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Building Information Modelling (BIM) Application in Construction Industry

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Abstract: ***The Building Information Modelling (BIM) includes design and construction information. It is not only visual presentation, but also state construction simulation. The main application of BIM is to provide 3D animation, environmental analysis, green energy analysis, crash detection analysis, quantity & cost analysis, operation and maintenance information. The BIM model provides platform for information integration. It is helpful for design evaluation and assist designer to verify drawing correctness and consistency. All kinds of information can improve project management level. By analysing relevant information of the construction process, the BIM model can provide a better way to the building operation management also. Therefore, many enterprises are starting to adopt BIM tool, but some of them do not know the BIM series function clearly, because there is no more specific reference to use. This article resource is according to literature review from different references, such as conference and journal articles. This article is to analyse BIM application in practices and compare & summarize relevant research results. The results display various influence through adoption of BIM, such as 3D/4D/5D/6D functions. Finally, the article objective is to promote the whole BIM functions could be applied completely in the construction activities.***

Keywords: building information modelling, BIM, construction industry, project management, BIM application

1. Introduction

With the development of the construction industry in recent years, the owner & developer's expectations are higher than before for their construction project. Because their requirements are increasing, such as the building quality, safety, earthquake resistance, green energy, environmental protection, work schedule control and the others. The construction design trend becomes complex. It needs more effective technology and tool to improve relevant work, such as 2D and 3D computer-aided design instrument, including the latest BIM technology.

BIM supports optimization of building designs in order to aid selection of alternative design elements and materials before they are actually constructed. In addition, the construction participants hope to know the visual building model through 3D appearance previously. It is helpful to communicate with the owner, architect and contractor, then reduce building design errors or variation orders. The BIM tool plays an important role in the construction activities. Wong, (2019) presented that BIM technology strengthened interaction between different parties.

Through various literature review articles about BIM application, the readers study the BIM technology and try to apply it in the construction industry. Because some of the articles' contents of BIM function are fragmentation or separation, so the participants need integral BIM application information. This paper aims to analyse relevant articles systematically, including BIM 3D/4D/5D/6D applications.

2. Methodology

The research method of this article is using various reference papers through online searching from google scholar. The main keywords include BIM application, BIM technology, construction industry, project management, the BIM advantages, and the others.

3. The BIM Application In Construction Industry

3.1. The application of BIM 3D model

In the building construction activities, the site planning is the first stage of construction commencement work, including the site entrance, temporary fence, tower crane location, hoister location, temporary generator, temporary water tank, and the other. How to simulate the real facilities & equipment relationship in the virtual space is an important work for construction engineers It needs tool to rehearse the relationship as much as possible in the virtual space. The BIM 3D model can show the various site components visually. Some of the site planning issues can be found out intuitively also. Lau, et al. (2018) have applied the BIM 3D technology during their pre-construction stage.

Stober, et al. (2018) presented an example of the BIM for designing parametric objects was to create a rich information model. Through the BIM 3D application, the main contractor participants can discuss the reasonably site plan according to construction condition and optimize the allocation space of facilities, equipment, and material store area. This process is helpful to construction management get suitable site layout and select a feasible construction plan.
In the traditional way of design working, the construction drawings are presented in main three views, layout, section, elevation. This leads to design information are separation easily. It is difficult for the designer to cooperate with each other due to the lack of unified data model. The BIM has the ability of information integration, visualization and parameter. It can reduce the repetitive work and interface difficulty. Jinhua, et al. (2019) presented an example of highway project are integrated on the unified BIM platform for collaborative management to achieve intercommunicate information, exchange isolated situation information, improve the parameter management. The BIM is no longer as a simple reference file and create a project resources. The construction participants use this platform to integrate

collaborative design between the various professional information.

Based on construction industry communication requirements, the project participants need exchange design information during the construction process. The platform is important for participants to share relevant information and directly improve the work efficiency for their next step work. It needs ensure the construction information accuracy and consistency to support cooperation between the various project participants. Mohammad, et al. (2018) thought the BIM brought major benefits for construction parties including building visualization innovation and project coordination improvement.

