Hivereads Press

Journal of Economic, Management and Engineering Research
Issue 1, Volume 1

Innovation and Development of Construction Project Management Under the Background of Intelligent Construction

Xuhua Zhan *

Anhui University Hefei, Hefei, China

Abstract: This paper discusses the opportunities and challenges faced by the field of construction project management under the background of intelligent construction, and focuses on the application of emerging technologies such as the Internet of Things, big data, artificial intelligence, BIM, and robotics in construction project management. By examining the current practice of construction project management, this paper proposes that under the background of intelligent construction, construction project management should develop in a more digital, intelligent, refined and sustainable direction. At the same time, this paper also explores the impact of intelligent construction on traditional management models and the new skills and knowledge that managers need to have, aiming to provide a framework for academics and engineering practitioners to understand and promote changes in construction project management.

Keywords: Smart Construction; Construction Project Management; Internet of Things (IoT); Big Data; AI;, Building Information Modeling (BIM); Robotics; Digital Transformation; Innovative Development

1. Introduction

As a key link to ensure that engineering projects are completed on time, on quality and on budget, the development level of construction project management is directly related to the efficiency, safety and sustainability of engineering construction. For a long time, the construction industry has faced challenges such as relatively low production efficiency, high labor intensity, high safety risks and serious environmental pollution. With the rapid development of information technology and automation technology, the concept of "smart construction" has emerged and has gradually become an important driving force for the transformation and upgrading of the construction industry.

Smart construction refers to the use of advanced technologies such as the Internet of Things, big data, artificial intelligence, BIM, and robots, which are deeply integrated with the entire process of construction projects to achieve digitalization, intelligence, refinement, and sustainability in the construction process. This revolutionary concept has not only changed the traditional construction method, but also put forward new requirements and challenges for construction project management. The traditional management model is powerless in the face of massive data, complex systems, and rapidly iterating technologies, and it is in urgent need of innovation and development.

This paper aims to explore the changes faced by construction project management under the background of intelligent construction. First, we will outline the core technologies of intelligent construction and their applications in construction projects. Secondly, we will focus on analyzing the impact of intelligent construction on traditional construction project management and explore the opportunities and challenges it brings. Subsequently, we will conduct in-depth research on the key innovative directions of construction project management under the background of intelligent construction, including the construction of digital management platforms, the development of intelligent decision support systems, refined construction organization and management, and full life cycle management based on digital twins. Finally, we will look forward to the development trend of construction project management under the background of intelligent construction and discuss the new skills and knowledge that managers need to have, in order to contribute academic thinking to promote the intelligent transformation of the construction industry.

2. Core Technologies and Applications of Intelligent Construction

Smart construction is not the application of a single technology, but the result of the integration of multiple advanced technologies. The following will introduce several core technologies and their applications in construction projects.

2.1. Internet of Things (IoT)

The Internet of Things deploys sensors, software and other technologies on physical equipment, buildings, vehicles and other objects to enable them to connect and exchange data. In construction project management, the application of the Internet of Things is mainly reflected in:

Intelligent construction site management: Real-time monitoring of construction site environmental parameters (such as temperature, humidity, PM2.5), equipment operating status, personnel location, material tracking, etc., to provide data support for safety management, resource optimization and environmental monitoring.

Intelligent safety monitoring: Use wearable devices, video analysis and other technologies to monitor workers' safety status in real time, warn of dangerous behaviors, and reduce the incidence of safety accidents.

Intelligent quality control: Through sensors and automated testing equipment, key quality indicators such as concrete curing and structural deformation are monitored in real time to improve the accuracy and efficiency of quality control.

2.2. Big Data

Construction projects generate a large amount of structured and unstructured data during the design, construction, operation and maintenance stages. Big data technology can collect, store, analyze and mine these massive amounts of data, thereby providing valuable insights for management decisions. Its applications include.

Cost forecasting and control: Analyze historical project data, predict cost risks of future projects, and optimize cost control strategies.

Schedule optimization: Analyze construction process data, identify bottlenecks, optimize resource allocation, and improve project schedule management efficiency.

Risk management: Identify potential risk factors, assess the probability and impact of risks, and develop appropriate response measures.

2.3. Artificial Intelligence (AI)

Artificial intelligence enables computers to perform complex tasks such as learning, reasoning, and problem solving by simulating human intelligent behavior. In construction project management, the application prospects of artificial intelligence are broad:

Intelligent decision support: Based on big data analysis and machine learning algorithms, it provides project managers with intelligent decision-making suggestions, such as the optimal construction plan selection and resource allocation strategy.

