

## Practice and Research on "BIM+Smart Construction Site" of Green Modern Office Building

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**ABSTRACT :** BIM + smart construction site is becoming the innovation point of the technical reform of the entire construction industry, is the driving force to solve the human resources and safety problems, achieve cost reduction and efficiency increase, and is an important solution to improve the brand and enhance the implementation capacity of general contracting. Taking the office building project of Fuzhou Architectural Design Institute as an example, the project takes the construction of the project "BIM + intelligent construction site system platform" as the starting point, takes the application of BIM Technology as the main line of informatization, and applies BIM Technology throughout the whole life cycle of project construction, so as to realize the informatization management of quality, progress, safety, materials, etc., and further promote the level of refined project management.

**Keywords-**BIM, smart construction site, information management

### INTRODUCTION

In the past decade, the construction industry in China has developed rapidly, various green modern buildings have been emerging constantly. In the face of the increasing application of unique and complex architectural design concepts, the participation of more and more large project volumes and more diverse service functions of project participants, the traditional project management system and construction technology means have shown signs of weakness, which can't fully meet the needs of engineering construction in the new era and new situation. The emergence of BIM technology has brought revolutionary influence for the construction industry to adapt to the transformation and upgrading of the new environment. Making full use of BIM technology is an important means for all participants in the construction industry to cope with new challenges in the construction industry under the new situation. With the all-round development of information technology in the construction industry, the combination of BIM and intelligent construction has become a more advanced means of project construction management. This paper explores the practical experience of information technology in high-tech modern green building projects by adopting the management concept of "BIM+smart construction site" during the construction of the new office building of Fuzhou Design Institute[1].

### I. ENGINEERING BACKGROUND

#### 1.1PROJECT GENERAL SITUATION

The project is located in Mapai Village, Wulongjiang Avenue, High tech Industrial Park, Fuzhou High tech Industrial Development Zone, Minhou Shangjie Street. The total construction area of the project is 31572.5 m<sup>2</sup>, including 24129.7.3 m<sup>2</sup> above ground, 7442.8 m<sup>2</sup> underground and the floor area is 9710.4 m<sup>2</sup>. This project is a design office building, with one floor of civil air defense basement, and the building height is 4.65m-5.8m; 11 floor production workshop is set on the ground, and the building height is 53.7m.

The floor slab of the project is made of prefabricated laminated plates, and the external wall panels of the 2-11 floors are made of prefabricated external wall panels. The prefabricated concrete external wall panels integrate enclosure, external decoration, waterproof and wall insulation, so as to achieve a truly fully assembled external wall system.

### **1.2 PROJECT CHARACTERISTICS AND DIFFICULTIES**

The floor slab of the project is made of prefabricated laminated plates, and the external wall panels of the 2-11 floors are made of prefabricated external wall panels. The prefabricated concrete external wall panels integrate enclosure, external decoration, waterproof and wall insulation, so as to achieve a truly fully assembled external wall system.

(1) The characteristics of the project:

1) The facade design of this project is ingenious, with rich architectural functions.

2) This project is a modern green building, which is located at the core of Fuzhou High tech Zone. It has the landmark building characteristics of the High tech Zone. It is characterized by high positioning standards, complex functional design and high construction standards.

3) The quality requirements are high. As a key project in Fuzhou, the project has passed the provincial project approval of science and technology demonstration. The owner and the Constructor pay special attention to the innovative technology in the project construction process, especially the application of information technology, digitization and other technologies. The project strives for quality or national high-quality project.

(2) Key and difficult points of the project:

1) The corridor of this project has a large span and is difficult to construct.

2) There is a large area of special-shaped fabricated external panels outside the external wall, which is difficult to construct.

3) Engineering Procurement Construction (EPC) is adopted, including prefabrication of external wall panels, near zero energy consumption decoration, intelligent internet of things fire water supply unit and many other professional subcontractors. It is difficult for the general contractor to coordinate and manage.

4) The project is high-tech. More than 10 innovative technologies have been adopted in the design of this project to increase the intelligent and digital level of buildings, mainly including: the overall application technology of prefabricated concrete wall panels suitable for Fujian, BIM design, fire water pump technology of special intelligent Internet of Things fire water supply units, pressurized air energy heat pump heating system, highly flexible overhead floor wiring technology, building intelligent control and the Internet of Things, The intelligent anti epidemic technology of access control, remote control, intelligent lighting and night scene lighting management system controlled by different scene modes, and super efficient intelligent indoor air quality control provide a more healthy, hygienic and humanized indoor environment, intelligent air-conditioning terminal and smart eye personnel perception system, as shown in Figure 1.

