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Analysis of BIM Technology in Construction Management Process

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Abstract. This article mainly explores the specific application of BIM technology in construction management and focuses on introducing the role BIM technology plays in multiple aspects such as ensuring project quality, guaranteeing construction safety, optimizing project progress, and on-site management. The research results show that BIM technology has characteristics such as visualization, collaborative workflow, and dynamic simulation. These features have significantly enhanced the precision of construction control and also improved both construction safety and efficiency. BIM technology not only effectively optimizes project cost and schedule management but also promotes construction practices towards intelligence and sustainable development, which fully demonstrates its great potential in the future implementation process.

Keywords: BIM technology, construction engineering, construction management.

1. Introduction

As the construction industry continues to move towards digital transformation and intelligence, building information modeling (BIM) technology is becoming increasingly common in various application scenarios. This innovative approach, by achieving visible and integrated information sharing and collaboration, provides particularly powerful support for construction management and ultimately enhances project efficiency. The quality standards have also become higher.

In the field of construction management, there are many major challenges, including those related to quality control, safety protocols, progress management, and whether on-site resources can be effectively allocated. Under such circumstances, the implementation of BIM technology is particularly crucial for solving these problems in construction management. BIM technology can rely on creating 3D models to identify potential design conflicts at an early stage, that is, conflict detection. This ensures that the project can proceed smoothly. The application of BIM technology in quality management has also been verified by many people as feasible. Managers rely on real-time updates of construction models and then analyze the data. It can respond quickly to the changes that occur on site, adjust the construction plan in a timely manner, and effectively prevent possible risks in terms of quality.

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2. Application of BIM technology in construction management

2.1. BIM technology concept, characteristics and development

BIM technology is an integrated information management tool of Building Information Modeling, or BIM for short. It has gradually become a crucial technical means in the construction industry [1]. BIM technology first emerged in the early 1970s as a two-dimensional design tool. According to the content of Reference, it started from a two-dimensional design tool [2]. It has gradually evolved into 3D modeling. Up to now, it is developing into building information modeling with data at its core. The core definition of BIM technology is to use digital 3D models to achieve information management throughout the entire life cycle of a construction project, which includes many different stages such as the design stage, construction stage, and maintenance stage. BIM technology has some very unique features, which are mainly reflected in the aspects of informatization, visualization, and collaborative work.

2.2. Application of BIM technology in construction stage

2.2.1. Site management

In construction projects, on-site management is like the key cornerstone of project execution. Its core responsibilities mainly include three key aspects. Firstly, it is necessary to ensure the safety of the workplace, so that the personnel working there will not encounter danger. Secondly, it is necessary to optimize the allocation of resources, so that various resources can be used reasonably. Finally, it is necessary to maintain strict quality control throughout the entire construction process to ensure that the quality of the products built meets the standards. These key components are extremely necessary for the success of the project. When advancing the project, they should be given priority. If on-site management can be effectively implemented, there will be many benefits. On the one hand, it can reduce costs and prevent the project from spending so much money. On the other hand, it can ensure that the operation is safe and the quality complies with relevant regulations In this way, the project will eventually be completed on schedule. From the perspective of safety management, the primary goal is to ensure that on-site operations are safe. Currently, there is a building information modeling (BIM) technology. If this technology is adopted, potential hazards within construction sites can be accurately identified and monitored [3].

In the field of modern construction management, BIM technology, namely Building Information Modeling, is an innovative digital solution. With its powerful information sharing ability and real-time monitoring ability, it can significantly improve the efficiency of on-site management [3]. BIM technology promotes information exchange among different disciplines by establishing three-dimensional digital models, reduces communication barriers caused by data asymmetry, and optimizes the process of collaborative work. All its real-time monitoring functions can dynamically track construction indicators, which enables on-site teams to quickly identify potential risks and resolve them [4]. The integrated monitoring system will analyze the real-time data on the utilization of resources at the construction site and the performance of workers, and then adjust the construction plan in a timely manner to ensure that the project schedule can be effectively managed.

2.2.2. Quality management

Quality management is a very crucial part of the construction process. It ensures that all final project specifications meet the established standards. Fundamentally, this dynamic and changing system

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consists of four key stages: the planning stage, the implementation stage, the inspection stage, and the improvement stage. Its main purpose is to apply scientific management methods. To reduce the possible uncertainties that may occur during the construction process, thereby enhancing the controllability and reliability of physical projects. In the actual construction process, quality management not only needs to meet the requirements of design, regulations and customer demands, but also involves optimizing the allocation of resources and reducing the costs required for construction.