Intelligent image recognition: Applied to scenarios such as quality defect detection, safety hazard identification, and progress tracking to improve detection efficiency and accuracy.

Natural Language Processing (NLP): Applied in areas such as contract management, document analysis, and intelligent customer service to improve information processing and communication efficiency.

2.4. Building Information Modeling (BIM)

BIM is a building information integration management method based on three-dimensional digital models, covering the entire life cycle of construction projects. In the context of intelligent construction, BIM is not only an information model, but also a data platform and collaboration tool:

Visual collaborative design: Enable information sharing and collaborative work among design, construction, operation and maintenance parties on a unified platform, reducing design conflicts and information transmission barriers.

Virtual construction and simulation: Conduct virtual construction and scheme simulation before actual construction to optimize construction organization and reduce on-site changes and rework.

Full life cycle management: Provide comprehensive information support for the operation and maintenance of buildings, and realize intelligent facility management and maintenance.

2.5. Robotics

The application of robotics in construction projects aims to replace or assist manual labor in completing repetitive, dangerous or high-precision tasks, thereby improving production efficiency and safety:

Automated masonry and welding robots: improve the efficiency and quality of masonry and welding and reduce labor costs.

Inspection and maintenance robots: perform inspection and maintenance operations in dangerous or hard-to-reach areas to ensure facility safety.

3D printing architecture: Use 3D printing technology to quickly build houses or components, improving construction speed and flexibility.

3. Impact and challenges of intelligent construction on traditional construction project management

The rise of intelligent construction has had a profound impact on the traditional construction project management model, and has also brought new opportunities and challenges.

3.1. Impact on traditional management model

Breaking down information asymmetry: Traditional management relies on manual collection and transmission of information, which is prone to information lag and asymmetry. Intelligent construction breaks down information barriers and improves management transparency and efficiency through real-time data collection and sharing.

Weakening of empiricism: Traditional management relies heavily on the personal experience of managers. Intelligent construction provides a more scientific basis for management decisions through data analysis and artificial intelligence decision support, reducing the deviation caused by empiricism.

Transition from labor-intensive to technology-intensive: Smart construction reduces dependence on manual labor through the application of automation and robotics technology, enabling the construction industry to transform from labor-intensive to technology-intensive.

Transition from linear management to collaborative management: The application of technologies such as BIM has promoted collaborative work among project participants, broken the traditional linear management model, and improved the overall efficiency of the project.

3.2. Challenges

Technology integration and compatibility: There may be compatibility issues between different smart construction technologies and systems. How to achieve effective integration of various technologies is an important challenge.

Data security and privacy: The collection and use of large amounts of data brings risks to data security and privacy protection, and it is necessary to establish a sound data management and security mechanism.

Talent cultivation and skills improvement: Intelligent construction requires compound talents with interdisciplinary knowledge and skills, and the traditional construction project management talent cultivation system needs to be reformed.

Cost investment and benefit evaluation: The application of intelligent construction technology requires a high initial investment. How to evaluate its long-term benefits and achieve return on investment is an issue that needs to be seriously considered.

Lagging behind in standardization and specification: The standardization and specification of smart construction-related technologies and applications are relatively lagging, which hinders the promotion and application of technologies.

Organizational culture change: The adoption of smart construction requires a shift in organizational culture, including acceptance of new technologies, trust in data-driven decision making, and adaptation to collaborative working models.

4. Key Innovation Directions of Construction Project Management Under the Background of Intelligent Construction

In order to meet the challenges and seize the opportunities brought by intelligent construction, construction project management needs to innovate in the following key directions.

4.1. Building a Digital Management Platform

Build a digital management platform that integrates multiple information sources such as IoT data, BIM models, and project management systems to achieve real-time collection, storage, analysis, and visualization of project information. The platform should have the following functions:

Unified data center: Integrate data throughout the entire life cycle of a project and break down information silos.

Real-time monitoring and early warning: Real-time monitoring of key indicators such as construction site status, equipment operation, personnel safety, and intelligent early warning.

Visual decision support: Through BIM models and data visualization technology, managers are provided with intuitive project information to assist in decision-making.

Collaborative working environment: Supports online collaborative work among all project participants to achieve information sharing and process optimization.

