Discussion on the Management Model of Municipal Road Engineering Based on the Whole Life Cycle

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Abstract: As a key component of urban infrastructure, the construction quality and management effectiveness of municipal road engineering have a profound impact on the operational efficiency of the city and the quality of life of residents. The traditional management model often focuses on the construction phase, with insufficient emphasis on pre project planning and post project operation and maintenance, resulting in difficulty in fully demonstrating the overall benefits of the project. The full lifecycle management mode emphasizes the overall management of the entire process from project planning, design, construction to operation and maintenance, and can comprehensively consider the needs and influencing factors of each stage. This article explores this model in depth, analyzes its advantages and implementation points, and provides theoretical support and practical guidance for improving the management level of municipal road engineering, ensuring engineering quality and efficiency.

***Keywords*:** full lifecycle; municipal road engineering; management model

1. Introduction

As an important component of urban infrastructure, the construction quality and management level of municipal roads directly affect the operational efficiency of the city and the quality of life of residents. The traditional management mode of municipal road engineering often focuses on the construction phase, with insufficient attention paid to pre project planning, post project operation and maintenance, resulting in difficulty in fully realizing the overall benefits of the project. The full lifecycle management model emphasizes the full process management from project planning, design, construction to operation and maintenance, which can comprehensively consider the needs and influencing factors of each stage, and achieve the minimization of project lifecycle costs and maximization of benefits. Therefore, studying the management mode of municipal road engineering based on the entire life cycle has important practical significance.

2. Analysis of Traditional Municipal Road Engineering Management Mode

2.1 Main stages and contents of traditional management mode

The traditional management model usually divides municipal road engineering into several main stages: planning, design, construction, and acceptance[1]. The planning stage is mainly determined by government departments based on the overall urban planning, combined with factors such as traffic flow forecasting, to determine the basic elements of road direction, width, and functional positioning, providing macro guidance for subsequent work. In the design phase, the design unit conducts detailed engineering design according to the planning requirements, including road structure design, drainage system design, traffic sign and marking design, etc., to form construction drawings. The construction phase is the core link of engineering construction, and the construction unit carries out construction according to the design drawings, involving multiple processes such as earthwork excavation, roadbed treatment, and pavement laying. It is necessary to strictly comply with relevant construction specifications and quality standards. During the acceptance stage, a comprehensive inspection of the project quality is conducted to ensure that the road meets the design requirements and functional requirements. Only after passing the inspection can it be delivered for use.

2.2 Problems with Traditional Management Models

The traditional management model has many drawbacks. In terms of stage connection, each stage is relatively independent and lacks effective communication and coordination mechanisms. Changes during the planning phase may not be communicated to the design unit in a timely manner, resulting in repeated modifications to the design; Design changes are only discovered during the construction phase, which can cause delays in construction progress and increased costs. In terms of management objectives, there is an excessive emphasis on quality and schedule control during the construction phase, with insufficient consideration given to the cost, environmental, and social benefits throughout the entire lifecycle of the

project[2]. For example, the convenience of operation and maintenance was not fully considered in the design, resulting in high maintenance costs in the later stage. In addition, the traditional management model lacks continuous tracking and management of the operation and maintenance of the project in the later stage, and facilities that are aging or damaged cannot be repaired in a timely manner, which affects the service life of roads and the normal operation of urban traffic.

3. Construction of Municipal Road Engineering Management Model Based on the Whole Life Cycle

3.1 Framework Design of Full Lifecycle Management Mode

The framework of municipal road engineering management mode based on the entire life cycle covers four stages: decision-making, design, construction, and operation and maintenance. The decision-making stage is the starting point of the entire project, which requires comprehensive consideration of various factors such as urban development planning, transportation demand forecasting, and environmental impact assessment. Scientific methods and models are used to conduct feasibility studies, determine the goals, scale, and construction plan of the project, and provide clear direction for subsequent work. In the design phase, multi-disciplinary collaborative design should be carried out based on the results of the decision-making phase. It is not only necessary to meet the basic functional requirements of the road, but also to consider the feasibility of construction, the convenience of operation and maintenance, and the coordination with the surrounding environment[3]. During the construction phase, it is necessary to strictly organize the construction according to the design requirements, strengthen quality, safety, and schedule control, and ensure that the project quality meets the standards. In the operation and maintenance phase, it is necessary to establish a comprehensive facility monitoring and maintenance management system, timely grasp the operation status of facilities, formulate reasonable maintenance plans, and ensure the normal use of roads.

