Research on application of building information management technology to engineering project management

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Abstract: as the construction industry develops, the scale and complexity of construction projects increase as well. Clients are having higher and higher requirements for management levels and quality of the projects, and the traditional extensive management modes no longer meet the needs of the modern construction industry. Meanwhile, the management expertise directly influences a construction company’s development, and introducing building information management (BIM) technology into construction projects cannot only improve the construction management, but promote efficiency and intensive development of construction companies. This paper probes into the application of BIM technology in construction and its impact, with a vision to provide some reference for future projects.

1. Introduction

1.1. Research background

As China’s economy enters the New Normal and under the impact of the coronavirus epidemic, the economic growth has shifted from fast development to stable development; and its development mode has become more quality- and efficiency-oriented. Behind these transformations, however, a lot of problems reared their ugly heads, such as imbalance between scale and profit, lack of expertise of project managers, etc., which are caused, in fact, by the backward extensive management modes in the past. The traditional project management mode is not amply supported by information technology, and the information integration and sharing tools are outdated, and thus effective integration of information cannot be realized. Management on such a basis fails to coordinate different parties involved. Therefore, to introduce BIM to construction project management can help enterprise in refined management and adapt to the new economic development pattern.

As pointed out in “2016-2020 Construction Industry Information Development Outline”, informatization is a major development strategy of the construction industry, and a necessary measure to improve the quality and efficiency of this industry. Thus, introducing BIM technology to construction project management not only meets the needs for development of construction companies, but follows the direction of sustainable development.

BIM is a major construction information technology. When applying BIM in design, construction and maintenance of projects, we can visualize and share in real time the parameters and important data...
to realize coordination. It can remedy the defects of engineering project management, and thus facilitate standardization and informatization of project management.

BIM has been applied to construction for quite a long time, but its practical application stays in collision test in the design stage and visualization, but seldom in the construction process. Meanwhile, for most enterprises, collection and sorting of data stay in the single project, while data and information of different projects are seldom integrated, thus making application of BIM stay on the superficial level. Therefore, improving the application of BIM to construction projects can effectively promote transformation of the project management mode. This paper studies the application of BIM in construction project management.

1.2 Research objectives
As the world enters the information age, traditional construction project mode needs to be reformed. There have been many successful cases for application of information technology to project management, such as application of information technology to medical service and to retailing and manufacturing. However, its application in the construction industry is limited. The main objectives of this study are as follows:

- By analyzing the current situation of traditional project management, this study intends to explore the feasibility and necessity of application of BIM to construction project management;
- By analyzing the application methods of BIM in the process of construction project management, this study aims to propose suggestions as to better apply BIM to the whole life cycle of construction projects.

2. Current research situations of BIM in China and abroad

2.1 Current research situation of BIM abroad
The concept of BIM was proposed by Prof. Chuck Eastman in the 1970s. The IFS standards released by the U.S. was one of the earliest BIM standards adopted in the world [1].

The BIM technology proposed by Burca Akinci has been widely applied to the construction industry. The computing model that can be further improved during construction can provide all participants in the project with the required information [2].

Ehsan Kamel argued that the BIM technology could be used to 3D modelling, structural analysis, and cost estimation [3]. A. Volkov, based on the expenditure and use model and valuation model, proposed the requirements for application of BIM technology, which are necessary conditions for large-scale application of BIM [4].

Peter Smith explored the problems facing the project managers in using BIM and proposed solutions and suggestions [5]. Po-Han chen conducted studies by combining the BIM 5D technology [6]. Ritu Ahuja and Anil Sawhney proposed a system development method based on BIM to make project quality control more effective and coordinated [7].

2.2. Current research situation in China
It has been long since BIM was introduced to China, but its application in practice has a short history.
By analyzing the papers on BIM published between 1971 and 2020, we found that BIM has drawn more and more attention among scholars in these years. Content analysis of these papers revealed that most of these papers focused on the design perspective, but few were on project management.

Analysis of papers on application of BIM to project management shows that BIM-based project management has drawn increasing attention from scholars since 2013. Current research in this regard is not sufficient, but the trend shows that more scholars will engage themselves in relevant studies.

