimely feedback of change information; The BIM technology is not well connected with the financial settlement system in the construction stage; And the BIM audit software is out of touch with the later cost control in the settlement audit and quality assurance maintenance stage. In order to solve these fault problems, it is necessary to build a unified digital platform to realize seamless docking and real-time updating of data, strengthen communication and cooperation among project teams, improve the proficiency of digital tools operation, and formulate strict data management and information flow management processes to realize digitalization, continuity and whole process control of project cost management, and improve the efficiency and accuracy of project management.

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1.2 Digital technical characteristics of the whole process cost

BIM technology realizes the digital transformation of cost management in the whole process of construction projects, improving accuracy and dynamics. Specifically, the feasibility study stage: use BIM software (such as Revit) to carry out 3D parametric modeling, generate accurate bill of quantities and cost estimation, and enhance scheme visualization and design coordination. Bidding stage: use BIM collaborative platform (such as Navisworks) for model integration and collision detection, optimize design scheme and identify construction problems in advance. Contract management stage: use contract management software (such as Procore) to realize contract electronization, so as to ensure the transparency of terms and consistent implementation. Settlement audit stage: BIM audit software (such as Solibri) is applied to provide multidimensional building information model to ensure the authenticity, accuracy and compliance of settlement.

BIM technology has obvious advantages in improving project information flow and collaborative efficiency, but it faces the challenges of high initial cost and data compatibility between software. It is suggested that unified data standards and interface protocols should be established, software compatibility should be strengthened, and project teams should be trained to improve BIM application ability, so as to improve information flow coherence and collaborative efficiency.

2 Analysis on the advantages of integration of whole process costmanagement software based on BIM technology

Under the background of digital transformation, the whole process cost management of construction projects is undergoing a transformation from traditional methods to modern management based on BIM technology.^[4] The first part of this paper has deeply discussed the application and necessity of BIM technology in project cost management. This part will further analyze the advantages of using a single software platform to run through the whole process of cost management, and compare the functions of different software to propose a comprehensive solution.

2.1 Advantage Analysis of Single Software Platform

Consistency and consistency of data: Using a single software platform, such as Guanglianda Cost Software, can ensure the consistency and consistency of data in all stages of the project from design to construction to settlement. This consistency avoids errors and information loss caused by data conversion between software in construction, and improves the reliability of cost management. For example, when transmitting data in multiple softwares, there may be format incompatibility or data loss, while a single platform can maintain data integrity and accuracy.

Improve work efficiency: A single software platform can realize seamless docking of workflow, reducing the time cost of switching between different software and data synchronization, thus improving work efficiency and project management speed. Switching between multiple softwares may lead to work interruption and reduced efficiency, while a single platform can provide continuous workflow and reduce interruption.

Reduce the cost of training and maintenance: For the project team, a single software platform means a lower learning curve and less training requirements, and at the same time reduces the complexity of software maintenance and upgrading, and reduces the long-term operating costs. Multiple softwares may require different operation skills and

maintenance strategies, but a single platform simplifies these requirements.

2.2 Comparison of software functions

Revit: As a BIM modeling software, Revit performs well in three-dimensional modeling and design, but its function in settlement cost comparison is limited. Revit can provide accurate bill of quantities and cost estimation, but it is not as good as professional cost software in financial settlement and cost control.

BIM5D: BIM5D software can simulate the changes and visas in the construction stage, but it is not as intuitive and powerful as Revit in modeling. BIM 5D has advantages in cost control and change management in construction stage, but its application in design stage is not as good as Revit's.

Guanglianda cost software: Guanglianda cost software has powerful functions in cost management, cost control and settlement audit, but it is not as good as professional BIM software in modeling and construction simulation. Guanglianda software can provide detailed information of building elements and realize accurate cost estimation and budget control, but its application in design and construction stage is limited.

2.3 Comprehensive solution

Through the above comprehensive consideration, the following is a solution mainly based on Guanglianda cost software, assisted by Revit/BIM5D:

Design stage: use Revit for 3D modeling and design to ensure the accuracy and feasibility of the design scheme. Revit's parametric modeling ability can provide accurate bill of quantities and cost estimation for the project, and lay a solid foundation for subsequent cost management.

