An effective study on the effect of intelligent construction on reducing the risk of railway construction

Zhaoyang Cui[1]

[1] School of Civil Engineering, Shijiazhuang Railway University, Hebei Province, China, 050043
424409372@qq.com

Abstract: *This paper intends to explore the function and approaches of intelligent construction in reducing the risks of railway engineering construction. By means of literature review and risk analysis, effective measures for lowering construction risks through the organic combination of intelligent construction and railway engineering are put forward, including data-driven decision support, real-time monitoring and early-warning systems, digital construction technology, intelligent equipment and automated construction, collaborative working platforms, etc. Finally, the prospects and potential of intelligent construction in reducing the risks of railway engineering construction are indicated.*

Keywords: *Railway Engineering; Intelligent Construction; Construction Risks*

0 Introduction

During the 14th Five-Year Plan period, all regions across the country responded to the national call and actively promoted railway engineering construction. The scale of engineering construction has been continuously expanding. In recent years, China's railway industry has achieved remarkable achievements that have attracted global attention, with both the operating mileage and high-speed railway mileage ranking first in the world. However, behind the rapid development, there are also some challenges and problems [1].

Railway engineering construction has the characteristics of large scale, high cost, and high risk. In practice, the construction environment of railway engineering is complex, and it is easy to be affected by unfavorable factors during construction, which increases the risk and may cause accidents. A large amount of manpower, material resources, and financial resources are often required in railway engineering construction. The occurrence of construction risks will cause personnel casualties, economic losses, and social impacts, etc. [2].

Based on China's "Made in China 2025", "Internet +" action plan, and the development plan for the next generation of artificial intelligence, etc. practical plans, information technology and intelligent equipment are gradually introduced into industrial production fields, leading the application and development of intelligent technology in the construction industry. Intelligent construction plays a decisive role in the transformation and upgrading of the future engineering construction industry. Therefore, intelligent construction will play an absolute role in reducing railway construction risks[3]. In this regard, Chinese experts have conducted research on this issue:

Song Sheng proposed that the construction risk of railway construction could be reduced by constructing a smart construction site. He pointed out that by combining modern information and

construction technologies, such as the Internet of Things, cloud computing, and artificial intelligence, through a combination of technology and human labor, the safety management level in railway engineering construction can be comprehensively improved [4].

Chen Dongyan pointed out that the safety management method of railway construction is outdated. In the traditional management mode, it is a manual management method, which has a series of problems and has a high construction risk. Chen Dongyan believes that innovation awareness should be established, and information technology and monitoring technology should be actively introduced to improve the efficiency and quality of safety management with information and intelligent management methods, and a modern safety management system should be established [2].

1. Risk analysis of railway construction

Railway construction risks mainly include: technical risk, natural risk, safety risk, social and environmental risk.

1.1 Technical risk

Because railway engineering construction involves complex technical problems, technical risk is one of the important types of risk. This includes factors such as improper design, incorrect selection of construction techniques or improper application of technologies. Errors or unreasonable designs that may occur in the design stage may lead to construction difficulties or safety hazards in the later stage; The use of new technologies and new materials may be uncertain, and the construction team's mastery of new technologies affects the construction quality and efficiency. The main reason of blasting risk is the improper operation of blasting technology, resulting in casualties and property losses. At the same time, blasting operations will produce strong vibration waves, which are easy to cause damage to surrounding buildings, Bridges, pipelines and other facilities [5].

1.2 Natural risks

Railway projects often cross different geographical environments, so they are susceptible to natural disasters, such as uncertain factors such as foundation subsidence, landslides, debris flows and small earthquakes [5]. The settlement of subgrade is mainly caused by water flow erosion. The ground gradually sinks under the action of water erosion. It is difficult to pave the track, and the operation risk is greater. The settlement of the roadbed will eventually lead to the deviation of the track and the change of the geometric shape, which is not conducive to the stability and safety of the train operation. In addition, curve deformation will affect the stability of train running on the curve and increase the risk of train derailment [5]. Small earthquakes are generally the inducing factors of geological disasters such as landslides and debris flows. Landslides and debris flows occur frequently in mountainous areas, which may lead to the destruction and burial of railway tracks and affect traffic. If it occurs in the construction section, it will not only cause economic losses, affect the construction progress, but also may cause casualties.

1.3 Safety risk

safety accidents in the construction process are another important type of risk, which may involve worker safety, equipment safety and other aspects. The main cause of railway safety accidents is human factors, and at the same time, the personnel are also the most hurt in the accident. Nowadays, in engineering projects, production tasks are tight and human resource safety management is difficult, which makes the safety accidents caused by human factors very high. If the personnel do not operate the machinery and equipment correctly and do not carry out the construction operation in a standardized manner, it will cause security risks and even cause casualties. Railway engineering construction operations sometimes need to be carried out in mountainous areas, plateaus and other

areas, which cannot be separated from the support of various mechanical equipment. Due to the safety threat of mechanical equipment itself, improper operation of personnel or unstable operation of machinery may cause safety accidents and threaten the life of construction personnel [4].

