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Research on Construction Technology of Water Conservancy Projects Based on "Internet + Smart Water Conservancy"

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Abstract: Water conservancy projects are responsible for power generation, irrigation, water supply, and flood control, which are crucial to national development and people's livelihoods, and are important infrastructure for promoting economic development. With the development of information technology, construction techniques based on the development of information technology, such as the Internet, have gradually been applied to various professional fields of construction engineering, bringing new opportunities for improving the intelligence level of hydraulic engineering construction. For water conservancy project builders, they should recognize the connotation of "Internet + Smart Water Conservancy" and leverage the value of smart water conservancy construction technology.

Keywords: Internet; Smart water conservancy; Water conservancy projects; Construction technology

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1. Introduction

The essence of "Internet + Smart Water Conservancy" is the integration of Internet information technology and water conservancy engineering. It combines the technological advantages of 5G, the Internet of Things, artificial intelligence, big data, cloud computing, etc., and can intelligently collect and analyze water conservancy engineering information, implement refined, intelligent, and efficient management of water conservancy projects, and improve the overall construction quality and efficiency of the project [1]. In the era of rapid development of information technology, "Internet + Smart Water Conservancy" is not only the main direction of water conservancy engineering construction technology development but also an important driving force for improving the quality of water conservancy projects, which deserves great attention from relevant parties.

2. Technical characteristics of "Internet + Smart Water Conservancy"

As an advanced construction technology for water conservancy projects, "Internet + Smart Water Conservancy" mainly includes the following characteristics: Firstly, comprehensive perception. "Internet + Smart Water Conservancy" can collect information elements such as machinery and equipment, engineering entities, and construction environments based on smart devices and sensors, enhancing the comprehensive perception of data information. Secondly, intelligent analysis. "Internet + Smart Water Conservancy" can leverage the technological advantages of artificial intelligence and big data analysis to deeply tap the potential and value of data information, assisting personnel to make more scientific construction decisions [2]. Thirdly, automatic control. The intelligent analysis results of "Internet + Smart Water Conservancy" can assist manual control. At the same time, it can automatically control equipment processes and make relevant optimization adjustments based on the actual situation of the construction site to ensure the normal progress of the construction process. Fourthly, collaborative management. "Internet + Smart Water Conservancy" can build a network communication system, realize data sharing, and allow various types of information to flow between the construction unit, construction unit, supervision unit, design unit, and other entities, breaking information barriers and ensuring collaborative management [3].

Compared to traditional water conservancy projects, "Internet + Smart Water Conservancy" offers numerous technological advantages. Specifically, in terms of data collection, "Internet + Smart Water Conservancy" enables real-time monitoring of data for abnormalities, improving the level of perception automation and avoiding the efficiency lags associated with single-point monitoring and manual measurement. In terms of information transmission, "Internet + Smart Water Conservancy" enhances information sharing, ensures digital transmission, and addresses the drawbacks of paper-based document transmission. In terms of management mode, "Internet + Smart Water Conservancy" tends to be more refined and centralized, avoiding the negative impacts of extensive and decentralized management [4].

3. Key construction technologies of "Internet + Smart Water Conservancy"

3.1. Big data and cloud computing technologies

The amount of data generated during the construction phase of water conservancy projects is immense, covering not only the construction level but also the management level. Both big data and cloud computing technologies are cutting-edge information technologies for data processing. Big data technology can enhance data management, improve data storage, analysis, and processing efficiency, and unlock the value of data. Cloud computing technology, on the other hand, ensures computing resources to support big data processing, enabling data applications to support different terminals and users. A big data platform developed based on the advantages of big data and cloud computing technologies can comprehensively integrate construction data, quantitatively analyze relevant indicators, and assist in optimizing construction plans.

3.2. Internet of Things (IoT) technology

IoT technology enables the interconnection of water conservancy construction machinery and equipment. During the construction phase, construction units deploy sensors at key locations on the construction site. These sensors collect various parameters such as construction stress, water level, displacement, and pressure, as well as information on rainfall, temperature, humidity, wind speed, and equipment fuel consumption and speed. They also determine whether the equipment is operating normally. For example, in dam construction, personnel can embed

fiber optic sensors inside the dam to monitor displacement, stress concentration and changes, and self-settlement phenomena, providing important reference data for subsequent construction decisions [5].

3.3. BIM technology

BIM technology is essentially a digital construction management technique that can create three-dimensional models, identify potential interference and collision risks during the construction process, and facilitate dynamic adjustments and visual management to aid in water conservancy project construction. BIM technology can also assist in cost accounting and engineering quantity calculations, enhancing the precision of cost control. Additionally, BIM technology allows for real-time recording of engineering entity quality information, enabling traceability for any issues that may arise during subsequent construction stages.

3.4. Artificial intelligence technology

Artificial intelligence, as a key information technology today, can achieve intelligent monitoring and early warning for water conservancy projects. By integrating construction decision-making, AI technology can establish construction safety warning models to automatically identify potential risks. AI can also optimize professional construction plans based on historical engineering experience, actual site requirements, and resource availability, thereby improving construction efficiency. Furthermore, AI technology can maintain equipment using techniques such as speech recognition and computer vision, reducing frequent equipment failures. Finally, this technology can detect whether the engineering entity quality meets standards based on image recognition techniques, for example, by determining whether the steel bar spacing complies with standards or whether there are cracks on the concrete surface [6].