Construction simulation and change management: In the construction stage, BIM 5D is used to carry out construction simulation and manage changes and visas. The 4D and 5D simulation functions of BIM 5D can help the project team to predict possible problems in the construction process and make timely adjustments, so as to optimize the construction process and cost control.^[3]

Cost management and settlement: During the whole project cycle, use Guanglianda cost software to conduct cost estimation, control and settlement audit. The strength of Guanglianda software lies in its ability to provide detailed information on building elements, realize accurate cost estimation and budget control, and ensure that the payment settlement is consistent with the actual workload.

2.4 Conclusion

By implementing a single software platform, significant advantages can be achieved in the whole process cost management of construction projects. This integrated solution can improve project collaboration, data transparency, risk management, cost control, quality assurance and environmental sustainability. Although there may be some challenges in the implementation process, these challenges can be overcome through careful planning and implementation. Finally, a single software platform will bring more efficient and economical future development to the construction industry.

3 Pre-application of BIM technology in the whole process cost of format digitalization

3.1 Deepening of design scheme

BIM technology plays an important role in improving the design, construction and management efficiency of building projects. Through the three-dimensional digital model, BIM technology realizes the visualization of the design scheme, enhances the coordination of the design team, reduces the design error rate and improves the design quality. Combined with tools such as CAD and Revit, BIM technology helps to check and avoid collision events and optimize design. 4D progress simulation links the design model with the construction progress plan, realizes the visual management of the construction progress and improves the construction efficiency. As shown in the figure, it is the deepening scheme of the project after BIM technology is applied, which can intuitively and clearly understand the layout of each pipeline (Figure 1).

BIM technology shows the construction process, technological process and operation principle in detail, which helps builders find unreasonable construction procedures, reduce rework costs and improve construction quality. It also carries out cost planning and management of the project, realizes dynamic control and management, and improves the operating efficiency of funds and rational distribution of resources. These advantages promote the efficient construction and operation of the project, and realize the improvement of design quality, the optimization of construction process, the enhancement of project management efficiency and the effective reduction of cost.

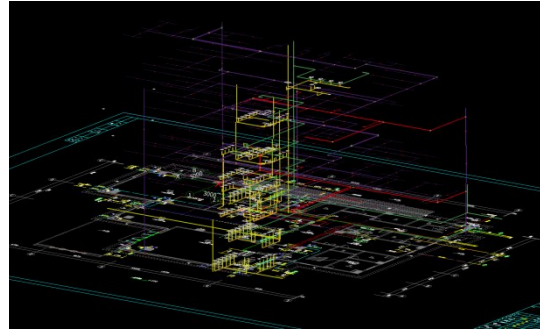


Figure 1 Water supply and drainage and water supply and drainage fire fighting model based on BIM technology.

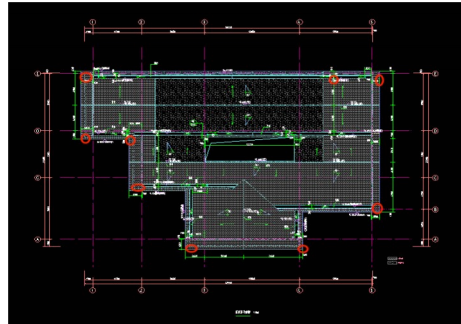


Figure 2 Construction plan design based on BIM technology

3.2 Project List Preparation

In the aspect of bill of quantities compilation, BIM technology realizes the accurate compilation of bill of quantities by automatically extracting design drawing information, model data and database data. It reduces human error, saves time and cost, improves cooperation efficiency, and enhances the visualization and traceability of bill of quantities. In the practical application of the whole process cost of BIM in Sunflower Kindergarten, BIM technology is outstanding in improving compilation efficiency, reducing errors and controlling cost. In the design stage, BIM technology reduces omissions and errors, and avoids cost overruns caused by design errors. In the construction stage, BIM's real-time data sharing and collaboration capabilities improve the efficiency of project management and reduce the delay and extra cost caused by poor communication. In the settlement stage, BIM technology ensures the integrity and accuracy of the data and effectively avoids the claim phenomenon caused by incomplete data. For example, the downspouts of cast iron products is calculated to be 8763m, but when the contract was awarded for the second time, the labor contractor proposed that some areas needed processing and construction, resulting in the actual construction area being larger than the calculated area, which led to economic losses for the general contractor. When the BIM technology is used to compile the bill, the construction content of the project in the building information model can be clearly defined, which can realize the accurate calculation of the consumption of various materials and the construction area and effectively safeguard the interests of all parties in the project. BIM technology has played an important role in controlling project cost, realizing cost control in design and construction stage and risk avoidance in settlement stage.

