

# Based on Digital Twin Technology, BIM Integration and Innovation in the Construction Stage of Smart Site

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**Abstract:** *In the new era of civil engineering industry, we are in urgent need of transformation and upgrading, this paper aims to integrate the traditional industry technology and digital twin technology, with building information model (BIM) as the carrier, in order to achieve the smart site, smart site as the goal, in the project construction stage to achieve technology integration and innovation, Finally complete the transformation and upgrading of the civil engineering industry to intelligence and digitalization in the new era.*

**Key words:** *digital twin technology, BIM technology, And smart worksite, Digitalization*

## 0. Introduction

Entering the 21st century, China's civil engineering industry is in the golden stage of transformation and upgrading. China's traditional civil engineering industry has tended to saturation, the traditional technology in the project construction stage there are many problems. For example, the traditional project construction pollution is serious, and our country pays attention to the concept of environmental protection runs counter. The construction workers are mainly migrant workers who do not understand the construction standards of the project, which leads to the slow construction progress of the project. Lack of scientific and technological innovation ability and so on. Under the development environment of the new era, the transformation and upgrading of the civil engineering industry is particularly important. Based on intelligent construction technology, this paper aims to develop digital twin technology and use building information modeling (BIM) to realize the transformation and upgrading of the project construction stage to the smart site, which can stimulate the inherent potential of the civil engineering industry. Focus on the development of BIM technology and digital twin technology integration, to achieve intelligent, digital, ecological construction standards.

## 1. The application and development of digital twin technology in the digital development of buildings

### 1.1 Connotation of digital twin technology

The connotation of digital twin technology is diversified, proposed by Glaesegen and Starge in 2012: Digital twin is an integrated multi-physical field, multi-scale, probabilistic simulation of a complex product, and uses the best available physical model, sensor update, etc., to reflect the life of its corresponding twin <sup>[1]</sup>. Through the collection and integration of large amounts of data and the construction of models, the decision of the project and the smooth progress of the construction plan can be promoted.

## ***1.2 Application of digital twin technology in project construction***

### ***1.2.1 Supervision and planning of construction progress***

Digital twin technology connects virtual with reality, simulates the building model, and uses VR technology to present the building in the project. In the construction process, the lofting robot is used to lofting the building model in the site, and the virtual reality is connected to better promote the decision making of the project manager.

### ***1.2.2 Safety management and timely warning***

The special advantage of digital twin technology is that it can greatly reduce the safety accidents in the construction stage. The integration of digital twin technology and sensor can carry out continuous construction detection for building load-bearing structure, hydropower system, pipeline system, etc. in the construction stage of the project, warn the problems that occur, monitor and warn the problems that do not occur, and minimize the occurrence of safety accidents in the construction stage of the project.

### ***1.2.3 Green construction and sustainable development***

Because the traditional civil engineering construction materials are mostly cement and concrete, the pollution to the environment is more serious. Adopting digital twin technology, the concept of energy saving and emission reduction is integrated with advanced technology to achieve green construction. The digital twin model can scientifically predict the consumption trend of water resources and provide a reliable reference for managers to make water-saving plans. For example, irrigation time and water quantity of lawn irrigation system can be scientifically controlled to reduce water resource consumption [3]. Sensors can be used to monitor the air quality of the construction environment to reduce the impact on the atmospheric environment. For high-rise and super high-rise buildings, digital twin technology is adopted to better simulate the flow of people, set up green flow channels, and solve the problem of crowd congestion.

## **2. Application of building information model**

BIM is an advanced technology that simulates building models through digital simulation and realizes building materialization, structure diversification and component real-name through modeling software. Among them, Revit and Navisworks realize the completion of related tasks such as building roaming animation production, rendering Settings, construction simulation and collision detection.

### ***2.1 Roaming Animation***

Capture and assemble key frames in Revit and Navisworks, display better and more intuitive effects on architectural models, and capture human-machine animation from a third-person perspective, giving people the feeling of being in the scene.

### ***2.2 Rendering Settings***

In today's modeling software, there is a large capacity of the material library, when building modeling, the relevant primitives of the material rendering Settings. For example, in the drawing of the door, the material of the door can be rendered as "cherry wood - red", and the characteristics of each structure can be intuitively displayed in the "real" rendering mode, which greatly facilitates the project construction personnel to arrange the construction plan.

### ***2.3 Construction simulation***

In Navisworks and other software, the graph elements in the building model are aggregated. Set the reference time and construction cost for the collection. It plays a monitoring role in project schedule management, asset management, cost management, etc.