The application of BIM technology in quality control can play a crucial role in several dimensions. In terms of optimization during the design stage and real-time monitoring during the construction process, by analyzing the process, we can clearly demonstrate how BIM technology improves the overall construction quality [5].

During the design stage, BIM technology can conduct multi-dimensional and all-round analysis and simulation of building information [6]. By establishing an accurate 3D model, designers can identify potential design flaws and issues related to construction feasibility relatively early, effectively reducing the need for rework in the later construction phase. By relying on BIM modeling, the project management team can identify safety risk points such as equipment transportation routes and construction loads at the initial stage, and then formulate emergency plans in advance to minimize the probability of risks. BIM also promotes the sharing of real-time information, which enables all stakeholders to be prepared in case of emergencies. Quickly access the updated data. In this way, the allocation of resources can be optimized, making the emergency response capability faster.

2.2.3. Project schedule management

In construction projects, progress management means effectively arranging and controlling construction activities within a specific time. The core of progress management is to ensure that the project can be completed within the specific time.It will be able to save costs and reduce budget of the project and also make the project more controllable.

With the widely used of Building Information Modeling (BIM) technology in project progrees management, the traditional way of schedule management of the past is becoming more and more informationized and visualized [7].

Building Information Modeling, has obvious advantages in the project progress management. When it comes to visual progress management and making decisions based on data, BIM technology witch relying on 3D modeling and dynamic visualization methods, can comprehensively display all stages of the project and present complex information intuitively. This make sure that all stakeholders can be able to quickly understand the specific status of the project's progress. There is a large-scale infrastructure project witch has adopted BIM technology. By using the real-time updated progress model, the project managers can easily identify error and take corrective actions in time And. it is also a good way to reduce the occurrence of dead line delays and resource waste.

In addition to the ones mentioned above, there is another advantage of using BIM technology in project management. The manager will be able to make Decision based on data [8]. BIM technology can integrate factors such as historical progress records, construction data and external impact, and then, build a reliable prediction model on this basis. This makes sure that the project teams could be able to plan and adjust the construction schedule more scientifically. Studies have shown that the project can be shortened through the application of BIM. What’s more, the quality and safety of the project can also be ensure [9].

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2.2.4. Construction safety management

Safety management is in fact, a very critical basic requirement of the management process of construction projects, in terms of the smooth implementation of the project. It is generally true that there has been more construction into safety requirements in the construction industry today [10]. Thus, adopting viable risk evaluation and control has gained special significance. BIM technology, or Building information model shows high potential in this sphere. Through virtual modeling of construction and data analysis, possible risk factors can be determined and preventive or prevention strategies developed.

HAZOP or Hazard and Operability Study is a common method when it comes to risk assessment. This approach is holistic in terms of the analysis of the possible anomalies in construction process and can use the multi-dimensional data offered by BIM technology to the full extent so that the staff taking part into the process could be in the visualized environment and be aware of exactly what it is all about the risks.

The BIM technology has the potential to produce a three dimensional model in detail with the help of visualization tools, of the construction location.Consequently, the real-time risk assessment and up-to-date information are provided. During the early planning phase of the project, the project team will be able to understand possible safety risks and subsequently establish positive emergency actions and plans to minimize the chance of exposure to risks. BIM technology can also promote the sharing of real-time data, ensuring that all stakeholders can immediately obtain the latest information when emergencies occur. This easy flow of information would be more rational when it comes to the allocation of resources, in addition to increasing the speed of the emergency response.

3. BIM technology application case in construction management

3.1. Application examples of BIM technology in construction safety management

Over the recent years, Building information Modeling or BIM technology has launched as an essential tool in building safety management. This method has been demonstrated to portray a very significant role in the safety control through some case studies. E.g. in one of the high-rise building projects the contractor integrated both BIM and VR technology to make virtual safety simulation room. When that immersive VR places workers in a simulated experience of an accident it enables people to actually experience potential hazards and this significantly improves their safety consciousness. BIM-AR technology also allows the company to access the site prior to construction, thereby allowing the personnel to learn the operating environment and safety measures. The construction site shall employ cameras sensors and local area network technology to gather the real-time visual data. Thereupon, the information gathered will be scrutinized, working with the assistance of the BIM platform. This way, it will be possible to maintain constant control over the state of safety [11].