3.2 The application of BIM 4D function

The BIM model is not only integration of the component information, but also provides a three-dimensional communication platform. Compared with the traditional method, it is very difficult to find out the clash problems between construction different special parties. The clash detection efficiency is greatly improved when the project participants through BIM application. It is easy to check the clash issues and helpful for participants to communicate. Then relevant participant can modify the design drawing to eliminate construction risks previously. For example, Mirzaei, et al. (2019) presented that BIM dynamic clash detection was developed to identify conflicts which extremely impacted on project performance. This approach can shorten the construction time, reduce hidden cost and improve the construction site work efficiency. Finally, BIM technology can find these potential design problems optimize design quality.

Koseoglu, (2019) thought that BIM are developed in order to increase productivity, efficiency and quality in construction by implementing various procedures, such as clash detection. By using BIM technology, the designers can easily check the conflict in the design stage under the virtual three-dimensional environment. This technology can greatly improve the comprehensive design ability for different special participants. It eliminates the construction collision risk and reduce delay cost through the construction coordination by BIM platform.

The traditional construction work schedule management is based on 2D drawing which has poor visibility problems. It leaded to communication difficulty between different participants. As a result, the actual construction progress often deviated from the work schedule plan. The BIM visualization technology simulates the project construction work process and establish the 4D management system, such as monitoring the entry time of construction manpower, material, equipment and other resources. Abiodun, (2019) believed that BIM technology has the capacity to provide work schedule management throughout the construction process.

The BIM 4D function guide each section work sequence in the construction period. This method is modelled as a powerful visualization and communication tool provide the project construction implementation details to the project participants. All participants are easy to know more about every construction schedule and monitor the project critical path. For example, the engineers Jose and Jacob, (2019) proposed to integrate BIM into an automated construction system, such as Planning and Operations Control Software for Automated Construction (POCSAC).

By linking BIM with the construction work schedule, the process information and time information are integrated into a visual 4D (3D+Time) model which can directly and accurately reflect the construction activity. The BIM 4D is one effective visualization management approach for the site assembly demands of in the construction process (Bataglin, et al., 2019).

Many safety problems are existing in the early design phase. The best effective way to eliminate hidden risks is from the design stage. Based on this concept, BIM tool provides suggestions for safety design through hazard analysis and carries out safety control on construction site. Furthermore, researcher Alizadehsalehi, et al. (2019) tried to combine BIM and unmanned aerial vehicles (UAV) to monitor the potential hazard location.

For example, Cheung, et al. (2019) applied the integration of BIM and Wireless Sensor Network (WSN) into a unique system which enables monitor the construction site visually under safety status. By using BIM corresponding accident analysis and simulation software, it simulates the disaster process before the accident emerged. This tool can analyse the reason of the accident and support first-aid plan. It provides important information for rescue workers when the accident appeared in the construction site. This method can reduce percentage of construction site accident and reduce the accident cost as possibly. It is helpful for participants to increase safety awareness in the construction activities also.
The building construction quality is an important work for the project management. It needs the effective tool to monitor the structure and architecture quality. BIM application contains various construction information including the materials and equipment data. So the site engineer can check the specifications quickly through model. In the technical quality management, the BIM can dynamically simulate the construction technical process. The BIM platform conducts the coordination among various professions to ensure the construction process feasibility and reliability. Li and Chen, (2019) presented an example that BIM technology reduces the quality damages which caused by the clash issues from various special work. Through the BIM technology application, the various steel components installation accuracy is ensured in the construction site condition.

According to BIM model information, the site engineer can check whether the site construction in accordance with BIM model or not. They can use tablet in the cloud way and verify size and the others. The BIM brings benefits including the ability to enhance overall construction quality and efficiency in the modern building project.

3.3 The application of BIM 5D function

According to the traditional method, the quantity survey is difficulty to calculate and waste more time. The other QS worker is hard to verify the amount also. As the application of BIM, relevant quantity is output directly from the model. It greatly improved the accuracy and efficiency for the project quantity survey.

The conventional quantity survey work relies on manual calculation based on the CAD documents. Because the CAD format only store the limited information. This is difficult to count automatically by the computer. The traditional method needs not only a lot of manpower but also lead to deviation easily. Ismail, (2019) presented that BIM developed more reliable cost estimates through BIM 5D reliable database information.

