Research on the application of smart sites: Research hub of Huzhou Qilitang Project Project for Example

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Abstract. Take the research hub project of Huzhou Qilitang Project as a case, Starting from information construction and intelligent management, Describe the application of smart sites technology in construction project management, Analyzes the application effect of smart site technology in production management, safety management, quality management, labor management, material management, equipment management, BIM technology management and green construction, With a view to providing reference for intelligent supervision of similar projects.

Keywords: smart sites, project management, BIM technology.

1. Introduction

Since the concept of "smart construction site" was put forward, the development of digitalization and intellectualization in the field of construction management in the construction industry is getting faster and faster, with the continuous maturity of information technology, the application of smart site technology provides an effective technical basis for the high-quality development of information construction project management. Therefore, more and more projects have carried out the application and research of smart site technology, the application of this technology is of great significance to improve the intelligent supervision of project management personnel.

There is a certain foundation for the research of smart site application in China. MA Zhiliang and others predicted the development trend of intelligent construction from the aspects of intelligent construction technology and intelligent construction management, to help relevant personnel in the industry establish a comprehensive understanding of intelligent construction. Zeng Ningshuang and others have built a site intelligent management operation mechanism based on BIM and intelligent construction, it is helpful to strengthen the visualization, real-time, efficient and sustainable management of the project construction site. In view of the difficulty in supervision of the Yellow River construction project in Shandong Province, Wang Ying and others have effectively improved the intelligent supervision level of the project by building a smart site management platform.

This paper takes the Huzhou Qilitang Project as an example, analyze the application and effect of smart construction site in the project, summarize the comprehensive application of advanced technologies such as intelligent application, AI technology, cloud technology, big data and BIM in the construction process, provide reference for the application of smart site technology in project management, let the construction site management realize visualization, intelligence and interconnection, and ultimately improve the management effect of the construction site.

2. Introduction to smart site system

The intelligent construction site system built by the project is a digital construction site intelligent management platform that includes digital construction site, material management, safety management, quality management, intelligent control, personnel management, production management, technology management, equipment management and other information integration. The smart site system

combines the advantages of informatization, intelligence and big data, effectively integrate relevant equipment and systems on the construction site, and constantly update the data of each terminal to the data center during the implementation of the project, the project management personnel can receive comprehensive visual information through the smart site data platform. The real-time monitoring of the project site through AI technology can intelligently identify various potential risks and give early warning in time, so as to provide project risk management results.

In addition, the smart site system is equipped with a collaborative operation management platform, Integrate intelligent technology and BIM technology to make overall planning for the application of the whole process of the project, the BIM model, intelligent hardware equipment, PC terminal system and other links of the project will be used for collaborative office work, it can effectively connect the construction unit, design unit, construction unit, supervision unit and other participants, realize the whole-process control of the project site by all participants, deeply carry out the whole-process application of smart construction sites, and provide digital platform guarantee for the whole process of fine management of project construction.

3. Intelligent management application

3.1. Intelligent production management

3.1.1. Fine management of production plan

The project management personnel plan ahead of time, Use the system to disassemble the planned tasks layer by layer from top to bottom, and reduce the time of task disclosure, Achieve accurate recovery of production progress through production task tracking, timely grasp the progress deviation. Since the application of the system, the average number of tasks per week has been more than 30, and the completion rate of tasks on schedule has increased from 63.3% in the first week to 93.9%,at the same time, the smart site platform is used to collect and capture the fragmented process data in the on-site production process, and automatically summarize it into the production management system for multi-dimensional analysis, the preparation time for the meeting was reduced from 2h to 0.5h, and each regular meeting saved 1.5h of preparation time for pre-meeting materials. The project management team focuses on the on-site problems through the smart site platform and digital regular meetings every week, coordinates the production resources, makes the next stage deployment for the on-site problems, and automatically generates the meeting minutes according to the meeting contents, which improves the efficiency by 40%. Under careful organization and control, the top of the scientific research building was completed 56 days earlier than the contract period. The intelligent production management platform is shown in Figure 1.



Figure 1. Intelligent production management platform

3.1.2. Real-time intelligent monitoring

The project has a high floor, Simplification of project management personnel, the traditional management method has a heavy burden on site patrol, and the office work and communication and coordination tasks are numerous, which cannot ensure that people are always on the site. The visualization of the site image enables the project management personnel to control the site status at any time and place, provides more efficient management grip for the management personnel, and can also find and take measures in time in case of labor shortage. Through comparison and calculation, the management personnel can save 1.5h/d of unnecessary time to go to the site through visual management. See Figure 2 for the scene real-time monitoring screen.