Meanwhile, as the Progress in National Engineering Quality Safety Improvement Initiative for the second and third quarters of 2018 and the second and third quarters of 2019 released by Ministry of Housing and Urban-Rural Development show, 616 and 799 construction projects have adopted BIM in the second and third quarters of 2017, respectively; while the number for the second and third quarters of 2018 amounted to 961 and 1305, respectively; the number for the second and third quarters of 2019 reached 1041 and 1540, respectively, a 68% and 92% year-on-year increase than 2017. The statistics above show that we application of BIM has seen wider application in construction projects in China.
Zhao et al. from Chongqing University studied the application of 4D virtual construction technology in engineering projects [8]. Chen Jie from Tsinghua University built a Cloud-BIM collaboration platform, and confirmed that cloud computing and BIM have the potential to support collaborative design of construction projects [9]. Yuan Yongbo from Dalian University of Technology studied the relationship of BIM application [10]. Zhang Ying applied BIM to practice and argued that preliminary modelling could provide more post-construction support [11].

3. Application of BIM in the whole life cycle of construction projects

In traditional project management modes, decision-making, implementation and operation of the projects are independent, and such independence leads to much trouble in project management. As a result, the project manager has hard access to all information and thus cannot obtain an effective information chain. Moreover, absence of effective connection among different links add to challenges in management. Introducing IBM to the whole life cycle of construction projects provides a good solution.

3.1 Application of BIM in decision-making of construction projects

Traditional decision-making in construction projects entails repetitive verification and modification. Introducing BIM to the decision-making stage cannot only realize informatized management of verification and modification process. Meanwhile, by using BIM, we can conduct modelling of different plans and overall planning of the projects, allowing decision-makers to better capture the conditions of the project and making it more convenient to retrieve materials.

3.2 Application of IBM in implementation of the project

3.2.1. The design stage

The design stage of a project includes the design preparation stage and the design stage. The quality of design has immense impact on the result of the project. In traditional project management, due to the many organizations included in a project, communication and collaboration are hard to realize, and as a result, the design concepts cannot be realized in construction. Meanwhile, due to the difference between the project effect drawings and the actual construction drawings, it is hard to control the investment. Therefore, for large and complex projects, the BIM can facilitate design due to its advantages like efficient visualization and parameters. Also, the models built in the planning stage can be forwarded to the design stage.

For large projects in the past, due to the complexity and difficulty in design and construction, there are many design problems. Using BIM in the design stage can solve problems in layout and piping, thereby improving the control of investment and construction cycles.

![Figure 5. Application of IBM in implementation of the project in the design stage](image)

3.2.2. The construction stage

During construction, the expertise of the project managers usually falls short of the ideal, leading to extensive management and managerial problems. Because of these problems, most of the time, on-site
construction management can rely only on the experience of the manager and thus is prone to errors. By introducing BIM to the construction stage, the 4D and 5D BIM-based management can accurately control the construction process, simulate the materials deployment, reduce safety hazards, and avoid unnecessary rework, thereby realizing information management of construction. For instance, software like Navisworks and Fuzor can be used during construction to avoid collisions in piping and realize remote video display. Using BIM in construction can also allow all parties involved better capture the progress of the project and make timely adjustment. The Guanglianda BIM 5D software can be used to realize information management of construction materials, quality control and all aspects of a project, thereby minimizing the losses in the project caused by human. For instance, BIM can be applied to quality supervision to control the quality of the project, produce documents and test results to better serve the project.

Figure 6. Project quality supervision and management system based on BIM

3.3. Application of BIM in construction project maintenance

Applying BIM to maintenance means combining BIM with project operation and maintenance to realize scientific management of the assets of construction projects. Using BIM can reduce the cost of operation and preclude potential disasters. In actual construction, the Internet of things technology and cloud technology can be used in combination with the BIM model and traditional maintenance to model the design and implementation of construction projects so that the model can better serve the operation of the projects. BIM is no longer a single model, but a system that provide comprehensive statistics that reflect the actual operation of the project, which reduces the cost and improves the efficiency of the project.

4. Conclusion

Using BIM in construction project management can solve many problems that traditional management modes fail to solve and realize refined management. Despite the many problems that this technology has in application, it is foreseeable that it will enjoy wider adoption in construction management.

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