4 BIM technology in the whole process of digital cost transformation process application

4.1 Optimize resource procurement

Digital transformation has improved the efficiency and quality of project management in the field of construction engineering. Through cross-regional collaboration and optimization of management process, accurate tracking and management of the whole project cycle are realized by using data analysis technology. Digitalization improves management efficiency in human resources, material supply chain, cost control and supplier relationship management. For example, in the construction of Sunflower Kindergarten, BIM technology helps the project team accurately understand the material cost and optimize the design scheme to control the cost.

In order to optimize the procurement of engineering resources, digital measures have been taken: building a digital procurement platform to break the limitations of offline procurement and realize online and automation of procurement processes; Establish a supplier management database to centrally manage supplier letters to ensure systematic and efficient management; Strengthen the digitalization of bidding and procurement, and enhance standardization and transparency; Implement a hierarchical examination and approval system to ensure compliance and safety; Establish a

unified supply chain digital platform to improve the speed and flexibility of response and provide data support for decision-making. These measures have effectively improved the procurement efficiency and project management quality.

4.2 Quality and quantity safety control in the construction process

The quality and safety management of residential buildings is very important for residents' safety and social stability, especially in the context of rapid urbanization. The current challenges include insufficient structural safety and seismic performance in the design stage, poor management in the construction stage, insufficient supervision and lack of regular inspection and maintenance in the operation and maintenance stage. In order to meet these challenges, the measures taken include strengthening design audit, strengthening construction quality control, establishing project supervision system and regular inspection and maintenance mechanism in operation and maintenance stage.

BIM technology provides a new solution in the design, construction and operation and maintenance stages. In the design stage, BIM identifies design conflicts in advance through 3D visualization and collision detection optimization schemes, such as 3D modeling of Sunflower Kindergarten. In the construction stage, BIM optimizes resource allocation through construction simulation and progress tracking, improves construction efficiency, and monitors construction progress and quality. In the operation and maintenance stage, BIM integrates building information, provides data support for facility management and maintenance, and improves the service life and performance of buildings, such as building quality analysis and safety assessment in the construction of Sunflower Kindergarten to ensure safe use.

Based on the quality and safety management system of BIM technology, the whole process of monitoring and optimization of building quality and safety management is realized through information means. The core contents include building an information platform for project management, formulating a standardized process for quality and safety management and establishing a data collection and analysis mechanism.

The key steps include making implementation plan, technical training and staffing, monitoring and adjustment to ensure the effective operation and continuous optimization of the system. BIM technology provides technical support for the quality and safety management of high-rise residential buildings and promotes the sustainable development of the construction industry.