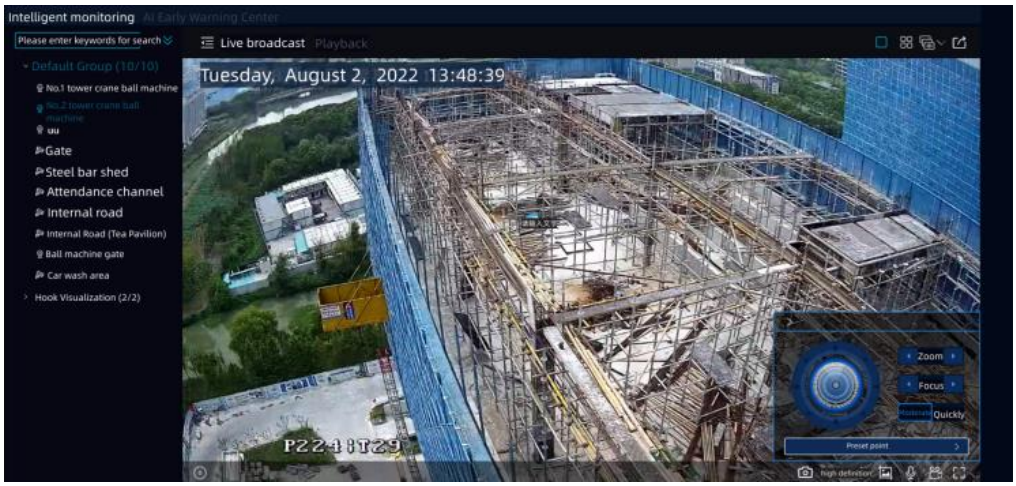

Figure 2. On-site real-time monitoring screen

3.1.3. Intelligent wear of construction personnel

Combining intelligent wearable equipment, personnel positioning technology and field layout model, the project can timely and accurately grasp the position, track and other information of workers, and quickly obtain the real-time attendance of each work area and each type of work, compared with the weekly production plan, the rapid adjustment was made for the shortage of workers in the working face, and the efficiency of on-site labor counting was increased by 10 times, facilitating the deployment of on-site personnel, and achieving refined management.

3.2. Intelligent security management

3.2.1. Background security supervision

The on-site safety management personnel use the mobile terminal safety management system to capture and upload the potential safety hazards in a timely manner during the safety inspection, so as to issue a rectification order for the potential safety hazards and urge the rectification personnel to rectify. The system automatically generates business documents such as records and rectification notices, replies and fines, collects security data, and automatically analyzes security management status through big data to help managers trace the source and improve quickly. Since the launch of the project system, 430 potential safety hazards have been dealt with, 425 have been rectified, and the current rectification rate has reached 99%. While dealing with the existing problems, the probability of subsequent such problems has been effectively reduced. See Figure 3 for smart security management platform.



Figure 3. Intelligent security management platform

3.2.2. Video AI monitoring

Using the AI intelligent algorithm of the intelligent site platform, the project will automatically identify and capture the unsafe behaviors of on-site workers without wearing helmets, masks, smoking, reflective vests and other unsafe behaviors through the camera, and link with the intelligent broadcast to broadcast the correction instructions. In the way of camera+AI algorithm+intelligent broadcast linkage, the purpose of timely finding and stopping violations of personnel is to replace the work of some managers patrolling the site.AI intelligent algorithm identifies 4.7 hidden dangers of unsafe behaviors of personnel per day, effectively complements the human hidden trouble troubleshooting loopholes, and effectively saves the on-site management personnel's inspection time, improve the efficiency of on-site safety hazard screening, ensure that on-site safety risks are controlled, and also carry out safety education through video recording to improve workers' safety awareness. AI monitoring interface of smart site platform is shown in Figure 4.

