Application of BIM + big data in the whole life cycle of engineering project

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Abstract. Green, healthy and sustainable development has always been the goal of engineering construction enterprises, which is consistent with the national green environmental protection policy. The application of BIM + big data in engineering construction can effectively help solve problems such as pipeline collision in engineering design, schedule cost control in construction, poor communication and coordination. Its application improves the construction quality and management level, and supports the sustainable development of construction enterprises. This paper first expounds BIM + big data technology, then analyses the application and effect of BIM + big data in each stage of engineering construction, and puts forward some suggestions for the current development status, which has certain practical reference value.

1. Introduction
At present, BIM Technology has been widely used in China's engineering construction, but most enterprises only apply BIM Technology to a single stage, and there are few cases that BIM Technology is applied to the whole cycle of engineering projects. Big data technology is also gradually applied to engineering construction, and the 13th five-year plan also puts forward the goal of digital construction industry. The integrated application of BIM + big data can effectively control the whole process of project construction and ensure the integrity of project data information. The information data provides the basis for the whole decision-making process and enhances the core competitiveness of the enterprise. Digital information is also the future development direction of the construction industry.

2. Overview of BIM + big data

2.1. BIM overview and features
Building Information Modeling is a digital three-dimensional information model of engineering project, which is established with the help of computer-aided tools. Its application can effectively manage the project. What’s more, the BIM collaboration platform provides an information sharing platform for the design, construction, supervision, operation and maintenance teams to add, delete, modify and check the project model. In this way, the project can be managed in an information-based way to accelerate the progress of project construction and reduce risks.

BIM has the characteristics of visualization, information integration, coordination, simulation, optimization and plotability. Visualization is mainly embodied in the three-dimensional model, in which people of all parties can directly see the three-dimensional renderings of the main building, components, reserved holes, etc. Information integration means that the model integrates all
information of the construction project, including geometric information (such as construction scale, location) and non-geometric information (such as product information, status information). The model information will be continuously improved in the process of project construction and shared in time in the design process to provide support for later decision-making and operation maintenance. Coordination is reflected in collision inspection of professional drawings and analysis of regional design layout, which can help to find and solve problems as early as possible and reduce rework rate. Simulation mainly combines with visualization to simulate the energy conservation and construction safety of the project. In addition, the construction schedule can be simulated by importing the schedule. On this basis, the cost is added to the integration of 5D model to analyse and control the cost. Optimization does not mean that BIM itself has optimization function, but integrates all information (such as construction, materials, construction schedule, cost.) into this file. In combination with other optimization tools, it helps technology and decision makers to optimize. Plotability is not only to export 2D drawings designed by CAD, more importantly, BIM can directly export the horizontal and vertical section drawings and the detailed drawings such as the comprehensive pipeline drawings and the reserved hole drawings after coordination and collision inspection, so that the designers can improve the drawings more intuitively and the constructors can better construct according to the drawings.

2.2. BIM + big data technology
Big data technology, as the current hotspot, has attracted the attention of various professional fields. It is a kind of technology that uses computer-aided tools to mine and analyse massive data information and extract valuable information to support enterprise decision-making, mainly including data collection, cleaning, storage and visualization. BIM + big data technology can not only provide visual technical guidance and detail collision detection scheme for project design and construction from a professional perspective, so as to help improve work efficiency and ensure construction quality, but also provide data support for project management and decision-making from a macro perspective, so as to improve management level and decision-making accuracy.

3. Application of BIM + big data technology in all stages of the project

3.1. Investment decision-making stage
The investment decision-making stage mainly includes investment opportunity analysis, preparation of project proposal, feasibility study and project approval. In this stage, big data technology is used to collect data information (including whether policies and regulations are allowed, local economic consumption level, existing project investment income, industry competition status, etc.) for induction and analysis, from which key data indicators are extracted to provide data support for investment decision-making. At the same time, big data platform is introduced in this stage, which is applied to the acquisition, storage and comparative analysis of information data in the whole life cycle of engineering construction to help improve the efficiency of project organization and management. By using BIM Technology, the geographical and geomorphic characteristics of the project site, the coordination relationship between surrounding climate and buildings can be input into the three-dimensional model, the relevant information of the project can be visualized, and the project site can be analysed in depth. So as to make the budget more accurate, the investment analysis more scientific, and the investment plan more reasonable.