4.2. Developing Intelligent Decision Support Systems

Utilize big data analysis and artificial intelligence technology to develop intelligent decision support systems and provide a scientific basis for project management:

Intelligent risk identification and assessment: Based on historical data and real-time information, predict project risks and assess their probability and impact.

Intelligent schedule optimization: Analyze construction process data, identify critical paths and bottlenecks, and propose optimized schedule plans.

Intelligent cost control: predict project cost change trends, provide cost control suggestions, and achieve refined cost management.

Intelligent resource allocation: Optimize the allocation of manpower, materials and equipment based on project requirements and resource status.

4.3. Realize Refined Construction Organization and Management

With the help of technologies such as BIM, IoT and robots, the construction process can be organized and managed in a refined manner:

BIM-based construction plan optimization: Use BIM models to visualize and optimize construction plans to reduce construction conflicts and rework.

Intelligent scheduling based on the Internet of Things: Real-time tracking and scheduling of personnel, equipment and materials through the Internet of Things technology to improve resource utilization efficiency.

Robotic automated construction: Use automated masonry, welding, spraying and other robots to improve construction efficiency and quality, and reduce labor costs and safety risks.

Digital twin-driven construction management: Build a digital twin model of the physical project to achieve real-time monitoring, simulation analysis, and predictive maintenance of the construction process.

4.4. Building a Full Life Cycle Management System Based on Digital Twins t

Using digital twin technology, we can build a digital model of the entire life cycle of a construction project and realize intelligent management from design, construction to operation and maintenance:

Virtual simulation and optimization in the design stage: Use digital twin models to perform virtual simulation and performance analysis of design solutions to optimize them.

Real-time monitoring and intelligent decision-making during the construction phase: Use digital twin models to monitor construction progress, quality, and safety in real time and provide support for management decisions.

Intelligent facility management during the operation and maintenance stage: Use digital twin models to monitor facility status, predict faults, and conduct intelligent maintenance to improve operation and maintenance efficiency and reduce costs.

5. Development Trend of Construction Project Management Under the Background of Intelligent Construction

Looking ahead, intelligent construction will continue to promote changes in construction project management and present the following development trends:

Comprehensive digitalization and intelligence: All aspects of construction project management will rely more on digital technology and intelligent algorithms to achieve digitalization and intelligence of the entire process.

High integration and collaboration: Various intelligent construction technologies and management systems will be highly integrated, and the collaboration between project participants will be closer and more efficient.

Data-driven decision optimization: Big data analysis and artificial intelligence will become the core driving force for management decision-making, enabling more scientific and accurate decisions.

Sustainable and green construction: Intelligent construction technology will be applied to green building materials, energy-saving design, intelligent energy consumption management, etc. to promote the sustainable development of the construction industry.

Personalized and customized services: Utilize technologies such as 3D printing to achieve personalized and customized production of building products to meet diverse customer needs.

Intelligent construction with human-machine collaboration: The future construction process will be a deep collaboration between humans and machines, giving full play to their respective advantages and improving production efficiency and quality.

6. Conclusion

Intelligent construction has brought unprecedented development opportunities to construction project management, but it has also posed severe challenges. Construction project management needs to actively embrace change, strengthen technological innovation, build a digital management platform, develop an intelligent decision support system, achieve refined construction organization and management, and build a full life cycle management model based on digital twins. Future construction project managers need to have interdisciplinary knowledge, keen technical insight, and an open mind to embrace change. Only through continuous learning and innovation can the construction industry truly achieve intelligent transformation, improve efficiency, ensure safety, reduce costs, and promote sustainable development.

References

1. Ma Zhiliang, Zhang Jianping, Wang Bo, et al. Research on the development trend of construction project management under the background of intelligent construction [J/OL]. Journal of Civil Engineering and Management: 1-11[2024-05-28].
2. Ministry of Housing and Urban-Rural Development. Action Plan for the Development of Intelligent Construction (2021-2023)[Z]. 2021.
3. Xiao Xuwen. Current status and prospects of intelligent construction development in China[C]. Journal of the Chinese Academy of Engineering, 2021, 3(1): 1-7.
4. Tsinghua University, China Construction Group Co., Ltd. Intelligent Construction Technology and Practice[M]. Beijing: China Architecture & Building Press, 2023.
5. China Construction Industry Association. Building Information Modeling Application Standard GB/T 51235-2017[S]. Beijing: China Planning Press, 2017.