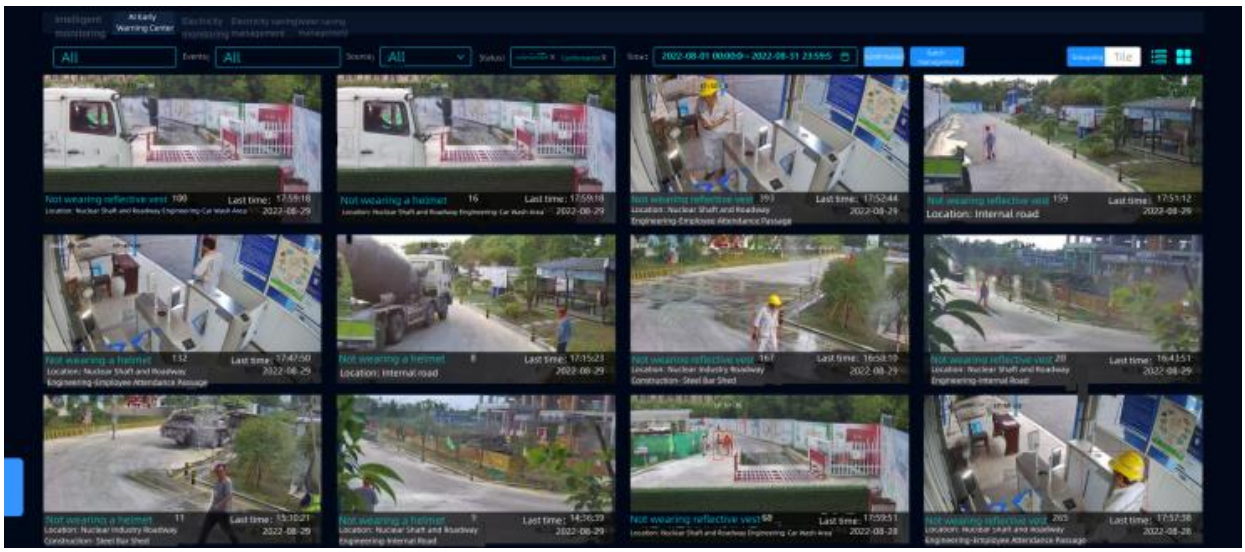

Figure 4. AI monitoring interface of smart site platform

3.2.3. Safe remote inspection

Safety production is one of the important links of the project site management, and the safety patrol inspection is very frequent. Through the safety visual management+video monitoring+hook visualization and the deployment of tower crane ball machine, when the safety management personnel

carry out the patrol inspection of the key working surface, they can open the platform to view it, and adjust the angle through the camera head pan and tilt to cover the main working surface on the site. Since the platform was launched, through video monitoring, project managers can remotely inspect the project, strengthen the awareness of project safety management, form the normal of high standard safety management and control of the project, and improve the level of safety management.

3.3. Intelligent quality management

3.3.1. Closed loop of quality inspection management

The quality management personnel take photos of the quality problems found on the site and upload them to the system on the mobile phone, and designate the person responsible for rectification to clarify the rectification period, which avoids the problems such as picture failure and untimely problem tracking that are often encountered in the traditional management mode. The quality inspection and governance cycle are greatly shortened, and the efficiency of problem rectification is effectively improved. The number of quality inspections increased from 2.57 to 3.23 times per day, the implementation of project inspections increased by 26% on a month-on-month basis, and the timely rectification rate increased from 89.61% to 94%.

3.3.2. Quality problem rectification cooperation

Through the online management of the system, the project has realized the speed of management, the whole business process of quality inspection can be processed by the system, the work task is automatically promoted, the personnel are automatically reminded, and the forms are automatically generated, so as to avoid repeated work, reduce the workload of data preparation, and greatly improve the efficiency of cooperation. The intelligent quality management platform is shown in Figure 5.



Figure 5. Intelligent quality management platform

3.4. Smart labor management

3.4.1. Real name system of labor service

The project uses intelligent terminal registration equipment for real-name registration, efficiently carries out personnel information collection and entry and exit management, optimizes the labor entry process, simplifies the work of management personnel, and reduces the subsequent communication costs. The labor entry management work is changed from 2 hours to 0.5 hours each time, with a management efficiency of 300%.

3.4.2. Automatic record of attendance information

The project safety director and the labor specialist will check the presence and attendance of the workers on the platform every month, export the daily or monthly attendance report of the effective working hours/workdays of the workers that have been counted, check the attendance sheet submitted by the team, assist the project in labor wage accounting, standardize the wage distribution of workers, and archive the process documents. Up to now, the project has accumulated more than 190000 attendance data. The system automatically generates attendance to improve efficiency, saving daily labor admission management time+wage attendance statistics time of 1h, and saving more than 80000 yuan of labor cost per year.