4. Application scenarios of “Internet + Smart Water Resources” and water conservancy project construction

4.1. Smart construction technology and equipment

The “Internet + Smart Water Conservancy” technology aims to enhance the automation and intelligence levels of construction techniques. Taking concrete production and pouring processes as an example, new concrete mixing stations are established at water conservancy project construction sites to improve the automation of mixing procedures. This ensures more precise measurement and proportioning of concrete raw materials, and instruments can monitor concrete quality in real-time, achieving the required compactness and uniformity. For earthwork excavation procedures, water conservancy projects can be equipped with GPS positioning for precise control of displacements of bulldozers, smart excavators, and other equipment. Filling equipment can receive and analyze design elevation data, automatically adjust the filling thickness, and control construction accuracy to within 5cm, further enhancing construction efficiency and quality [7]. Additionally, drones used at hydraulic engineering construction sites are crucial equipment for realizing the “Internet + Smart Water Conservancy” technology. Drones can provide a broader perspective by overlooking the construction site from a high altitude, without incurring excessive costs for the project party. Drone aerial photography technology can also reasonably control the engineering quantity. Similarly, robots can replace humans in hazardous environments, ensuring the safety of construction workers.

In the case of the South-to-North Water Diversion Project, the application of numerous IoT monitoring systems and three-dimensional geological modeling in tunnel construction has resulted in more precise and safer

tunnel control. The project party has installed sensors inside the tunnels to monitor various parameters such as groundwater pressure, displacement, and surrounding rock stress, allowing for adjustments to excavation and support methods to improve tunnel construction quality and safety [8].

4.2. Digital construction management platform

The digital construction management platform can enhance the intelligence level of water conservancy project construction management. Firstly, the platform enables fine management of construction progress, integrating BIM technology model information and on-site progress data to achieve visual progress management. The management platform can generate reports to assist personnel in analyzing progress deviations and provide reference values for adjustments to construction plans. Secondly, the platform optimizes resource allocation. Through data collection on human resources, equipment, and materials, and algorithm optimization, the platform achieves reasonable resource allocation. If material demand is insufficient, the platform can generate a procurement plan in a timely manner, reducing inventory costs [9]. Additionally, the platform improves cost, safety, and quality management. In terms of cost, the platform collects construction progress and BIM model information, automatically calculates the cost of completed works, monitors construction costs in real-time, and achieves dual improvements in accuracy and efficiency based on digital management techniques. Regarding safety and quality, the platform collects engineering safety information based on a database to determine if large-scale rectification is required. It also promptly identifies common quality issues in water conservancy projects, serving as an important reference for subsequent construction improvements [10].

Taking the Three Gorges Water Conservancy Project on the Yangtze River as an example, the project team introduced technologies such as Beidou positioning and optical fiber sensing to monitor dam safety, including parameters like dam stress, seepage, and deformation. After data collection, it is transmitted to the data center through communication networks, where big data technology is used for subsequent early warning and processing. During the operation of the project's navigation lock, the project team also utilized artificial intelligence technology to optimize ship passing, significantly improving the efficiency of lock navigation.

4.3. Intelligent construction monitoring

Water conservancy projects involve numerous excavation processes for foundation pits. For sloped excavations, "Internet + Smart Water Conservancy" technology can deploy various devices around the foundation pit and slope, including crack meters, tilt sensors, and displacement sensors. These devices collect displacement information to assess whether the foundation pit slope is deforming. If artificial intelligence equipment detects continuous deformation exceeding the threshold, it sends warning signals to staff, prompting them to take prompt and correct action to ensure the safety of the foundation pit slope [11]. Additionally, this technology monitors the quality of concrete, which forms the main structure of water conservancy projects. For example, temperature directly affects the risk of concrete cracking. Temperature sensors are embedded inside the concrete to collect surface and internal temperature information. If the temperature difference exceeds standards, the system automatically activates a cooling water circulation system to reduce the risk of concrete cracking. Furthermore, the "Internet + Smart Water Conservancy" technology platform utilizes advanced techniques like face recognition and video monitoring to check the safety status of equipment and personnel. If personnel enter the site without wearing a safety hat, the system provides an instant warning as a reminder [12].

4.4. Construction virtual simulation

"Internet + Smart Water Conservancy" technology enables virtual simulation of construction scenes and techniques, typically achieved through AR and VR technologies. Simulating the construction process ahead of time helps personnel identify construction issues and quality defects, optimizing construction processes and techniques. AR and VR technologies also aid in personnel training. By setting up various virtual environments, construction workers can quickly enhance their familiarity with the construction site. Compared to theoretical training, virtual environments provide stronger persuasion, enhancing training effectiveness and facilitating cost control [13].

5. Conclusion

In summary, "Internet + Smart Water Conservancy" integrates multiple advanced information technology advantages, including the Internet of Things, big data, cloud computing, artificial intelligence, etc., which can enhance the collection and analysis of construction information and comprehensively improve the efficiency and quality of engineering construction. Water conservancy engineering enterprises should face up to the development trend of intelligent construction technology in the future, vigorously introduce advanced technology, and inject new strength into the development of the water conservancy engineering industry.

Disclosure statement

The author declares no conflict of interest.

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