3.2. BIM technology application in engineering quality control

BIM technology plays an important role in building quality managemen. Taking a Large-scale bridge construction Project as an Example, the construction team integrated the Internet of Things and BIM technology, which enabled real-time monitoring of the temperature, humidity and material quality at the construction site, achieving digital supervision of engineering quality. The construction team utilized temperature/humidity sensors and Internet of Things facilities connected to the BIM

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platform, fully leveraging the platform's multi-party collaboration capabilities. If there are any problems with construction or material quality, the BIM system will immediately alert the management, ensuring that corrective measures are taken in a timely manner. This application has significantly improved the efficiency of construction teams in quality management, effectively reduced material waste, and greatly lowered costs [12].

3.3. Application of BIM technology in construction schedule management

Application of BIM technology in construction schedule management BIM technology plays a particularly crucial role in construction progress management. Take a seven-story office building project as an example. The construction team used BIM modeling tools to formulate a progress plan and created a virtual construction plan. They tracked the floor progress according to the specified deadlines and component milestones, thus achieving real-time monitoring of the entire project schedule. This process is essentially to draw structural diagrams layer by layer, then establish a 3D model, and then use this 3D model as the basis for computer simulation of virtual building schemes. By using this method, potential problems can be identified early and adjustments can be made in a timely manner to prevent risks. This approach can improve efficiency by reducing material waste and labor costs. It can also visually highlight the situation of progress delay, allowing people to clearly understand the completion status of the project [13].

4. Conclusion and outlook

This article, by studying the application of BIM technology in construction management, points out its crucial role in enhancing project quality, ensuring construction process safety, making project progress more reasonable, and improving resource allocation. With the transformation of the construction industry towards digitalization and intelligence, BIM technology, with its visual and integrated information management capabilities, It is gradually replacing the traditional management model and promoting comprehensive innovation in construction management.

In terms of construction quality management, BIM technology will apply collision detection and dynamic monitoring methods to assist professionals in promptly identifying potential issues during the design and construction phases. This approach can significantly reduce the probability of rework and enhance the overall quality level of the project. BIM can accompany the creation of the 3D model that will help the construction team display the plan of work in the definite way in the course of the particular work implementation. In this way it is possible to optimize the construction details and in this way the mistakes caused by the information asymmetry could be reduced as much as possible. Regarding safety management, BIM will model the construction site and make and develop scientific and reasonable safety rules and emergency rescue and rescue measures. This has the power to both minimize the risk of accidents as well as increase safety awareness of the workers. Its industry needs to be concerned about all its risk prevention and control capabilities.

Regarding project progress management, BIM technology may encourage information exchange and interrelation between various parties working on the project through real-time update and visual management. By doing so, when the construction team encounters such scenarios then they can manage the emergencies quite fast and ensure that the project does not advance in an uncontrollable manner. The decision-making mechanism based on the facts can ensure more scientific and reasonable scheduling of both projects, more efficient distribution of resources, and multiplication of the overall positive economic effects. Based on the findings of the case study, Bim-driven construction projects have realized comparatively high-profile effects in enhancing the progression

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of the development process and lower the costs. It confirms the fact that this technology has tremendous potential as applied in practice. Analyzing a specific project at a high rising building, it is possible that BIM technology is an important tool active at construction quality control, management of the construction site, and other issues. And also in rendering this role effective it is impossible without effective cooperation on the part of all interested parties.

In the future research, the combination of BIM technologies with other tools to support the construction management will be the main trend to ensure that construction management development. The goal of resource optimization, control costs and larger cost management capabilities of the project may be achieved with this approach of integrating BIM technology with the other management tools. Through the use of BIM technology, it can correctly address issues facing construction management as well as offer viable technical support to the sustainable development of construction industry. To realize growth in the future, the construction industry will also be more and more dependent on this technology, to drive continuously the ability to innovate and better.

The findings that are made by the present study will help furnish some reference materials and real-life scenarios wherein the application of BIM technology can be explored, and also help professionals in the industry acquire their own understanding of the BIM technology. We hope that in future practical work, more extensive research work can be carried out. This article aims to provide some valuable references for the academic community and industry practice, thereby promoting innovation in construction project management and enabling it to make progress.

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