3.5. Smart material management

3.5.1. Self-service weighing intelligent acceptance of material

The site weighbridge is connected to the material management system of the platform, realizing the digital process control of bulk material procurement, site acceptance and on-site material receipt. Material acceptance through push task can greatly improve the acceptance efficiency and reduce the later statistical work. The acceptance record can be used as the basis for the receipt order to avoid repeated document preparation and improve efficiency.

3.5.2. Automatic data accounting strengthens material control

Weigh and accept incoming materials and outgoing wastes to ensure authenticity and accuracy, avoid cheating of personnel, keep original vouchers and influence materials complete, and share data transparently throughout the process, so as to prevent cheating systematically. After the installation of the weighbridge, all bulk materials entering the site need to be weighed and accepted. In the first month, the system analysis shows that the concrete exceeds the negative tolerance by 2.7%. The project takes this as a starting point to strengthen the control of the supplier, and the supplier who exceeds the negative tolerance agreed in the contract will be demobilized and interviewed for rectification.

3.6. Smart device management

3.6.1. Real-time monitoring and analysis of tower crane

Through the IOT equipment, it can intelligently identify the driver's identity information, monitor the lifting weight, amplitude, height, load ratio, torque ratio and other equipment information in real time, and ensure the safe and standardized use of tower crane operation. The visualization of the hook makes the lifting operation of the tower crane zero blind area, which greatly improves the safety factor of the operation. Since the application of smart construction site, the risk source of tower crane on site has been effectively controlled, and no minor injury or above accidents have occurred. The smart site platform makes statistical analysis of the alarm data of each tower crane, and makes comparative analysis horizontally and vertically. It assists the management personnel to carry out safety education and disclosure to the operators. It uses data analysis to replace the previous standard template, improve the safety awareness of the operators and ensure the safety of mechanical operation. See Figure 6 for smart device management platform.