3.2. Project preparation stage
The main work in the project preparation stage includes the design and optimization of the construction scheme, the detailed design of the construction drawings, and the preparation of the project construction conditions (including land acquisition, equipment preparation, etc.). With BIM Technology, the model can be built on the three-dimensional information platform at the beginning of the scheme design, and the "turnover model" method applied at the initial stage is abandoned. The
scheme design is combined with the performance analysis of BIM Technology to quantify multiple indicators of architectural design and support the optimization of architectural performance and scheme design. For example, the method of "sunlight path study" in Revit can be used to analyse the sunshine, and the method of interaction between Revit and ANSYS Fluent, Pyrosim, EASE, Pathfinder can simulate and analyse the characteristics of wind environment, fire smoke spread, acoustic environment, and personnel evacuation. BIM Technology is applied to structural design, and combined with other software to analyse the floor stress, comfort and other structures, so as to improve the stability of structural design [2-3]. In the in-depth design of the scheme, the visualization of BIM Technology is used for drawing review, collision inspection of drawings within and among disciplines, clear height analysis, pipeline comprehensive optimization, etc., so as to discover problems in the design process in time, correct and optimize the design layout [4]. In the whole process of design and optimization, BIM collaboration technology provides a platform for file interaction and resource sharing, so that all participants can design, optimize and modify based on the same BIM model under the unified information standard, and finally form a unified BIM file. The BIM model can output the detailed drawings of building structure, such as horizontal and vertical section drawing, pipeline comprehensive drawing, reserved hole drawing.

BIM file contains detailed component price information. Based on this file, the extracted quantities can be obtained quickly and accurately, which provides the basis for cost control in the design stage. At the same time, big data technology can be used to collect, sort out and analyse the accumulated original data of existing projects. The unreasonable factors in the past engineering design and its cost budget are found out, and the optimization design scheme is analysed in time according to the actual engineering situation, so as to effectively control the cost in the design stage.

3.3. Bidding stage
Bidding is an important process of cooperation between investor and construction company. BIM file contains all the digital information of the construction project. The engineering calculation software can quickly and accurately summarize and calculate the engineering quantity, which is convenient for the bidding enterprise to calculate the quotation. Through the BIM, the bidding enterprise can minimize the miscalculation and omission in the cost process; it can also simulate the construction process in a visual form to show the construction effect; through the BIM-4D model to demonstrate the construction scheme, it can show the overall control ability of the enterprise on the project construction details, schedule, safety management, etc. [5] With the help of big data technology, we can crawl the data of relevant project asset cost and carry out cleaning and visual analysis, so as to provide decision-making basis for bidding enterprises.

The tenderer can use BIM software to check the bill of quantities, analyse the consumption of human, machine and material, and various rates, and find out the phenomenon of unbalanced quotation and collusion between bidders in time [6]. Using big data technology to deeply analyse the data indicators in the bidding quotation, combining with the community mining algorithm to analyse the relationship network between the main bodies, to prevent the occurrence of bidding collusion [7].

