Journal of World Architecture, 2025, Volume 9, Issue 6
https://ojs.bbwpublisher.com/index.php/JWA
Online ISSN: 2208-3499
Print ISSN: 2208-3480

Key Points and Innovative Practices in Technical Management of Municipal Engineering

Wenjie Du*

Shenzhen Municipal Group Co., Ltd., Shenzhen 518000, Guangdong, China

**Author to whom correspondence should be addressed.*

Abstract: Technical management in municipal engineering is crucial for urban development. While it encompasses core elements, it faces bottlenecks such as a lack of standardization. To address this, it is necessary to build a whole-process quality management system, innovate safety risk prevention and control mechanisms, and develop smart construction site management systems, among other measures. At the same time, different municipal projects have specific technical management priorities. The level of technical management should be enhanced through standardization, digitalization, greening, and intelligent management.

Keywords: Municipal engineering; Technical management; Innovative practices

Online publication: December 31, 2025

1. Introduction

Technical management in municipal engineering is of great significance to urban development. To promote the high-quality development of municipal engineering construction, the state issued the "Guiding Opinions on Promoting Technological Innovation and Management Enhancement in Municipal Engineering" in 2023, emphasizing the importance of improving the technical management level of municipal engineering. Currently, technical management in municipal engineering faces bottlenecks such as a lack of standardization, inefficient resource allocation, and lagging application of new technologies. Practices such as constructing a whole-process quality management system, innovating safety risk prevention and control mechanisms, and developing smart construction site management systems promote its development in terms of quality, safety, efficiency, and other aspects, aligning with policy direction. These efforts help municipal engineering achieve standardization, digitalization, and greening, provide technical management paradigms for new urbanization construction, and promote sustainable urban development.

2. Connotation and current situation analysis of technical management in municipal engineering

2.1. Basic concepts and core elements of technical management

Technical management in municipal engineering refers to the use of scientific methods to plan, organize, coordinate, and control various technical activities and related elements in municipal engineering construction. It aims to ensure that project construction proceeds smoothly according to predetermined goals, effectively improving project quality, ensuring safety, and controlling costs [1]. The core elements of technical management cover technical standards and specifications, which are the guidelines for project construction, clarifying specific requirements and quality standards for various construction operations; technical schemes, which are construction strategies formulated based on project characteristics and needs, including construction techniques and processes, directly affecting project progress and quality; technical personnel, the executors of technical management, whose professional competence and skill levels are crucial; and technical data, such as construction drawings and change records, which provide comprehensive and accurate technical basis for project construction, playing a key role in the smooth advancement of the project and later maintenance.

2.2. Development bottlenecks in technical management of municipal engineering

The development of technical management in municipal engineering faces multiple bottlenecks. The lack of standardization is the primary issue. Currently, technical management in municipal engineering lacks a unified and detailed standard system, leading to significant differences in technical operation specifications, quality acceptance, etc., among different projects, affecting overall project quality and collaborative work efficiency [2]. Inefficient resource allocation is also prominent. Resources such as technical personnel, equipment, and materials are allocated unreasonably across various project stages, with talent shortages and idleness coexisting, and frequent delays in equipment/material supply or wastage, restricting the effective implementation of technical management work. Furthermore, the application of new technologies lags. Although new technologies continue to emerge in the field of municipal engineering, due to imperfect technology transfer mechanisms and insufficient personnel training, new technologies are difficult to integrate quickly into actual projects, making it hard for projects to achieve ideal results in efficiency improvement, energy saving, and environmental protection.

3. Analysis of key points in technical management of municipal engineering

3.1. Construction of a whole-process quality management system

In the technical management of municipal engineering, the construction of a whole-process quality management system is extremely critical. Starting from the design stage, detailed technical disclosure is needed to ensure all construction parties clearly understand the design intent and technical requirements, avoiding deviations during construction. During the construction process, the PDCA cycle (Plan, Do, Check, Act) is used to dynamically control project quality. By carefully formulating quality plans, strictly executing construction operations, regularly inspecting construction results, and promptly addressing discovered problems while formulating improvement measures, a management closed loop is formed. Simultaneously, a construction quality traceability system is built to ensure that once quality problems occur, they can be quickly traced back to specific links and responsible persons. Such comprehensive, full-process management can effectively enhance the quality of municipal engineering and ensure the smooth progress of projects [3].