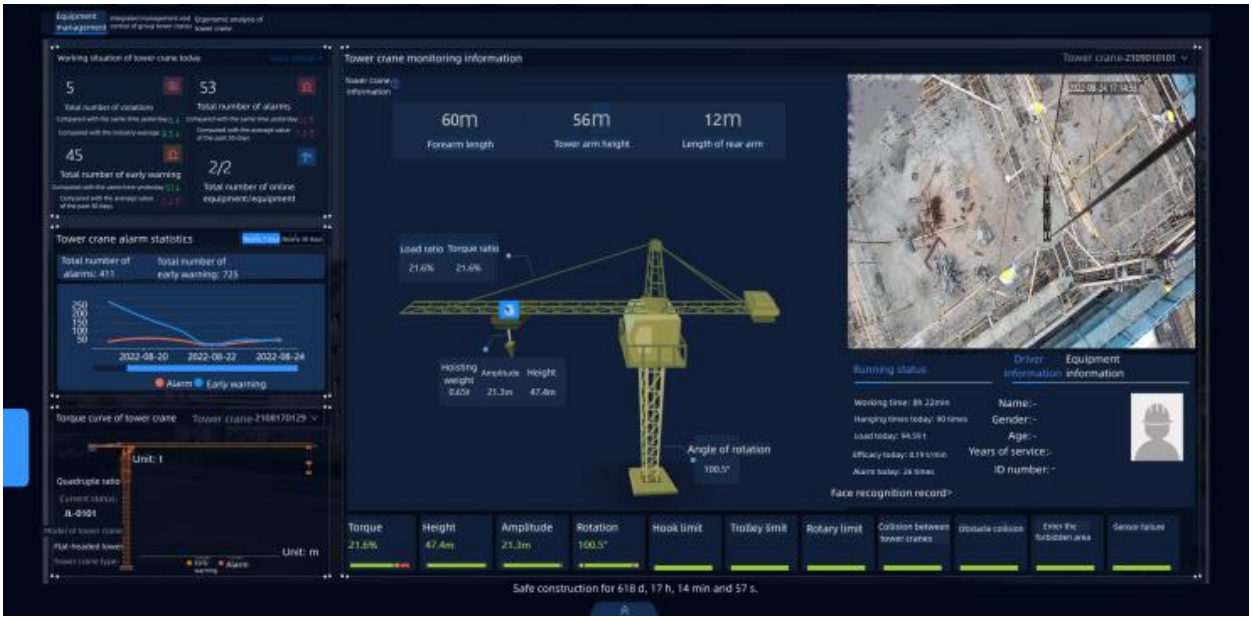

Figure 6. Smart Device Management Platform

3.6.2. Equipment QR code patrol

The equipment inspection platform generates the QR code of the temporary power box to achieve one code for one box. The electrician shall fill in the inspection record of the electric box by scanning the code during the daily inspection. The record contents include: whether there is unauthorized connection, whether the grounding is normal, whether there is one switch for one machine, the integrity of the box and accessories, leakage protection and air switch status. After each inspection, the inspector shall take photos and upload and sign for confirmation. The patrol inspection records are the real time of the system, so as to prevent the inspectors from cheating and ensure the equipment safety patrol inspection in place. See Figure 7 for details of equipment patrol records.

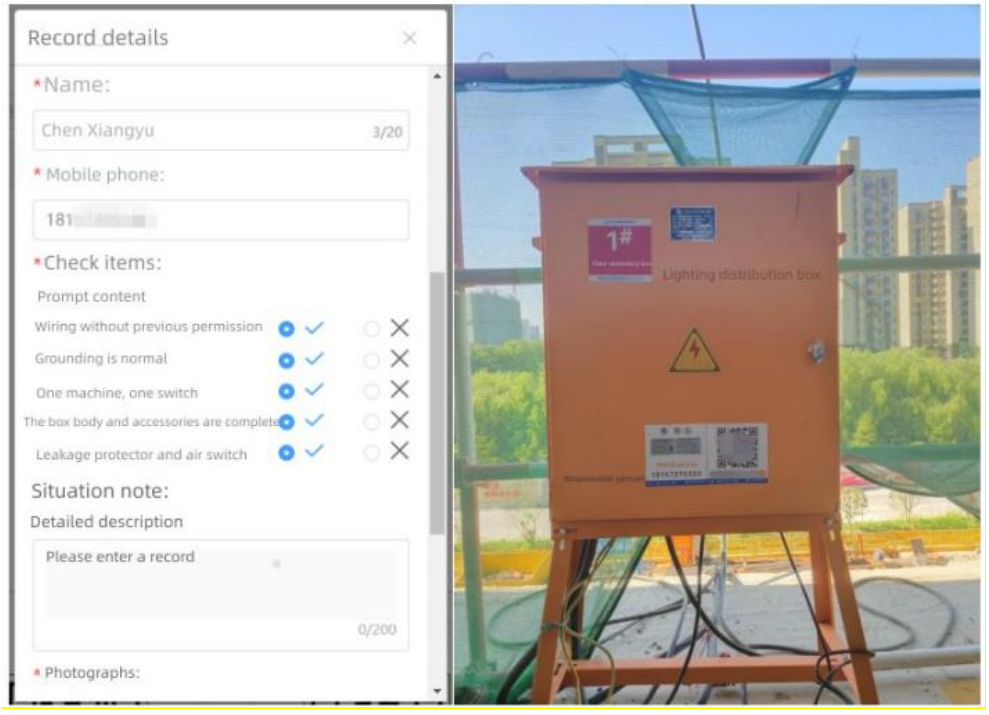

Figure 7. Details of equipment patrol records

3.7. BIM+technology management

3.7.1. BIM 3D visualization disclosure

In terms of technology, BIM model online preview, model connection, BIM progress display, BIM process disclosure and other functions are realized. Through the 3D model disclosure, the complex nodes are presented intuitively, the connection documents are standardized, the audio and video explanations are easy to understand, and the technicians are assisted to guide the on-site construction. In order to improve the effect of disclosure and reduce the risk of construction technical errors, the project can view the BIM visual disclosure animation by pasting QR code on the site, link sharing, and scanning the mobile phone to view the BIM visual display animation, improve the display effect, and reduce rework caused by quality problems caused by unclear process points. The BIM+technology management platform is shown in Figure 8.