5) The large amount of input of labor force, turnover materials and tools, and large machinery, so it is difficult to carry out effective turnover management within the section.

6) The accuracy of construction Measurement is required to be high. The project has a unique shape, so high requirements are put forward for the plane positioning and space dimension measurement during the structure construction.



**Figure 1 Design sketch of energy-saving night view of the project**

## **II. APPLICATION GOAL**

### **2.1 APPLICATION PURPOSE OF COMPANY**

(1) With taking the construction of the project "BIM+Smart Site System Platform" as the starting point, and taking BIM technology as the core means of digital management of the project, we have deeply practiced in the full life cycle of the green and modern office building, such as positive design, on-site construction management, process material collection, use and operation management, to realize the intelligence and informatization of quality, progress, safety, materials, etc., and further promote the refined management level of the project.

(2) With using information technologies such as "cloud computing, big data, the Internet of Things, intelligence, and mobile Internet", we can conduct digital management on the progress, quality, safety, materials, equipment, labor, and real-time status of the construction site. Through a unified management and control platform, we can create a comprehensive dynamic scoring system for the project, and gradually achieve a comprehensive perception of people and things, project risk prediction and prevention, and intelligent decision-making analysis of project management and control.

(3) Responding to the "Digital Fuzhou", we will further improve the informatization level of the company, accelerate the digital transformation of the enterprise, create a benchmark for the informatization management of the "construction production base" project, and create an award for excellence after the completion of the project.

## **2.2 INTENTION OF THE PROJECT MANAGEMENT**

(1) By the system management platform of "BIM+smart construction site", we can realize the refined and collaborative management of the Owner, the Designer, the Constructor and other participants in the project construction and production process.

(2) During the whole process of construction, the data collection and information integration visual management for the management of manpower, material resources and other elements can realize the collaboration and intercommunication of all participants[2].

(3) The project is managed by Guanglianda production, including quality, safety, technology and other software applications.

(4) By using "BIM technology", we can carry out forward design, deepening construction, 3D visualization of technical disclosure, etc., simulate the production process in advance, and improve the production efficiency of the whole process of the project.

(5) Through the application of new information management technologies and means, in response to the call of "Digital Fuzhou" construction, we will further improve the informatization level of the company, accelerate the digital transformation of enterprises, create the industry's project informatization management benchmark, and strive for the national, provincial and municipal high-quality project code for the project.

## **III. APPLICATION CONTENT**

Based on the "BIM5D+smart site system platform" of Guanglianda, the project uses BIM technology, Internet of Things technology and other information management means, to carry out stage management activities, including forward deepening design, splitting optimization and coding of prefabricated components, construction scheme, quality, safety, production technology, data, smart site and party building education during the construction process. The data generated in the construction process can realize the interconnection and sharing of all participating units, and can be used as the basis for the later use and operation and maintenance of the building. Through the integrated application of the "BIM+Smart Construction Site" management system, a digital control command center is formed, which is not only convenient and intuitive for external display, but also allows project leaders to take a holistic view and make decisions.

## **IV. PRACTICE PROCESS OF PROJECT INTELLIGENT CONSTRUCTION**

### **4.1 FORMATION OF BIM+SMART SITE MANAGEMENT PLATFORM**

The project builds a "BIM5D+intelligent construction site data decision-making system", as shown in Figure 2, this Management platform integrates various business modules of the project participants and hardware equipment related to the video monitoring system, mechanical equipment monitoring system, labor management system and dust monitoring system of the intelligent construction site which can form an information command center. The data collected by various equipment connected to the platform can be displayed in one diagram and one model, Digitize the project construction process.



**Figure 2 Management platform of BIM+smart site**

### **4.2 QUALITY MANAGEMENT APPLICATION**

The on-site quality inspector shall be the main person to track the construction quality, take photos and describe the problems found, upload them, and notify the corresponding responsible person. After the rectification is completed, the responsible person will feed back and the problem creator will sort out the

problems after verification to form an effective closed-loop quality problem handling mechanism, as shown in Figure 3.

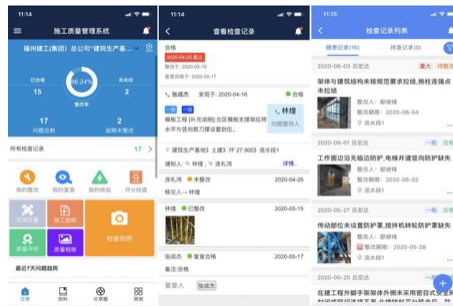


Figure 3 Mobile terminal quality management system

4.3 SECURITY MANAGEMENT APPLICATION

In terms of safety education, the "BIM5D+Smart Site Data Decision System" is equipped with a safety VR system module. Construction managers and operators can immerse themselves in the VR equipment for safety education and experience various close virtual scenes of production safety accidents in a three-dimensional way, so as to deeply understand the importance of safe construction and further enhance safety awareness, as shown in Figure 4.