3.2. Innovation in safety risk prevention and control mechanisms

Innovation in safety risk prevention and control mechanisms within municipal engineering technical management can be achieved by establishing a risk early warning system and a dynamic assessment model based on BIM technology. In municipal engineering, foundation pit support and underground pipeline protection are crucial. The risk early warning system based on BIM technology can monitor the stress, deformation, and other conditions of foundation pit support structures in real-time. When data approaches or exceeds safety thresholds, it issues timely alerts, enabling workers to take rapid measures to avoid accidents [4]. The dynamic assessment model, targeting underground pipeline protection, dynamically assesses the degree of impact on pipelines based on project progress, predicts potential risks in advance, and helps adjust construction schemes to ensure the safety of underground pipelines. These two aspects cover specialized schemes, achieving precise control of risks in key links of municipal engineering, enhancing the scientificity and effectiveness of safety risk prevention and control, and building a solid safety line for the smooth progress of the project.

4. Innovative practice paths for technical management in municipal engineering

4.1. Construction of management information platforms

4.1.1. Development of smart construction site management systems

In the innovative practice of technical management for municipal engineering, the development of smart construction site management systems is crucial. Integrating IoT sensors, mobile terminals, and cloud platforms forms a real-time monitoring system [5]. IoT sensors are widely deployed at key parts of the construction site, capable of collecting data such as temperature, humidity, noise, dust concentration, and equipment operating status in real-time. Mobile terminals facilitate construction personnel to input and query information anytime, anywhere, such as construction progress and quality inspection results, achieving timely information sharing. The cloud platform, as the data hub, stores, analyzes, and processes various collected data. Through big data analysis technology, it mines potential risks and problems, providing scientific decision-making basis for managers, assisting in the efficient, safe, and high-quality advancement of municipal engineering, and greatly improving the efficiency and precision of technical management.

4.1.2. Application of BIM collaborative management platform

In the technical management of municipal engineering, the application of a BIM collaborative management platform is essential. This platform enables visual verification of engineering parameters. Using the BIM 3D model, complex engineering parameters are presented intuitively and visually, allowing technical personnel to accurately identify potential issues in design and construction parameters and make timely adjustments, avoiding construction risks [6]. Simultaneously, it establishes a digital workflow for multi-party collaborative work. All parties involved in construction, design, and other aspects can share data and communicate in real-time on the same platform, breaking down information barriers and reducing errors and delays caused by poor information flow. Parties make collaborative decisions based on the platform's real-time data, significantly enhancing the scientificity and efficiency of decision-making, effectively improving the overall efficiency and quality of technical management in municipal engineering, and promoting the smooth implementation of projects.

4.2. Innovative application of green construction technology

4.2.1. Prefabricated construction technology system

In the prefabricated construction technology system for municipal engineering, the carbon emission control scheme for standardized production of prefabricated components and modular installation is crucial. Standardized production of prefabricated components, by establishing unified production standards and using advanced molds and automated equipment, improves production efficiency and product quality, reducing additional carbon emissions caused by rework and scrap [7]. Meanwhile, in the modular installation phase, precise construction process planning and advanced hoisting equipment enable fast and accurate installation, shortening the construction period and reducing energy consumption and carbon emissions during construction. Furthermore, integrating carbon emission control concepts into the design phase optimizes component design, making components easier to standardize and install modularly, reducing carbon emissions from the source. Through these measures, green and low-carbon development is achieved in the prefabricated construction technology system for municipal engineering.

4.2.2. Construction management of sponge city facilities

In the construction management of sponge city facilities in municipal engineering, the construction process innovation and acceptance standards for LID facilities such as permeable pavements and retention basins are crucial. For permeable pavements, material selection and laying processes should be optimized, using new materials with strong permeability and good durability to ensure efficient rainwater infiltration and stable road structure. During construction, parameters such as slope and porosity must be precisely controlled to ensure smooth drainage. Retention basin construction focuses on structural design innovation, improving space utilization and water storage capacity, using advanced waterproofing and anti-seepage technologies to prevent water leakage. During the acceptance phase, key indicators such as the permeability coefficient of permeable pavements and the storage capacity of retention basins are strictly tested according to relevant standards to ensure all indicators meet requirements, guaranteeing the effective functioning of sponge city facilities [8].

