Research on Intelligent Application of Construction Project Management Method in the New Era

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Abstract: Intelligence has penetrated all walks of life with the rapid development of information technology. In the field of construction management, the application of intelligent technology is also increasingly extensive. Intelligent management methods can not only improve the efficiency and quality of construction projects but also reduce costs and waste of resources. This paper focuses on the intelligent application of construction project management methods in the new era. By analyzing the problems existing in the current construction management, the application of intelligent technology in every link of project management is expounded, including construction site management, material and equipment management, schedule control, quality supervision, and so on. At the same time, the paper also puts forward relevant suggestions on the popularization and application of intelligent management methods, which provides a reference for the innovative development of construction project management.

Keywords: Construction engineering; Management method; Intelligent; Apply

1. Introduction

The construction industry is one of the pillar industries of the national economy, which plays an important role in promoting social development and improving the living environment. In recent years, the construction industry in China has shown a good situation of expanding scale and improving technology day by day. Simultaneously, the construction project is becoming more and more complex, and the traditional management mode has made it difficult to adapt to the requirements of the new situation. To further improve the management level of construction projects and achieve cost reduction and efficiency, it is urgent to introduce advanced concepts and technologies. With the rise of modern information technologies such as big data, cloud computing, the Internet of Things (IoT), and artificial intelligence, a new round of scientific and technological revolution characterized by intelligence is sweeping the world. The application of intelligent technology to construction project management

can effectively solve the problems of low efficiency and serious waste of resources in traditional management methods [1]. With the advantages of informatization, automation, and intelligence, intelligent management methods have shown great potential in optimizing processes, improving refinement levels, and ensuring project quality and safety. Therefore, actively exploring the application of intelligent technology in construction project management is of great significance for enhancing the core competitiveness of the construction industry and promoting the transformation and upgrading of the industry.

2. Intelligent requirements in construction project management

2.1. Construction project management status and challenges

China's construction industry after many years of rapid development, both in the scale of engineering and technical level, has made great progress. However, there are still some problems to be solved in current construction project management.

Firstly, many construction enterprises follow the traditional management mode and rely on manual operation and experience judgment. The degree of information is not high and it is difficult to adapt to the increasingly complex engineering needs. Secondly, the construction project involves many links and a wide range of participants, and there are difficulties in coordination and cooperation at various stages, which affects the progress and efficiency of the project.

Additionally, due to the lack of scientific planning and effective supervision, a large amount of construction materials, equipment, energy, and so on, is wasted, which not only causes economic losses but also brings negative impacts on the ecological environment. Finally, engineering quality and safety risks cannot be ignored. Some projects have common quality problems and safety accidents, which reflect the loopholes and shortcomings in management. Facing the challenge of the new era, construction management needs to change and innovate. The introduction of intelligent management methods and the full use of advanced technological achievements can effectively crack the current management problems and promote the high-quality development of the construction industry.

2.2. Development and application prospects of intelligent technology

In recent years, the new generation of information technology represented by artificial intelligence, big data, and the Internet of Things has developed rapidly and been widely used in various industries, which has greatly changed the traditional way of production and life. As an important part of the national economy, the construction industry is also facing a wave of technological change.

At present, building information model (BIM), radio frequency identification (RFID), virtual reality (VR), drones, robots, and other intelligent technologies have emerged in the design, construction, operation, and maintenance of construction projects. The application of these advanced technologies makes engineering information more transparent, management processes more efficient, and quality and safety more guaranteed [2].

Taking BIM technology as an example, it realizes the information integration and sharing of the whole life cycle of buildings through digital models. Using the BIM platform, it is possible to optimize the design scheme, simulate the construction process, and conduct collision inspection, thereby improving the quality and efficiency of the project. Another example is unmanned aerial vehicle (UAV) technology, which obtains engineering image data through aerial inspection and combines it with an intelligent analysis algorithm to find quality defects and

safety risks in construction in time.

In general, intelligent technology has the characteristics of accurate information collection, efficient data processing, and wide application scenarios, which can well meet the needs of construction project management. In the future, with the further development and integration of 5G, artificial intelligence, and other technologies, intelligent management methods will be more widely applied in the construction field and become the core driving force leading the industry change.

3. Application of intelligent technology in construction project management

3.1. Intelligent construction site management

A construction site is the core area of construction project management, which is directly related to the achievement of project quality, schedule, cost, safety, and other indicators. Traditional construction site management mainly relies on manual inspection and paper ledger, and there are some problems such as inadequate supervision and lagging information. The introduction of intelligent management methods can effectively improve the efficiency and level of construction site management.

Among them, the application of Internet of Things technology makes construction site management more intelligent. By deploying various sensors on the construction site, such as temperature and humidity sensors, noise sensors, PM2.5 sensors, and many more, environmental data can be collected in real-time and uploaded to the management platform. Through the visual interface, managers can intuitively grasp the working conditions of the construction site and optimize the construction organization plan in time.

