

Research on the Optimization of Whole-Process Management of Construction Engineering Projects Based on BIM Technology

Renqun Yu

Longquan Water (Tianchang) Co., Ltd., Chuzhou, Anhui, 239000, China

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Abstract: Construction engineering projects are characterized by long construction periods and large capital investments. Effective cost control at each stage is essential to significantly enhance the value of engineering projects. With its unique advantages, BIM technology has gradually become a core tool for optimizing the whole-process management of construction engineering projects. It not only helps construction enterprises save substantial costs but also promotes the transformation of the construction industry towards informatization and intelligence. Starting from the characteristics of BIM technology, this paper analyzes the problems existing in its application in the whole-process management of construction engineering projects and proposes targeted optimization strategies, including improving the technology application system, establishing a collaborative management mechanism, and strengthening the training of BIM professionals. The aim is to provide references for enhancing the efficiency of whole-process management of construction engineering projects and to promote the in-depth application and development of BIM technology in the construction engineering field.

1. Introduction

The construction scale in China has been still expanded for many years, and with the complexity of engineering project became more and more intricate. With the gradual development of construction engineering, traditional project management models have encountered a lot of challenges and cannot meet modern high-quality and efficient management requirements. In this context, as a digital technology with data collection, modeling analysis and collaborative management functions, BIM technology provides a new way out of integrating and optimizing the whole-process management of construction engineering projects. At present, the application of BIM technology in the field of construction engineering has gradually transitioned from the initial exploratory stage to a large-scale and deep development stage. However, its actual management value is limited by various factors in real applications, so construction enterprises must still actively seek scientific and practicable optimization strategies to improve the individual project management level of construction engineering projects.

2. Characteristics of BIM Technology

BIM technology has become an important innovative tool for construction project management due to its three core characteristics that distinguish it from traditional technologies. These characteristics provide key technical support for optimizing whole-process management.

Firstly, information integration. Traditional project management often relies on external resources for information, leading to fragmented data about various aspects of the project and hindering effective collaboration among stakeholders. Such a BIM model can flexibly incorporate the geological survey data and design parameters of the early stage of project construction, schedule plans, material information, cost data during its construction phase, as well as equipment parameters, energy consumption data and maintenance records in operation and maintenance process. Not only does this make it possible to input data once and reuse it multiple times, which can prevent the risks of repeated input errors, but also provides information support that is comprehensive and accurate

for all participants of scientific management decisions supported by the project ^[1].

Secondly, 3D visualization. Relative to the traditional 2D drawings, BIM technology can establish three-dimensional visual models and give an intuitive description of the design schemes and construction processes as well as details of the components regarding construction engineering projects. This can help designers pinpoint design flaws and better optimise schemes earlier. It also makes it clearer for project personnel, construction units, supervision units and other parties about what needs to be done in a project, effectively reducing communication errors.

Thirdly, collaboration. IntroductionThe construction engineering of is a complex system with multiple participants. Traditional management models still use paper documents or single software for information transfer between different parties, leading to problems such as information lags and poor communication. The collaboration management platform establishes a real-time data sharing mechanism, enabling all participants to work together in the same model environment. Real-time update of optimized design schemes to the BIM model by design units, adjustment and implementation of construction plans according to the updated model by construction units, supervised real-time monitoring of construction quality through the model, and acquisition of project design and construction information in advance for operation preparation by operation & maintenance ^[2].

3. Problems with BIM Technology in the Whole-Process Management of Construction Engineering Projects

3.1 Incomplete Technology Application System and Insufficient Adaptability to Actual Project Requirements

At present, the BIM technology has been laid great emphasis on modeling and collision detection in the design stage, and short of deep application in advanced dynamic scheduling control during construction stage, real-time management of cost accounting in construction stage, intelligent equipment management in operation & maintenance. Consequently, the management properties of the BIM technology have not been maximally taken advantage of. Some of the projects have built BIM models in design stage, but they still use traditional schedule management software on construction stage and do not deeply integrate the planning with its corresponding 3D BIM model so as to realise the real-time tracking and deviation warnings of construction schedules. Nowadays, there are a wide variety of BIM software on the market, and poor compatibility of different software's data formats easily leads to "data islands", thus restricting information transfer across various stages and participants of projects. In addition, a number of BIM technology solutions not only focus on technological promotion but also ignore the scale, type and management requirements of actual projects, making it impossible for the application technology to keep pace with actual projects in many cases, and increasing project management costs considerably.