5. Practical case analysis of technical management in municipal engineering

5.1. Underground utility tunnel construction project

5.1.1. Shield tunneling technical management scheme

In a utility tunnel project in a megacity, shield tunneling technical management is crucial. To ensure smooth construction and the safety of the surrounding environment, shield parameters need to be optimized. Through precise calculation and simulation analysis, reasonable parameters such as propulsion speed, earth chamber pressure, and grouting volume are determined to reduce disturbance to the soil [9]. For surface settlement control, surface deformation data is monitored in real-time, and shield construction parameters are adjusted promptly based on monitoring results. Advanced grouting technology is used to synchronize grouting during the shield advancement process, filling the gap between segments and the soil, effectively controlling surface settlement. Simultaneously, technical training for construction personnel is strengthened to ensure they master shield tunneling techniques and strictly follow operating procedures, safeguarding the quality and safety of shield tunneling in the underground utility tunnel construction project.

5.1.2. Practice of intelligent operation and maintenance management system

In the practice of the intelligent operation and maintenance management system for underground utility tunnel construction projects, the whole-life-cycle management system demonstrates significant practical application effects in the health monitoring of the tunnel structure. This system uses various sensors to collect data on stress, deformation, etc., of the tunnel structure in real-time and accurately assesses and predicts the tunnel's health status through data analysis and processing technologies [10]. For example, it can promptly detect potential structural damage to the tunnel caused by geological settlement or changes in external loads, providing a strong basis for operation and maintenance personnel to develop maintenance strategies in advance. Meanwhile, based on the system's historical data and model analysis, the inspection cycle and maintenance plans for the tunnel can be optimized, reducing operation and maintenance costs and improving the safety and reliability of the tunnel operation. This practice of the intelligent operation and maintenance management system provides an efficient and scientific paradigm for technical management in the field of underground utility tunnels in municipal engineering.

5.2. Urban road rapid transformation project

5.2.1. Innovation in traffic diversion technology

In urban road rapid transformation projects, innovation in traffic diversion technology is extremely critical. Using traffic flow simulation technology, the construction scheme for occupying roads is optimized. By collecting data such as traffic flow, vehicle type, and peak/off-peak hours on the road section, a precise traffic flow simulation model is built using professional software. Based on the simulation results, the location of construction enclosures, the area of occupied roads, and the construction sequence are adjusted to reduce the impact on traffic. Simultaneously, the public information release system, information such as construction road occupation, traffic diversion routes, and estimated construction duration are promptly communicated to the public. Using multiple channels such as social media platforms, traffic radio, and electronic display screens for release allows citizens to plan their trips in advance, improves traffic diversion efficiency, ensures basic smoothness of urban traffic during construction, and effectively reduces traffic congestion and safety hazards caused by construction.

5.2.2. Environmental noise reduction construction management

In the environmental noise reduction construction management of urban road rapid transformation projects, the combined application of low-noise paving equipment and dust monitoring systems has achieved remarkable results. Low-noise paving equipment reduces construction noise at the source; its advanced design and technical optimization effectively reduce noise generated during equipment operation and material paving. The dust monitoring system monitors the dust situation at the construction site in real-time; once the set threshold is exceeded, an alarm is triggered immediately and linked to dust suppression equipment. The combined application of the two, while ensuring the construction progress of the road rapid transformation, reduces the impact on the lives of surrounding residents. On the one hand, low-noise paving equipment reduces noise pollution, preventing residents from high-decibel interference; on the other hand, the dust monitoring system precisely controls dust, creating a healthier construction environment. This combined application model provides an efficient and innovative practical example for environmental noise reduction construction management in municipal engineering, promoting the upgrade of technical management in environmental protection and noise reduction in municipal engineering.