## **2.4 Collision detection**

In the construction of large-scale projects, the structure construction, hydropower system, pipeline system, ventilation and lighting system of the building need multiple technicians to cooperate, which may cause some structural incoordination, resulting in slow project progress. The addition of collision detection enables each system in the building to conduct collision and conflict early warning in three-dimensional, timely detection of potential problems, which not only reduces the occurrence of safety accidents, but also reduces the number of safety accidents. But also reduce the construction time and cost.

## **3 The construction requirements of the smart site**

### **3.1 The connotation of the smart site**

The application of smart site technology in construction project management is gradually becoming the development trend of the industry. It combines the Internet of Things, big data analysis, artificial intelligence and other advanced technologies to improve construction efficiency, reduce costs, and improve site safety and environmental management through real-time monitoring and intelligent management<sup>[2]</sup>. The so-called smart site is to make the traditional site form digital, green and modeling, and realize the transformation and upgrading of the site ecology through digital twin technology and BIM technology.

### **3.2 Examples of integrated development of smart construction site and new technology**

The project of Qingdao Global Financial Plaza in Shandong Province consists of 1 super high-rise office building, 3 high-rise residential buildings and underground garage, with a total construction area of 192 321.02 m<sup>2</sup>. The main body of the residential buildings is shear wall structure (among which 3 # residential buildings are prefabricated structure, the assembly rate is 51%), and the office building is the frame core tube structure. The facades are all glass curtain walls, and some aluminum and stone curtain walls, which are beautiful and generous<sup>[4]</sup>. In this building, the digital twin technology is cleverly integrated with the construction phase of the project. Through intelligent monitoring of big data, the entry and exit of vehicles and the attendance of relevant personnel are recorded, safety fault inspection is carried out by detecting sensors, and collaborative management of the project is carried out by using BIM technology. The diversification of technology and the visualization of the construction process promote the development of smart construction sites, provide innovative integration ideas for project staff, and better promote the development of China's civil engineering industry.

## **4 Development of digital twin smart worksites**

Domestic scholars have conducted extensive research on the integration of digital twin technology and BIM technology in the construction stage of smart site. Jiang Jianhua, Zeng Yi, Chen Zhihui and Weng Zhixiong pointed out that in the construction implementation stage, based on the BIM information model jointly completed by various professional designers, with the help of GIS information system and construction process monitoring system, the whole process of construction implementation of the project can be truly reproduced through digital twin technology. In order to carry out rationality evaluation and research on each stage of the construction process, real-time improvement of each stage of the process, and continuous optimization of the construction implementation plan<sup>[5]</sup>. Dewey research points out that by building BIM+ smart site platform, it solves problems such as difficulties in data and information integration, enhances the visualization of construction site management, reduces the safety and quality risks of the project, and realizes the fine

management and intelligent decision-making of construction projects [6]. Yin Yi's research on 筌 points out that BIM+ smart site technology has important application value in the construction of super high-rise housing construction projects, which can realize visual construction, overall coordination and intelligent management decision-making on the construction site. With the digital transformation of Chinese construction enterprises, BIM+ smart site management mode can effectively improve the construction management efficiency, enhance the core competitiveness of enterprises, and make the domestic smart site platform more diversified, which has far-reaching significance for the promotion of smart city [7].

BIM+GIS achieves construction geographic information monitoring, BIM+ smart construction site improves the digitization level of the construction site, and makes the project gradually develop into a digital twin smart construction site. With digital twin technology as the core, the visual display of building information model (BIM) is not only the initial intention of realizing the development of "smart site", but also a new opportunity for the transformation and upgrading of civil engineering industry in the new era, and also a response to the country's exploration of the inherent potential of digital twin smart site.

## **5 Core problems and solutions of digital twin smart site**

Digital twin smart construction site is a comprehensive innovative concept, after the continuous research of domestic scholars, there are still some problems.

### ***5.1 Lack of core technical personnel***

The development of digital twin smart site needs a number of technical integration and coordination, at present, the relevant domestic technical personnel are not enough to complete the operation and integration of project technology from development to completion, and now it is urgent to train high-quality interdisciplinary talents, carry out intelligent construction, intelligent manufacturing and other specialty specialties in colleges and universities, and transport more high-quality talents for the construction of smart site.

### ***5.2 The existing hardware and software system of intelligent construction in China is insufficient***

At present, the domestic patent holding rate of construction high-tech is insufficient, such as construction robots, building sensors and other rely on imports, the domestic has not mastered its core technology, subject to foreign restrictions, and the research level of high-tech construction machines still lags behind foreign countries. For the current development status, we should carry out technological reform in the new era, strengthen the overcoming of high-tech difficulties, grasp the core technology in our own hands, and realize the transformation and upgrading of the construction industry.