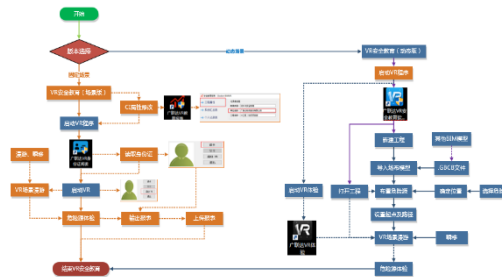


Figure 4 Safe VR operation process

In terms of site management, the project safety administrator shall inspect the potential hazards on the construction site every day, and notify the responsible person of the relevant team leader for rectification after finding the problems. Through the Guanglianda BIM5D management platform, the safety problems were compared before and after rectification, as shown in Figure 5, and the responsibility tracing system was improved. The problems occurred shall be statistically analyzed, the root causes of the problems shall be summarized, and the safety management of the construction site shall be improved. For major problems, one click to send the rectification form.



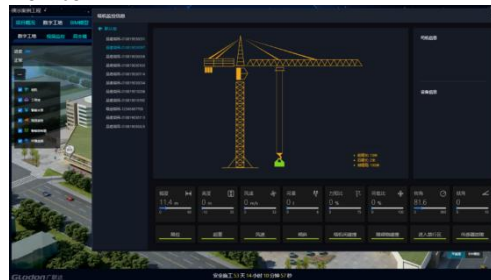
Figure 5 Safety data analysis board

4.4 MONITORING APPLICATION OF VERTICAL TRANSPORT MACHINERY

By installing various sensors and monitoring cameras on tower cranes, construction elevators and other lifting machinery, as shown in Figures 6 and 7, the project establishes a monitoring system for construction lifting machinery, and combines the hook visualization system to achieve centralized monitoring and real-time data transmission for tower crane monitoring, tower cluster anti-collision, tower crane area protection and hook visualization.



**Figure 6**Construction elevator monitor



**Figure 7**Real time monitor of tower foundation

**4.5 GREEN CONSTRUCTION APPLICATION**

Based on the Internet of Things platform of the smart construction site, the project builds green and civilized construction monitoring systems such as environmental monitoring, dust alarm, automatic spraying, and collects real-time data of the project environment, energy consumption, and monitoring quickly and efficiently. Through data analysis, comprehensive control of the construction site is achieved, as shown in Figure 8.

It is mainly applied in the following aspects:

(1) Green construction - environmental monitoring

1) Dust monitoring: through connecting the dust monitoring equipment on the construction site and PM2.5 data, we can conduct real-time tracking monitoring. At the same time, we can set the environmental threshold, the system intelligently recognizes the environmental data, automatically starts the spray system and other dustproof equipment, and makes records.

2) Noise monitoring: we can view the noise data of each noise monitoring equipment on the construction site, view the current real-time data, or retrieve and view the corresponding historical records in the form of reports and charts.

(2) Green construction - spray system

The construction site adopts a control system that controls the remote spraying of spraying equipment to realize the connection of spray equipment such as fog gun spraying, tower crane spraying, wall spraying, etc. The on-site spraying operation can be carried out manually, regularly and in the way of linkage with dust raising equipment, so as to improve the construction environment of the construction site.

(3) Green construction - temporary water and electricity monitoring system

1) We can establish temporary water and electricity monitoring systems to realize remote data reception, which is convenient for green energy conservation management of the project.

2) The statistical data can guide the construction cost calculation of subsequent projects, control the water consumption as agreed, and save energy and environmental protection.



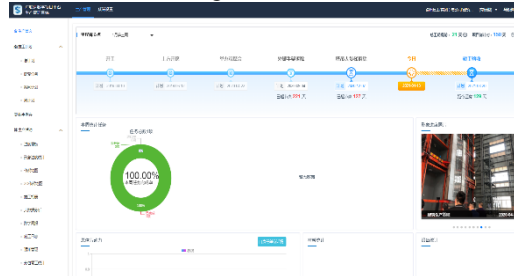
**Figure 8**Environmental monitoring system

**4.6 PROGRESS MANAGEMENT APPLICATION**

The overall plan, monthly plan and weekly plan of the project are edited and submitted online through



the information management platform. At the same time, the previous weekly and monthly progress plans and overall progress plans of the project are consulted to facilitate the coordination of the previous plans and to strictly control the milestone progress. The plan task is distributed online. The construction manager and the team can view the plan arrangement at this stage. At the end of the weekend or month, the plan content is filled in one by one to quantify the completion rate. The reason for the unfinished plan is analyzed and the specific improvement measures are filled in, as shown in Figure 9.