Moreover, the use of drones, laser scanning, and other equipment has also greatly improved the digitization level of site management. The UAV is equipped with high-definition cameras to take aerial photos of the construction site, and through intelligent algorithm processing, three-dimensional point cloud models can be quickly generated for engineering volume statistics and progress tracking. By scanning the construction site, the laser scanner generates an accurate three-dimensional model to provide data support for site layout and program optimization. Smart wearable devices such as smart helmets and smart work clothes have also begun to appear at the construction site. Through the built-in chip, these devices can locate the location of workers in real-time, monitor the vital signs of workers, and promptly warn and take emergency measures once dangerous situations are found.

3.2. Intelligent material and equipment management

The material cost accounts for a large part of the project cost, and the quality of the material directly affects the quality of the project. Equipment is an important tool for construction production, and its state is directly related to construction efficiency and cost. Therefore, strengthening the management of materials and equipment is an important part of construction project management. RFID technology is an effective means to realize intelligent material management. By pasting electronic labels on building materials and using radio frequency communication, the whole process of material procurement, transportation, storage, and use can be traced in information management. Once the problem material is found, the source can be queried in time to prevent quality accidents.

Furthermore, automation equipment such as storage robots and intelligent forklifts are also gradually applied to material management. For example, the automatic guided transport vehicle can realize the automatic distribution

of materials between the warehouse and the construction site according to the preset route. Loading and unloading robots can replace workers to complete the loading, unloading, and stacking of materials, improving efficiency and improving the working environment.

In terms of equipment management, intelligent technology is also promising. The combination of IoT technologies such as sensors and quick-response (QR) codes with equipment management systems can realize the digital collection and condition monitoring of equipment information. Through big data analysis, it is possible to predict the health status of equipment, develop scientific maintenance plans, and reduce unplanned downtime.

Additionally, remote fault diagnosis, intelligent scheduling, and other technologies have broad application prospects in equipment management. Once the equipment fails, the management personnel can remotely analyze the cause and guide the maintenance without going to the site. According to the construction task and platform schedule, the intelligent scheduling system can optimize the use of equipment and reduce standby waste. Intelligent material and equipment management makes full use of information technology to realize the closed-loop management of the whole life cycle of materials and equipment, which plays an important role in reducing costs, ensuring quality, and improving efficiency.

3.3. Intelligent schedule and cost control

Project delay and cost overruns are common problems in project management, and their root causes are unreasonable planning, asymmetric information, and inadequate management and control. The application of intelligent management methods can solve these problems from the source and achieve fine and dynamic schedule cost control. Through the BIM platform, the design drawing, bill of quantities, construction schedule, cost budget, and other data are integrated into a three-dimensional model. The virtual construction simulation technology can simulate the progress of the project and optimize the construction scheme. By conducting a comparative analysis with the actual progress, timely deviations can be identified, allowing for adjustments to the construction plan.

Based on the project's actual progress and market information, resources can be dynamically optimized, and costs effectively controlled. Big data analysis technology has also created conditions for intelligent schedule cost control. By aggregating all kinds of data such as owners' needs, design requirements, construction logs, material utilization, and mechanical platform shifts into the management platform, and using big data algorithms for association analysis, the project progress law can be revealed and resource allocation optimized. Machine learning algorithms can also train historical data to form cost prediction models to provide accurate support for engineering costs [3].

Moreover, emerging technologies such as smart contracts and blockchain also have broad application prospects in engineering payment settlement and supply chain finance. The smart contract can automatically settle the project payment according to the contract agreement and the project progress, reducing the risk of bad debts. Linking construction process data can realize information sharing and transaction traceability, and provide financing convenience for upstream and downstream enterprises in the supply chain. Intelligent schedule cost management and control uses information technology to open up the data barriers of design, procurement, construction, settlement, and other links, to achieve collaborative management of the whole life cycle of the project, and to improve management efficiency, but also to better control the project cost [4].

3.4. Intelligent quality and safety management

Engineering quality is related to the use function and safety performance and affects the durability and aesthetics

of the building. Construction safety is related to life and property, once there is an accident, the consequences are unimaginable. Strengthening project quality and safety management is the bountiful responsibility of each construction participant [5].

In terms of quality management, BIM technology has become the industry standard. Using BIM, virtual inspections can be carried out before construction to identify design defects and construction difficulties and formulate targeted quality control measures. In the construction process, entity information is collected by laser scanning and other technologies and compared and analyzed with BIM. Quality deviation can be found in time and accurate quality control can be achieved. Non-contact detection techniques such as infrared thermal imaging and X-ray flaw detection are also popularized in engineering quality inspection. Using these technical means, the quality problems inside the building components can be probed without damage, and the quality hidden dangers can be disposed of in time. In the face of increasingly complex construction projects, it is difficult to detect quality defects by manual sampling alone, so it is imperative to introduce advanced detection technology [6].