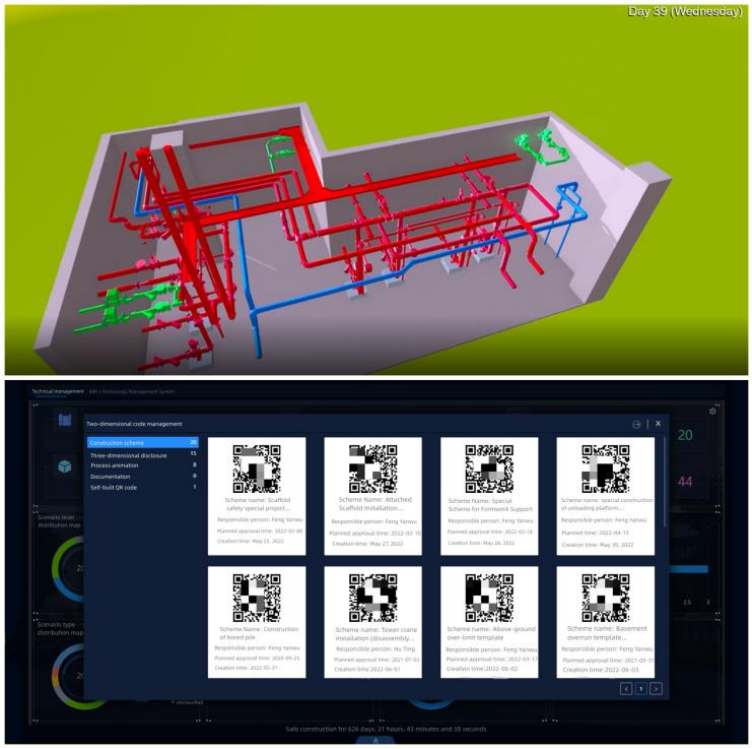

Figure 8. Example of a figure caption

3.7.2. Online collaborative sharing of technical documents

The project technology department will upload the site construction plan, technical disclosure and construction drawings to the platform for classification and sharing, so as to realize paperless office work and facilitate all management and construction personnel to view in real time through mobile phone. Through online scheme approval, work efficiency is accelerated and useless "errands" are reduced. All kinds of approval opinions are fed back in time. Through online scheme approval, work efficiency is accelerated, useless "errands" are reduced, various approval opinions are fed back in time, and technicians can adjust the scheme online in real time, greatly improving the approval efficiency. After the approval of the scheme, the online QR code technical disclosure shall be carried out, so that the level 1, level 2 and level 3 disclosure shall be implemented to individuals, and the disclosure contents shall be checked at any time to guide the on-site construction.

3.8. Smart green construction

3.8.1. Meteorological forecast aided scientific construction

The platform provides the weather forecast information of the project area, and replaces the manual query in the original project management with the barometer. The management personnel can view the recent weather forecast at anytime and anywhere, and assist the production task arrangement. In

case of bad weather, the system will intelligently prompt the scientific construction, and assist the smooth progress of the project. As the summer weather in the project site is exceptionally high, the project will properly adjust the construction time of the site through environmental monitoring and high temperature warning, smart site platform and scientific construction tips, and provide heatstroke prevention drugs to ensure the safety of employment. The digital construction environment monitoring platform is shown in Figure 9.



Figure 9. Digital construction environment monitoring platform

3.8.2. Environment real-time monitoring linkage automatic spraying

The project monitors the dust, noise and other contents of the site in real time through the environmental monitoring equipment. When the site noise and dust exceed the standard, the mobile terminal of the management personnel will be triggered and an early warning will be received. For example, when the on-site PM2.5 exceeds the set threshold, it will automatically trigger the opening of the on-site spraying equipment to achieve effective dust reduction, effective isolation of dust at the project working face, rapid suppression of dust in the project area, and basic clearing of dust outside the project area.

3.8.3. Application of intelligent water and electricity meter

Through the application of intelligent water meter and intelligent electricity meter, the water and electricity consumption are intelligently monitored, and the system automatically reads, without the need for on-site meter reading, and the efficiency is improved by 10 times.The system conducts multi-dimensional analysis of the monitoring data, and the project formulates reasonable saving plans and measures according to the water and electricity use conditions analyzed by the platform, so as to save resources to the maximum extent, which has formed a good demonstration effect for promoting the development of the construction industry in Huzhou City with carbon peak and high-star green buildings.

4. Conclusion

The Qilitang Project in Huzhou City is a project built with a smart construction site information technology, during the construction of the project, the smart site system is used to realize smart management of production management, safety management, quality management, labor management, material management, equipment management, BIM technology management, green construction and other work links of the project, some achievements have been made in the field of informatization and intelligence of construction site management, further improving the level of project construction

management. Through the application research and analysis of the smart site in the Qilitang project in Huzhou, it fully demonstrates the characteristics and advantages of integrated application of intelligent technology, hoping to provide reference for intelligent management of engineering construction, provide help for smart site technology in construction industry informatization construction.

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