3.2 Inadequate Collaborative Management Mechanism and Low Collaborative Efficiency among Multiple Participants

BIM technology is known for its collaborative nature, but to date most construction engineering projects have not formed a comprehensive collaborative management mechanism based on BIM technology, resulting in generally low collaborative efficiency of multiple participants . To begin with, there are no standardized collaborative management standards. It is easy to cause problems such as non-standard information input, untimely updates and chaotic permissions, affecting the orderly implementation of collaborative work due to not clarifying the specifications for entering information, the frequency of updates and the division of permissions for each module in BIM model between participants. Secondly, The Functions of Collaborative Management Platform Are Incomplete. Regarding some of platforms offer just information sharing functions only but lack core collaborative functionalities like real-time oral communication, task delegation, timeline planning and problem feedback -- which can not satisfy the genuine need of collaboration among more than two persons ^[3]. Thirdly, there is a lack of collaborative awareness among all participants. Some

units still have the habit of "independent operation" management model and do not pay attention to BIM collaborative management. Disturbance in document tiller sharing and creation of a work team which further lowers the effectiveness rate.

3.3 Insufficient Reserve of Professional Talents and Weak BIM Technology Application Ability

The successful utilization of BIM skills calls for composite talents who have a knowledge background in construction engineering project management and knowledge of BIM tool operation and application. But at present, the reserve of such talents in the construction industry is seriously insufficient, becoming a bottleneck that restricts the in-depth application of BIM technology to whole-process management. Firstly, for practitioners in the traditional construction industry, their knowledge structure is relatively unitary. Most of the personnel only have some common management knowledge and experience, but lack systematic learning about BIM technology principles, software usage skills, data analysis and other aspects, so they can not use BIM technology effectively to complete management work. In particular, the training professional construction of BIM specialty colleges and universities and vocational colleges is behind the teaching in our country, about curriculum setting of relatively disconnected with compatibility with industrial demand. The primary issue with Graduates is that they do not have the knowledge of any project and it becomes really difficult for them to adapt to get a job on time. Moreover, enterprises do not pay enough attention to the basic training of BIM technology for existing employees; most enterprise's training is only limited to simple operation in software, and there is no more advanced training on application scenarios in whole-process management, so that the BIM technology application ability of employees cannot meet project management needs ^[4].

4. Optimization Strategies for Whole-Process Management of Construction Engineering Projects Based on BIM Technology

4.1 Improve the BIM Technology Application System and Enhance the Adaptability of Technology to Project Requirements

BIM technology has certain deficiencies in traditional management and can make up for these deficiencies through whole-process project management docking. And to achieve its value in application, construction enterprise should establish a complete BIM technology application system, so as to make it adapt to the requirements of project characteristics. In order to achieve this, construction companies should timely promote the deep application of BIM technology throughout the life cycle of the project, breaking through the application pattern that emphasizes design and ignores construction and operation maintenance. In addition to traditional modeling and clash detection in the design stage, construction enterprises should carry out performance analysis and scheme comparison through BIM technology, so as to improve the scientificity and rationality of their design schemes. In the construction stage, it is required to deeply combine the relevant content of BIM model with schedule plans, cost data, and quality standards, so as to establish "BIM + schedule management", "BIM +cost management" and"BIM+quality management" integrated platform to realize real-time tracking of construction schedules and dynamic accounting of costs.tracking quantitative quality control. At the operation and maintenance stage, they should establish an intelligent operation and maintenance platform based on the BIM model, by collecting various information such as equipment operating data, energy consumption data and maintenance records to realize fool-proof warnings of equipment faults, performance optimal energy consumption monitoring management and automatic construction of some intelligence for preparing maintenance plans to enhance operation and maintenance management efficiency ^[5].