3.2 Key management points and collaborative mechanisms at each stage

The management points of each stage are closely connected and each has its own focus. In the decision-making stage, it is necessary to ensure the scientificity and rationality of the decision, fully collect and analyze relevant information, and compare multiple options. In the design phase, emphasis should be placed on innovation and optimization, adopting advanced design concepts and technologies to improve design quality. During the construction phase, it is necessary to strengthen on-site management, strictly implement construction specifications and quality standards, enhance safety management and civilized construction. During the operation and maintenance phase, an information management platform should be established to achieve real-time monitoring and data analysis of facility status. At the same time, it is necessary to establish an effective collaborative mechanism and strengthen information sharing and communication coordination between different stages. By regularly holding joint meetings and establishing information sharing platforms, problems that arise between different stages can be resolved in a timely manner to ensure the smooth progress of the project. For example, in the design phase, the feasibility of construction and the requirements for operation and maintenance should be considered. If design problems are discovered during the construction phase, they should be promptly reported to the design unit for modification.

3.3 Advantages of Full Lifecycle Management Model

The management model of municipal road engineering based on the entire lifecycle has significant advantages. From a cost perspective, it can achieve the minimization of the entire lifecycle cost. By optimizing design and construction plans, waste and rework during the construction process can be reduced, and construction costs can be lowered; Meanwhile, a reasonable operation and maintenance plan can extend the service life of facilities and reduce the cost of later maintenance and replacement. In terms of quality, this model emphasizes full process quality control, mutual supervision and restraint at each stage, which can effectively avoid quality hazards and improve engineering quality. In terms of benefits, it comprehensively considers economic, social, and environmental benefits, not only meeting urban transportation needs and promoting economic development, but also emphasizing coordination with the surrounding environment, reducing negative impacts on the environment, and improving the city's image and residents' quality of life. In addition, this model also helps to improve the scientificity and standardization of engineering management, enhance the awareness of full lifecycle management of management personnel, and promote the overall improvement of municipal road engineering management level.

4. Measures to ensure the implementation of a full lifecycle management model

4.1 Policy and regulatory safeguards

Policies and regulations are important basis and strong support for the implementation of the full lifecycle management model. The government should introduce relevant policies to clarify the status and role of full lifecycle management in municipal road engineering, and encourage and guide all parties such as construction units, design units, and construction units to actively adopt this model. At the same time, relevant laws and regulations should be formulated and improved to regulate management behavior at all stages, clarify the rights and obligations of all parties involved, and establish strict punishment measures for violations of regulations, ensuring that there is a legal basis for full lifecycle management and that violations will be prosecuted. In addition, establish a standard specification system for full lifecycle management, unify management requirements and technical indicators at each stage, and provide clear guidance for project implementation.

4.2 Technical Support Guarantee

Advanced technology is the key to the effective implementation of the full lifecycle management model. On the one hand, we should actively promote the application of new technologies, materials, and processes to improve the construction quality and operational efficiency of the project. For example, using intelligent monitoring technology to monitor the operational status of road facilities in real time, promptly identifying and addressing potential issues; Utilize information management platforms to integrate and share information at various stages, improving the scientific nature of management decisions. On the other hand, we will strengthen technological research and innovation, carry out scientific research and development to address difficult issues in the entire lifecycle management, and provide technical reserves and solutions for the implementation of the model.

4.3 Talent team guarantee

The implementation of the full lifecycle management model requires a high-quality and specialized talent team. Universities and vocational colleges should optimize the curriculum of relevant majors, strengthen the theoretical and practical teaching of full life cycle management, and cultivate compound talents who understand both engineering technology and management knowledge. At the same time, strengthen the training and continuing education of existing practitioners to enhance their awareness and ability in full lifecycle management. Construction units, design units, etc. should establish a sound talent incentive mechanism to attract and retain outstanding talents, providing talent guarantee for the implementation of the full life cycle management model.

5. Conclusion

The management model of municipal road engineering based on the entire lifecycle is a comprehensive and systematic management model that can overcome the drawbacks of traditional management models, achieve the minimization of project lifecycle costs, and maximize benefits. By constructing a full lifecycle management model framework, clarifying management points and collaborative mechanisms at each stage, and taking corresponding safeguard measures, the level of municipal road engineering management can be effectively improved, providing strong support for urban development and residents' lives.

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