1.4 Social and environmental risks

The construction of railway projects may have impacts on the surrounding communities and the environment, such as noise pollution and ecological damage. These risks are not conducive to the sustainable development of railway engineering [6]. Or may cause landslides, foundation collapse and other natural disasters to further threaten the railway facilities, resulting in losses.

2. Methods of intelligent construction to reduce the risk of railway construction.

2.1 Data-driven decision support

The use of big data and artificial intelligence technology to analyze the data generated during railway construction can identify potential risks in advance. Deep learning algorithms are used to predict possible delays and cost overruns during construction by analyzing historical project data. PaddlePaddle was used to build a number of model construction algorithm service platforms such as architectural design and optimization model, energy simulation and prediction model, building intelligent control model, fault detection and diagnosis model, etc. Realize the application of artificial intelligence algorithm in reducing the risk of railway engineering construction [7].

2.2 Real-time monitoring and early warning system

With the advent of the 5G era, Internet of Things technology has the characteristics of ultra-high speed and low latency, which greatly improves the efficiency of data transmission and information exchange [8]. Therefore, it is more feasible to monitor the construction site by using technical means such as sensors and monitoring equipment. All kinds of data are collected in real time through the device, and a large amount of data is fed back to the analysis platform. After intelligent analysis and algorithm processing, these data form visual reports and charts, so that project managers can find potential problems or risks in time. This system can take action before engineering problems such as soil settlement and equipment failure occur. Real-time construction monitoring can realize the real-time update of digital construction plans. Through real-time monitoring and data feedback, the digital system of the whole construction process of construction engineering can respond to changes more flexibly, improve construction safety and reduce construction risks [9].

2.3 Building digital technology

Building Information modeling (BIM) and computer-aided design (CAD) techniques can identify possible design defects and construction conflicts at the design stage, reducing rework and delays. At the same time, BIM can also be used for progress management and resource allocation in the construction process to improve construction efficiency. Virtual reality (VR) and augmented reality (AR) technology can simulate the construction process, help construction personnel familiarize themselves with the construction environment in advance, and reduce the risk of site construction.

2.4 Intelligent equipment and automated construction

The whole construction process of construction projects will develop in the direction of intelligence, and intelligent robots will be more popular. The use of automated construction equipment can improve the construction accuracy and reduce human error. Drones can be used in construction site monitoring, reconnaissance and safety inspections, and provide data support for construction by quickly taking high-definition pictures. Artificial intelligence algorithms can analyze construction risks based on real-time data, historical experience and project characteristics to reduce construction risks [9]. At the

same time, equipment such as drones can operate in hazardous environments, reducing worker safety risks.

2.5 Collaborative work platform

Establish an integrated collaborative work platform to ensure that all participants (design, construction, supervision, etc.) can share information in real time and enhance communication and coordination [3]. Reduce the risks caused by information asymmetry.

Through the above research and practice, intelligent construction can effectively reduce various risks in railway construction and improve the success rate and safety of the project.

3 Conclusion

Since the fourth Industrial Revolution, technologies such as artificial intelligence, big data, and the Internet have developed rapidly. The traditional construction management form has no longer adapted to the requirements of The Times, and the intelligent construction technology came into being. Intelligent construction technology plays an important role in reducing railway construction risk, improving management quality and promoting railway development. With the continuous deepening and application of these technologies, we have reason to believe that future railway construction will be more efficient, intelligent and environmentally friendly. By summing up experience and pioneering innovation, more feasible strategies are provided to reduce the risk of railway construction and promote the sustainable development of railway engineering.

References

[1] Ji Chengcheng. Research on the status quo and Innovation Strategy of railway project Management in the new era [J]. Heilongjiang Transportation Science and Technology,2023(7):174-176

[2] Chen Dongyan. Research on Construction Risk and Safety Management of railway Engineering [J]. Science and Technology Information, 2021 (9) : 86-89

[3] LI Yingjiu. Application of Intelligent Construction Technology in Railway construction management [J]. China Railway, 2018 (5) : 1-7

[4] SONG Sheng. Risk and Safety Management of Railway engineering Construction [J]. Heilongjiang Transportation Science and Technology. 2023,46 (07) :171-173

[5] LI Huajun. Construction Risk and Safety Management Measures of railway Engineering [J]. Transportation Manager World. 2023 (28) :31-33

[6] Chen B. Sustainable Development Strategies and Practices in Railway engineering and construction [J]. Land Bridge View. 2024 (08) :124-126

[7] Xiao Penglin, Zeng Shajie. Research and Practice of Architecture Algorithm Service Platform Based on Deep Learning Framework [J]. Digital Communications World. 2024 (04):98-107

[8] 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]. Smart Buildings and Smart Cities. 2024 (11) :95-97

[9] Wang Su. Analysis on digitization of the whole construction process of building engineering from the perspective of Intelligent construction [J]. Construction Science and Technology. 2024 (09) :88-90