5.3. Inter-basin water transfer project

5.3.1. Technical management of large-diameter pipeline installation

In the technical management of large-diameter pipeline installation for inter-basin water transfer projects, quality control of the pipelines themselves is crucial. Large-diameter pipelines need to possess characteristics such as high strength and corrosion resistance, and parameters such as pipe diameter and wall thickness must strictly comply with design requirements. During the installation process, precise measurement and positioning are the foundation, using advanced measuring instruments to ensure the position and slope of the pipeline laying are accurate. The operation specifications of large hoisting equipment cannot be ignored; operations must strictly follow procedures to ensure stable lifting and accurate docking of pipelines. Meanwhile, welding technical management is a key link. Welders must be certified, welding process parameters such as current, voltage, and welding speed must be strictly controlled, and non-destructive testing must be conducted after welding to ensure welding quality meets standards. Additionally, safety management during installation is essential, setting up warning signs and providing safety training for construction personnel to ensure the smooth progress of large-diameter pipeline installation.

5.3.2. Whole-process BIM application in the project

In the inter-basin water transfer project, the whole-process BIM application achieves full-chain management from the design model to the as-built digital twin. In the design phase, BIM technology is used to create accurate 3D models, conduct visual design and analysis of key facilities such as water transfer routes, pumping stations, and tunnels, identify design conflicts and in advance, and optimize the design scheme. During the construction period, based on the BIM model, progress simulation is conducted to reasonably arrange construction sequences and resource allocation. Simultaneously, it is used for quality and safety management, tracking construction status in real-time and solving problems promptly. By the completion stage, through scanning and data integration of the actual construction results, an as-built digital twin model is constructed, completely recording project information, providing an accurate basis for subsequent operation and maintenance, achieving efficient whole-life-cycle management, and improving the technical management level of municipal engineering.

6. Conclusion

Technical management in municipal engineering is crucial for promoting urban development. In practice, the construction of a standardization system provides unified norms and standards for project implementation, effectively guaranteeing project quality; the digital transformation utilizes information technology to achieve efficient, precise, and intelligent project management; the greening development direction conforms to environmental protection concepts, reducing the negative impact of projects on the environment. The construction path of an intelligent management system based on the integration of all elements can comprehensively enhance the technical management level of municipal engineering. These key points and innovative practices not only provide strong support for the efficient advancement of municipal engineering itself but also contribute referable technical management paradigms for new urbanization construction, promoting urban construction towards a more scientific, intelligent, and green direction, helping cities achieve sustainable development, and improving the quality of life of residents.

Disclosure statement

The author declares no conflict of interest.

References

[1] Liu N, 2021, Research on Engels' View of Nature and Its Innovative Practice, thesis, Northwest Normal University.

[2] Liao J, 2022, Research on the Technical Management Improvement Plan for Mold Development in FY Company, thesis, Jilin University.

[3] Iita M, 2021, The Impact of Innovative Practices on the Performance of Listed Companies on the Nairobi Securities Exchange, Kenya, thesis, Capital University of Economics and Business.

[4] Hua Y, 2021, Research on Problems and Countermeasures in Safety Production Supervision of Taizhou Municipal Engineering, thesis, Nanjing University of Science and Technology.

[5] Lin H, 2022, Research on Cost Management of Municipal Engineering in X Construction Enterprise, thesis, University of Chinese Academy of Sciences.

[6] Wang G, 2023, How to Strengthen Technical Management of Municipal Engineering. Brick and Tile World, 2023(24): 145–147.

[7] Zhang A, 2021, A Brief Discussion on Construction Technical Management Strategies for Municipal Engineering. China Construction Metal Structure, 2021(9): 30–31.

[8] Lai J, 2023, Research on Technical Management of Soft Foundation Treatment in Municipal Engineering Construction. Home Industry, 2023(12): 179–181.

[9] Sun D, 2024, A Brief Discussion on Technical Management and Practice of Bidding for Municipal Engineering Supervision. Construction Supervision, 2024(3): 49–50.

[10] Zheng X, 2021, A Brief Analysis of Municipal Construction Engineering Quality and Construction Technical Management Paths. Model World, 2021(16): 139–141.