3.4. Project implementation stage
The implementation stage of the project is a process in which both parties of investment and construction invest a lot of people, money and materials to turn the design "blueprint" into an engineering entity. The comprehensive application of BIM + big data in the construction stage can enable the project management personnel to effectively control the construction details, quality, progress and cost, and make the construction personnel to grasp the latest data of project changes in time. Its application mainly includes the following aspects: (1) Construction guidance: BIM can accurately simulate the special construction scheme, important construction nodes and complex construction process. Therefore, the visual form is used to guide the construction of site construction personnel to ensure the construction quality and progress. It can also simulate the general layout of the construction site and put forward the optimized layout plan to ensure the orderly construction. (2)
Construction coordination management: BIM coordination technology provides a platform for data and information resources sharing among the owners, construction units and disciplines, promotes sound communication, ensures the timeliness and accuracy of all data in the construction process, and brings great convenience to coordination management. (3) Construction change management: the modification of construction drawings in BIM file can not only realize the linkage modification of each detail drawing, but also avoid the error caused by incomplete modification of drawings compared with 2D drawings. (4) Construction schedule control: the 4D virtual build based on BIM Technology is to set the time parameters reasonably according to the schedule. By using this method to simulate the construction process in the form of visualization, we can find the construction quality, construction risk and other problems that may exist in the construction process in advance. Big data technology is applied to analyse the delay of construction period caused by seasonal weather and unreasonable construction sequence. Then, according to the results, the response plan is formulated and the construction sequence is optimized to ensure the project delivery on time. (5) Construction cost control: the BIM-5D model integrated by three-dimensional model, construction period plan and cost plan, which can count the consumption of components and raw materials in each stage and form a list. Let the list compare and analyse with the consumption in the actual construction process, and grasp the cost expenditure in each stage in real time [8]. The project manager shall make optimization and adjustment according to the cost plan at any time to maximize the reasonable cost and benefit. (6) Construction safety management: big data technology is widely used in construction safety management and risk identification. The safety management engineer uses big data technology to mine data about human and mechanical activities, risk sources and accumulated construction safety [9]. And cleaning analysis, data and visual processing, from which we can obtain important indicators of safety management in the construction process, and can monitor the use of construction safety equipment in real time, which provide basis for construction safety management and prevent the occurrence of safety accidents. The results of data analysis can also be used as data to conduct safety education and training for construction personnel to ensure safe construction. At the same time, the BIM and the security management big data platform are linked to get the security construction plan.

3.5. Completion acceptance and operation and maintenance stage
After the completion of project construction, both parties shall carry out acceptance and delivery, and then enter into the project operation and maintenance stage. After the completion of the project, the completion settlement based on BIM documents has a high accuracy, which avoids the contradiction between the construction parties to the greatest extent. After acceptance, BIM documents shall be delivered. Combined with big data technology, the operation and maintenance management platform is built to carry out information management for engineering projects. It is mainly used in the following aspects: (1) Space management: Based on the operation and maintenance platform, the internal space of the building can be reasonably planned to maximize the space utilization [10]. (2) Facility management: BIM includes detailed information of equipment production date, service life, specific specifications, space orientation, etc. Maintenance personnel use big data technology to check the equipment regularly, which can reduce the occurrence of accidents. In addition, BIM can also be used to accurately locate the faulty equipment, timely repair and feedback records. (3) Data management: the operation and maintenance platform based on BIM + big data integrates the detailed data of each stage in the early stage, which can be extracted at any time to support operation management. At the same time, the maintenance change data in the operation process needs to be updated in real time to support the later operation and maintenance.
4. Development prospect

At present, the development of construction informatization is in a basic stage, and there are few cases of BIM + big data application in the whole construction, operation and maintenance process. In view of the current development situation, we should speed up the digital transformation of the construction industry from the following aspects: (1) The state promotes a unified BIM technical document standard, so that BIM documents can be connected and applied indiscriminately in the process of design, cost and construction, and operation and maintenance can improve the communication and cooperation efficiency of all departments. (2) It focuses on training compound talents who understand both management and technology in the field of engineering construction. So that it can promote the application of BIM + big data, and really apply it to the whole construction life cycle, rather than stay on the guidance of theoretical research. (3) In depth application of big data platform for data collection and storage functions, to solve the problem of large and scattered data in all stages of the project. The establishment of big data platform can provide effective basis for project management decisions. (4) It is important to ensure the authenticity of the case data of successful application of engineering construction, and provide technical guidance and application reference for the development of information technology in the construction industry.

5. Conclusion

In conclusion, BIM + big data applied to the whole process of the project can help the managers to carry out fine management and improve the decision-making level; it can also provide help for design, construction, operation and maintenance personnel in the form of visualization, so as to ensure the project quality. What’s more, its application can control the cost in the whole process, and promote the development of China's construction industry informatization to a higher stage.

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