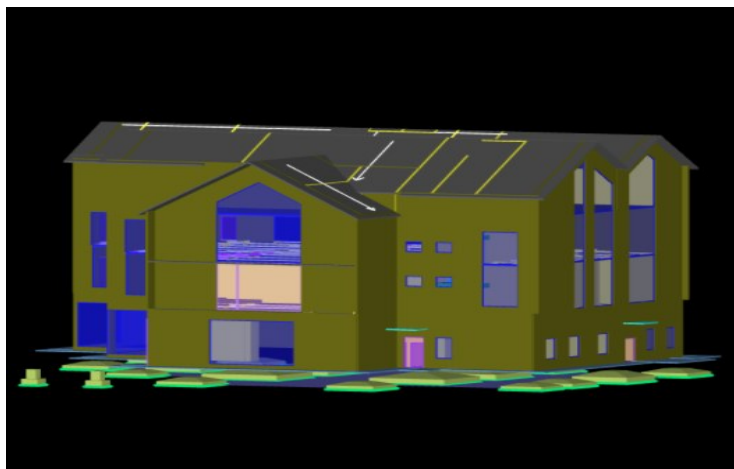


Figure 3 3D model established under BIM technology

4.3 Project Schedule Management and Financial Settlement

In project management, BIM technology optimizes the schedule and financial management. Through the 4D simulation and dispatching mechanism, BIM realizes dynamic and visual progress monitoring, finely manages people, materials and progress, integrates with field data, and adjusts deviations in time. In technical construction, BIM platform integrates data to form a virtual construction plan, and guides field operations through dispatching work orders. The design unit uploads the three-dimensional model to the BIM platform, and the construction unit executes it accordingly to ensure safety and compliance. BIM system records materials and mechanical information to support detailed management of construction plan.

As a bridge between implementation and planning, the dispatching list allocates tasks and resources through BIM platform, and the supporting monitoring system ensures the authenticity of data and improves management efficiency. In the financial aspect, BIM provides building element information, realizes cost estimation and budget control, integrates with project management software, realizes real-time correlation between progress and cost, and ensures that settlement is consistent with workload. When the design changes, BIM can quickly update the cost and schedule, reduce

construction errors and rework, and reduce the cost. As a document platform, BIM simplifies the settlement process, enhances information transparency and promotes communication and cooperation. BIM technology also ensures construction quality, optimizes supply chain management, reduces inventory cost, provides cost analysis and report, and supports payment settlement decision. Automatic payment process reduces errors and speeds up payment. The risk management function of BIM identifies and plans countermeasures to reduce the risk impact. These methods effectively control the project cost, optimize the settlement process, reduce disputes and speed up payment.

5 BIM plays a crucial role in the latter stages of the digital transformation of the entire project cost management process

5.1 Settlement audit

Settlement audit is the key link to ensure the authenticity, accuracy and compliance of project settlement. It involves reviewing the contract price, changes, visas and other information. Under the background of digital transformation, settlement audit is particularly important for the later management of Golden Sun Kindergarten, which improves the review effectiveness of completion settlement and realizes fine accounting. BIM technology provides a comprehensive building information model, which helps to comprehensively review the engineering quantity, cost and time, and ensure the rationality and authenticity of settlement. BIM technology integrates information, reduces errors and omissions, visually displays projects through three-dimensional models, helps auditors identify problems and improve design, and saves about 15% of audit time and cost. This method not only improves the audit efficiency, but also ensures the accuracy and fairness of settlement.

5.2 Warranty maintenance

Warranty maintenance refers to the service that manufacturers or service providers provide free maintenance or replacement for quality problems or failures during the warranty period of products or services. This service aims at protecting consumers' rights and interests, improving customer satisfaction and maintaining the reputation of enterprises. From the perspective of the digital transformation of the whole process cost, there are risks such as unreasonable resource allocation in the quality assurance maintenance link. BIM technology provides reliable and high-quality information on project design scale, schedule and cost in the quality assurance maintenance of Golden Sun Kindergarten, which helps to allocate resources reasonably, ensure maintenance quality and efficiency, and reduce maintenance cost by 20%. BIM technology records the previous scheme information, allowing the maintenance management unit to compare the records at different time points and types, and track the facilities, maintenance status and progress. This is helpful to verify the rationality, quality and feasibility of the design scheme, and reduce mistakes and omissions. Through BIM technology, the maintenance work of Golden Sun Kindergarten during the warranty period was completed ahead of schedule, the maintenance cost was reduced by 20%, and the customer satisfaction was continuously improved.

6 Epilogue

In this paper, the application of BIM technology in the whole process of construction cost management is discussed in depth, and the key role of BIM technology in improving the efficiency, accuracy and dynamics of cost management is clarified. BIM technology optimizes design scheme, bill of quantities, resource procurement, quality and safety control, project schedule management and financial settlement through its three-dimensional parametric modeling and real-time data updating capabilities, and significantly improves the modernization and intelligence level of project cost management. In the stage of settlement audit and quality assurance maintenance, BIM technology further ensures the authenticity and accuracy of project settlement, and provides support for the rational allocation of maintenance resources. These applications not only improve the quality of construction projects, but also provide new impetus for the sustainable development of the construction industry. With the continuous maturity and wide application of BIM technology, we have reason to believe that it will bring more efficient and economical future development to the construction industry.

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