**Figure 9** Production schedule analysis

#### 4.7 LABOR ATTENDANCE MANAGEMENT SYSTEM

A gate is set at the entrance and exit of the construction site, as shown in Figure 10. In combination with the face recognition equipment and the smart helmet worn by workers, the worker attendance records and site location records are transmitted to the cloud server in real time. In combination with the BIM model, the project management personnel can master the site activities of personnel through the smart site management platform.



**Figure 10** Real name channel at the construction gate

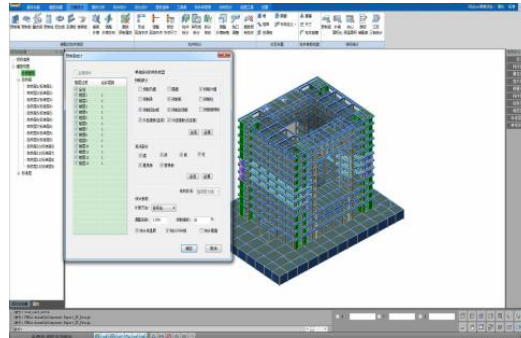
Based on the AI system, the personnel avatars are located at the real name system entrance and exit and the construction site, and whether they wear helmets is detected. At the same time, the intelligent safety helmet recognition technology is used to capture the dynamic picture of on-site personnel operation in real time, analyze the operation process of on-site construction workers and surrounding working faces, and form a summary report of safe production operations to improve the management of on-site safety behaviors, as shown in Figure 11.



**Figure 11** Project labor attendance data statistics

#### 4.8 TRACING THE WHOLE LIFE CYCLE OF CONCRETE COMPONENTS

As required by the Owner, BIM+Internet of Things control is adopted for the design, production and construction of the fabricated components of the Project. Under the active coordination of the Owner, the project "BIM5D+Smart Site Data Decision System" platform can seamlessly connect the building component design, factory production, transportation, installation, operation and maintenance and other links to achieve the full life cycle digital management of fabricated concrete components, including: the basic attribute information of components, such as length, width, height, volume, weight, concrete grade, etc., and the production process information of components, such as order scheduling time, production time Warehousing time and delivery time provide management basis for project progress decision.<sup>[3]</sup>



**Figure 12**Assembled component design code

## V. APPLICATION EFFECT SUMMARY

### 5.1 ENTERPRISE VALUE

The intelligent construction integrated platform supported by big data enables enterprise management and decision-making, and provides data support for data driven business innovation and management innovation. At this stage, the Fuzhou Design Institute Building Project, through the application of science and technology, such as BIM technology, cloud, big data, Internet of Things, mobile Internet, and in combination with the project management personnel's information management and control of quality, safety management, production progress, labor employment and other aspects of management objectives in the whole process of engineering procurement construction project construction management, improves the scientificity, reliability and effectiveness of project management, and achieves accurate project management Refined management and lean management.

### 5.1 PROJECT APPLICATION VALUE

(1) Based on the integrated collection, integration and analysis of project management data in the "BIM+Smart Site" management platform, effective information in the project production process can be accurately extracted and screened to achieve accurate project management.

(2) Based on the "BIM+Smart Construction Site" management platform, each participant can decompose, assign and divide responsibilities for their own project management objectives, monitor project management traces, and achieve fine management of the project.

(3) Based on the management platform of "BIM+smart construction site", the manpower and material resources in the project production process are scientifically and reasonably allocated, the project management behavior is standardized, and the lean management of the project is realized.

(4) The project realizes the interconnection between mobile terminal and cloud platform through smart site management platform and mobile Internet. Through the dynamic project management of smart mobile terminal, the work collaboration efficiency is greatly improved, and the digital and visual construction management is realized.

## VI. CONCLUSION

Based on the practical experience of the new office building project "BIM+smart construction site" of Fuzhou Architectural Design Institute, this paper analyzes the application exploration of intelligent construction management, including prefabricated component optimization design, quality management, safety management, progress management, labor management, vertical transportation machinery and equipment management, green construction management and other intelligent construction management carried out by the project construction participants based on the "BIM5D+smart construction site system platform" in the process of project design and construction. The digital intelligent construction management of the project is still in the period of continuous exploration and research, but from the overall implementation process and practical effect, the standardized implementation scheme of the BIM+smart site management concept has basically formed. However, the overall cost of this project is relatively high, which is suitable for key construction projects. For general engineering projects, it is necessary to further decompose the construction content of BIM+smart construction site, conduct value analysis, and provide targeted solutions.

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