In terms of security management, intelligent technology has also played a role. Traditional safety management mainly focuses on civil air defense, which has many loopholes and low efficiency. By arranging an intelligent monitoring system on the construction site and using a computer vision algorithm, it can automatically identify all kinds of unsafe behaviors and linkage alarm equipment for a timely warning. Training platforms such as virtual reality/augmented reality (VR/AR) are also widely used in safety education [7]. Using VR/AR technology, safe operation training and emergency drills can be conducted in the virtual construction environment, so that workers can feel various risks in the scene, thereby improving safety awareness and practical operation ability [8].

The smart site, smart helmet, and other system platforms realize the all-around intelligent supervision of the construction site. Integrating video surveillance, behavior recognition, positioning tracking, big data analysis, and other functions. The smart site platform can realize the visualization, digitalization, and intelligence of site management. Through the built-in sensor, the smart helmet can accurately locate the position of the worker, monitor the vital signs of the worker, and timely alarm and take measures when encountering dangerous situations [9].

Intelligent quality and safety management starts from two aspects of technology and management, uses advanced digital means and intelligent equipment to realize the dynamic control of the whole process of project quality and safety, prevents common quality problems and safety accidents from the source, and escorts the high-quality development of construction projects.

4. Suggestions for promoting the application of intelligent management methods

As a new modern management concept and method, intelligent management needs to be widely and deeply applied in the field of construction engineering. Combining the status and development needs of the construction industry in China, the following suggestions are put forward.

4.1. Strengthen top-level design and improve standards and specifications

The implementation of intelligent management first requires competent government departments to strengthen top-level design and policy guidance. Formulate medium and long-term development plans for intelligent management, and elevate intelligent construction to a national strategic height. Research and promulgation of policies to support the development and application of intelligent technology, and give preferential treatment in terms of capital, tax, land, and many more. Accelerate the preparation and revision of BIM, Internet of Things,

big data, and other related standards and specifications to provide a basis for the implementation of intelligent management norms. Encourage local governments to try first, summarize, and promote the experience of intelligent construction pilots, and create a good intelligent application environment [10].

4.2. Vigorously cultivate talents and improve management ability

Intelligent management puts forward higher requirements for the professional quality of employees. On the one hand, it is necessary to strengthen the training of compound management talents, explore the new model of school-enterprise joint, production-education integration, and build several high-level intelligent construction talent training bases. On the other hand, it is necessary to increase the training of front-line managers and improve the ability of project teams to use intelligent technology. Introduce and train a group of leaders who understand both management and technology and play a leading role in the demonstration. Simultaneously, scientific research institutes, software companies, and other subjects are encouraged to participate in the training of intelligent talents to deliver new forces for the industry [11].

4.3. Focus on integrated innovation and build an industry platform

Intelligent management involves multiple dimensions such as technology, management, and business, and requires system integration and collaborative innovation of management concepts, technical means, and business processes. All parties involved in industry, university, and research should strengthen cooperation, focus on key common problems in project management, and carry out key technology research and achievement transformation of intelligent management. Build an industry-integrated service platform for intelligent management, realize the convergence and sharing of various data resources, and provide enterprises with intelligent solutions for the whole life cycle of design, construction, operation, and maintenance [12]. Strengthen the publicity and promotion of intelligent management, hold high-level forum meetings, build platforms for the exchange of experience, and create a development atmosphere of open sharing and collaborative innovation [13,14].

4.4. Strengthen demonstration and guidance and promote the deepening of application

Select leading enterprises and major projects with foundation and conditions to carry out pilot demonstrations of intelligent management, and play a leading role. Encourage large building central enterprises, design institutes, and other units to actively adopt intelligent management mode, and form many intelligent application models that can be copied and promoted. Support powerful enterprises to build intelligent management platforms, and provide professional technical services for small, medium, and micro enterprises. Improve the evaluation mechanism of intelligent management applications, strengthen process supervision and performance assessment, and strengthen the application effectiveness. At the same time, increases the intelligent transformation efforts, extends the intelligent management to the existing buildings, further expands the application scenarios, and promotes comprehensive intelligent construction management [15].

5. Conclusion

Construction project management in the new era is facing new opportunities and challenges. The introduction of intelligent concepts and technologies into the whole process of management and the use of information technology to optimize business processes is not only an inevitable choice to conform to the trend of modern times, but also the only way to achieve high-quality development of the construction industry. With the increasing maturity of

BIM, the Internet of Things, big data, artificial intelligence, and other technologies, intelligent management will be more widely and deeply applied in the field of construction engineering. Construction enterprises should take the initiative to adapt to the new round of scientific and technological revolution and industrial change trends, accelerate the pace of digital transformation, arm project management with intelligent means, and strive to improve the level of fine management. Concurrently, industry authorities, scientific research institutions, universities, enterprises, and other parties should also work together to take multiple measures in intelligent talent training, key technology research and development, standard formulation, typical demonstration, and other aspects, to jointly promote innovative development of intelligent construction project management, and contribute wisdom and strength to the high-quality development of the construction industry.

Disclosure statement

The authors declare no conflict of interest.

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