Based on the above work, construction enterprises should also continuously strengthen BIM software compatibility construction and promote unified data standard communication standards. Industry associations should lead in establishing unified BIM data exchange standards, clarifying the standardized data format and information code rules of inter-software to reduce "data islands" on the one hand; Alternatively, software companies should also be encouraged to develop BIM

software with cross-platform data compatibility functions or third-party tools for data conversion to realise seamless data connection between different software. Moreover, during the project initiation stage, relevant BIM software and technology solutions should be selected according to project scale, type of resisting a premium hot specializing equipment-management requirements and costs incurred in that an approach combining people and technology avoids blindly pursuing technological advancement; can guarantee that the application of technology meets the actual needs of the project.

4.2 Establish a BIM Collaborative Management Mechanism and Improve the Collaborative Efficiency among Multiple Participants

Building construction engineering projects due to the complexity of implementing multiple subject entities must establish a BIM collaborative management mechanism according to the specific circumstances to allow all the subject entity reasonable application of BIM technology. First of all, unified BIM collaboration management standards should be established to clearly define the division of labor and work process of all participants. During the early stage of project construction, the construction unit should take charge and work with design, inspection and maintenance and other related parties to determine rules regarding BIM information input standards, updating frequency and authority segmentation in order for collaborative work to follow established guidelines. Secondly, the optimization of BIM collaborative management platform function should cater to the cooperative needs among multiple participants. With real-time communication, task assignment and problem feedback modules integrated into the existing platform of construction enterprises, it can be realized the whole-process collaborative management of "information sharing-task assignment-problem solving-achievement archiving" ^[6]. At the same time, mobile access should be supported so that on-site management personnel can view models and enter data and feedback problems in real time, enhancing the convenience and timeliness of collaborative work. Thirdly, Enhance the collaborative awareness of all participants to cultivate collaborative culture. Using project initiation meetings and special training sessions, construction companies should publicize the concept of BIM collaborative management and its advantages to all participants to transform the traditional "independent operation" management concept. It is necessary to set up a collaborative work evaluation mechanism, with indicators including the timeliness of information sharing and efficiency of problem rectification integrated into performance evaluations for all parties so that all sides will be encouraged to do their best in collaborative work, an atmosphere of collaboration and win-win management formed ^[7].

4.3 Strengthen the Training of BIM Professionals and Improve the Technology Application Ability of Practitioners

In order to strengthen the force of compound talents in construction enterprises, this paper puts forward that it is necessary to enhance the training intensity of BIM technology for all kinds of employees and improve their ability to apply technology. Construction enterprises will in practice make plans of staff training into different layers and categories. That is, both the management personnel and the project team should conduct specialized training on "BIM technology and project management" to improve the decision-making capability using BIM technology. Technical personnel should be trained in the operation of BIM software and whole-process application scenarios to improve their technological application levels. And the operation personnel of front-line was also trained, at least an elementary training for them to view the model and know some information from it to complete his construction operations in BIM way. Meanwhile, take an active part in BIM professional qualification certification, and link the examination results with title evaluation and salary promotion to stimulate the enthusiasm of employees ^[8].

In addition to strengthening the training of personnel in building enterprises, there is also a need to build an industry BIM talent exchange platform for talent growth. The industry associations can regularly carry out seminars and skill competitions of BIM technology application to build a platform where practitioners exchange learning and show their skills. An established BIM talent pool can be integrated to excellent talent resources in the industry, so as to provide direct talent

support once for some projects and directly promote career development of practitioners while enhancing the flavor of improving overall quality-greatness of the industrys BIM Talent Team. In addition, the business-university cooperation must be more intense. Universities can also introduce some practical courses, BIM applications in construction management, BIM and intelligent operation and maintenance, including BIM data analysis according to the whole-process management of construction engineering projects, appropriately increase project case teaching class hours and software practical training hours students can participate in the actual project BIM application practice process accumulation of work experience achieve "school enterprise collaborative education".

5. Conclusion

BIM technology is a core tool for the digital transformation of the construction industry, which can technically support the whole-process management optimization of construction engineering projects. Today, an increasing number of construction enterprises are starting to use BIM technology for whole-process project management with some initial success. But at the same time, there are also problems like incomplete technology application system, collaborative management mechanism is not perfect and lack of professional talents reserve. It is necessary to take corresponding measures to solve these problems, so as to obtain the maximum application value of BIM technology. Forward-looking construction engineering project management, with the deep integration of BIM technology and big data and artificial intelligence, IoT and other technologies in the future, its whole-process management will be better intelligent and efficient application to promote China's construction industry high-quality intelligent development.

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