### ***5.3 The construction site supervision system is not complete***

In the process of transformation of today's construction sites, there are some construction sites for residential, communication, water and electricity, safety and other facilities supervision is not in place. In the project, the coordination of various departments is not strong, resulting in the implementation of smart chemical industry becomes extremely difficult. These problems are mainly due to the failure of site managers to fulfill their regulatory responsibilities. For the future development of smart chemical industry, it is the top priority to enhance the responsibility consciousness of site management personnel, and improve the site supervision system, in order to escort the development of smart site.

### ***5.4 Lack of attention from the government***

The local government also needs to actively promote the laws and regulations related to the promotion and application of smart site, promote the improvement of the promotion quality of smart site in construction units in both directions, effectively ensure the standardization and legitimacy of the promotion and application of smart site, and ensure that the promotion and application of smart site have laws to follow<sup>[9]</sup>. The government is always the beacon of site development, and the strong support of the government's policies provides unlimited confidence and potential for the development of the digital site.

## 6 Concluding Remarks

The digital twin of the construction process requires a digital model, real-time management information and a comprehensive intelligent perception network. Under this goal, the traditional construction mode with discrete information can no longer meet the requirements. It is necessary to provide data support and guidance for project management decision-making through a highly integrated information platform. The mode transformation can be realized by means of "collaboration, interconnection and wisdom" <sup>[8]</sup>. The arrival of the new era has brought unlimited opportunities and challenges to the traditional civil engineering industry. The rapid development of Internet of Things technology, cloud computing technology, big data technology, 5G technology, AI, blockchain, is constantly pouring into the construction stage of construction projects, the digital twin smart site stands out among them, and the new people-oriented development concept promotes the rapid development of smart site, which is not only to realize the transformation and upgrading of the traditional civil engineering industry, It is the only way to realize the digital city and the smart chemical industry. Under the guidance of national policies, more and more industries are moving towards the ladder of intelligent transformation and upgrading. By finding problems, sorting out problems and solving problems, the civil engineering industry in the new era will release unlimited potential.

## References

- [1] Fang Yi, Zhuo Jiancheng, Du Mengfei. *Application and development of digital twin in intelligent construction of rail Transit [J]. High-speed Railway Technology*, 2024, 15 (01): 68-73+78.
- [2] HUANG Zhene, Zheng Haiyu, ZHONG Xiuyan. *Application and Exploration of BIM Cloud Platform based on 5G+ Smart Construction Site in Construction information project management [J]. Intelligent buildings and wisdom city*, 2024, (11) : 95-97. The DOI: 10.13655 / j.carol carroll nki ibci. 2024.11.030.
- [3] Rin, Song Xuejiao. *Practice analysis of digital twin technology in smart sports venues [J]. Sporting Goods and Technology*, 2024, (23): 193-195.
- [4] LI Lulu, ZHANG Baolong, Shang Shengyue, et al. *Application of smart construction site in construction site management [J]. Building Safety*, 2024, 39 (11): 66-69.
- [5] JIANG Jianhua, Zeng Yi, Chen Zhihui, et al. *Exploration of urban digital transformation based on BIM and digital twin technology [J]. Industrial Building*, 2023, 53 (S1): 789-791.]
- [6] Du Wei, Fang Minjie, Zhou Hua, et al. *Based on the digital management and application of BIM platform + wisdom site [J]. Journal of intelligent city*, 2022, 8 (11) : 67-70. The DOI: 10.19301 / j.carol carroll nki ZNCS. 2022.11.023.
- [7] Yin Yi. *Research and Application of BIM+ Smart Construction Site System in Project Construction Stage -- Taking a super high-rise housing construction project as an example [J]. China construction metal structure*, 2023, (3) : 160-162. The DOI: 10.20080 / j.carol carroll nki ISSN1671-3362.2023.03.051.
- [8] LIU Chuang, ZHOU Qianfan, XU Lishan, et al. *Research and Application of key Technology of "smart, transparent and Green" digital twin construction site [J]. Construction Technology*, 2019, 48 (01): 4-8.
- [9] Chen Minqiang. *Problems existing in the promotion and application of smart construction site by construction units [J]. Low Carbon World*, 2024, 14 (03): 172-174. DOI:10.16844/j.cnki.cn10-1007/tk.2024.03.025.