Sometimes, the statistical quantity is invalid because of the adjusted design. But the BIM is a different tool because it is engineering information database. BIM provides the various quantity information and helps computer to carry out statistical analysis quickly. The updated quantity summary is generated rapidly by BIM 5D function. It extremely reduces potential manual errors. The accurate quantity survey is obtained easily through BIM 5D application. For example, the engineers Menon and Varghese, (2019) developed labour productivity data acquisition method by integrating BIM tool. Nowadays, BIM 5D is widely used for the project budget estimation and construction cost control.

For example, Ashokkumar and Varghese, (2019) adopted the BIM application of construction waste management (CWM) which could be utilized to minimizing construction waste generation in the design. In addition, the application of BIM technology can reduce the waste of reinforcement by analysing the structural steel ratio of buildings and combine with RFID (Radio Frequency Identification) technology to strengthen construction waste management, recover recyclable materials at the construction site.

The construction variation order is not helpful to realize project cost control under the investment objective. So the construction industry needs necessary technology to improve the design accuracy as much as possible and reduces the variation order during construction process. If the change inevitable, the BIM 5D model could possibly integrate relevant variation information including quantity, cost and work schedule.

3.4 The application of BIM 6D function

The building operation and maintenance management needs the whole facilities control system. However, the traditional building construction information are often fragmentation from various contractors or suppliers. So it is to rely on a large number of manual record in the early operation period and often leads to data errors. With the application of BIM, construction project management Iyakoregha, et al. (2019) developed new competencies that enable construction project hand over effectively. Through the BIM 6D application, a large amount of construction information contained into BIM platform. The BIM 6D combine with operation and maintenance information for the building management system. In addition, the BIM combined with RFID facilities label chip is helpful for operator to get relevant data & information in the building clearly and quickly.

During the building service period, the structural and equipment facilities (such as facade, column, beam, electric, water supply, firefighting system, etc.) need to be constantly maintained. The successful maintenance plan should improve building performance and reduce overall maintenance costs. Lin, et al. (2019) tried to exploit a Final As-built BIM Model Management (FABMM) system based on BIM model for owners to execute inspection, modification, and confirmation work before project closeout. Green building evaluation system is to assess building design result according to the owner or government requirements, including building energy consumption analysis, indoor natural ventilation, sound environment analysis, internal and external airflow simulation, lighting analysis, crowd flow analysis and the other related building performance evaluation. For example, BIM was used to assist the architectural design, which can directly analyse the energy consumption. The BIM tool is combined with professional building system analysis software and verify energy efficiency according to design regulations and sustainable standards. Through these analysis and simulation, the calculation parameters can improve the whole building property performance.

4. Discussion and Conclusion

There are several 3D software in construction industry, such as 3Dmax, Sketchup, and the others. Many of these 3D visualization display is only for rendering in the earlier stage. The communication gap existed in construction parties, because the traditional drawing contained limited information lead to difficulty to execute in construction stage. There are a lot of design work finished based on the traditional CAD platform and using three views (such as layout, section and elevation) to present their stereoscopic results. This fragmentation information is easy to make participants lack of the understanding ability in the complex projects. Based on the current digital city construction, Xiao, (2018) presented that the BIM function could combine architectural planning into digital city.

BIM platform is not only providing the visualized three-dimensional graph previous for participants but also including series of construction information. It promotes interactive communication and feedback for the design results. The point is the building project plan, design, construction and operation are carried out in a visual state. The BIM is implemented in the Architecture, Engineering and Construction (AEC) inevitably, because the construction project demand sustainable, efficiency and cost improvements throughout project life cycle. Azmi, et al. (2018) thought the building construction project was involved with many professional parties, the BIM technology established the platform to communicate with each other. The participants are easy to understand designer proposed solutions through taking advantage of BIM and reduce the misunderstanding expression for each other.

With the concepts of Smart City in the construction industry, the BIM technology has become a hot research topic also. The BIM tools need exploit more application for construction industry in the future.

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