An Assessment and Evaluation Framework for Highway Construction Management based on Data Analysis of the Project Management Platform

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***Abstract*—With the application of digitization and informatization in China's industry, the informatization level in highway engineering construction has gradually improved. This paper establishes a comprehensive assessment and evaluation framework based on a typical project management platform. Through business data analysis, real-time assessment and evaluation of the project progress, project quality and project safety are realized. The successful application of the evaluation framework has effectively improved the quality and efficiency of highway construction management.**

Keywords- assessment and evaluation; construction management; data analysis; digitizationl; management platform

I. INTRODUCTION

The development of road transportation in China can be simply divided into three stages: the initial development stage (the early 1980s), the high-speed development stage (the 1980s to the early 21st century), and the digital and intelligent stage (the 1990s to date) [1-2]. At present, China's road and expressway mileage is in the first echelon in the world. And it continues to grow at a steady rate every year [3-4]. However, the rapid development of transportation has also brought severe challenges and great pressure to the construction and management [5-6]. The traditional management model can no longer meet the management requirements, and digital methods must be adopted for construction, operation, and management [7-8].

At present, the digitalization of the transportation industry is developing steadily, but it still faces several problems [9-10]. Firstly, there is no industry consensus on the boundaries of highway digitization. The top-level architecture has not yet been established. The importance of digitization of highway infrastructure is beyond doubt, but there is no industry consensus on the definition and content of digitization. The digitalization of highway infrastructure is an industrial technology revolution that revolves around the digital transformation of the entire chain of highway construction, management, maintenance, and transportation. Its most important feature is to use data as a production factor, establish a data ecosystem, enable management decision-making and intelligent production, improve quality, increase efficiency, and reduce costs. The existing technical methods, standard systems and management systems need reform, and the corresponding basic research work is not yet sufficient.

Secondly, the digital foundation is weak, and the standard systems is not perfect. Although China's highway informatization started early, the problems of insufficient data collection and low data quality formed during its development have become increasingly prominent. The construction and maintenance operation management system is scattered and the application popularity is not high. Information transfer between stages still relies on paper documents. The data catalogue for the life cycle management of road infrastructure is not yet complete. The standard systems for data collection, transmission, exchange, and application in highway infrastructure construction is not yet sound.

Finally, the informatization application is decentralized, and the institutional mechanism is not yet perfect. Existing

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survey and design software, and management information systems in the construction and maintenance operation stages are all oriented to the needs of individual business applications. The need for information exchange and sharing in the entire life cycle of highway infrastructure has not been met. The granularity, reliability and timeliness of data are insufficient, and data reuse is technically difficult. Industry supervision of various businesses at various stages lacks efficient and convenient digital methods.

In response to the above problems, this paper establishes a standard project management system based on a large-scale sea-crossing bridge construction project, the Huangmaohai Link Project. This paper further develops an evaluation framework for data collection, utilization, and evaluation. Through this evaluation framework, managers can monitor the project progress, project quality, project safety and other key business indicators in real time. The application of this evaluation framework will make a good demonstration for the establishment of highway infrastructure data architecture and the promotion and application of highway infrastructure digitalization.

II. INTRODUCTION OF HUNAGMAOHAI LINK PROJECT

The Huangmaohai Sea-crossing Bridge is the west extension of the Hong Kong-Zhuhai-Macao Bridge. The route starts from Gaolangang Port in Zhuhai, crosses the Huangmaohai waters, and ends at Taishan, Jiangmen. This project is the first major project to implement *the Outline Development Plan for the Guangdong-Hong Kong-Macao Greater Bay Area* [11]. This highway shortens the travel time from Taishan to Gaolan Port from 1 hour to 20 minutes, which greatly promotes the development of western Guangdong and coastal areas [12]. The construction scale of the project is huge. The total length of the project is 31.26 kilometers, of which the sea-crossing part is about 14 kilometers. The main structures include 2 cable-stayed bridges (Huangmaohai Bridge with a main span of 2×720 meters, Gaolangang Bridge with a main span of 700 meters), 20 other bridges, 2 tunnels, 4 interchanges, and 1 service area.

To achieve the overall goal of "Building a World-class Sea-crossing Bridge", the Huangmaohai Link Project promotes modern engineering management through digitization and informatization. The project develops a collaborative management platform, a digital construction platform and a remote information command platform. The project management platform integrates the core business data in the construction phase to achieve the purpose of information sharing and management collaboration. The Huangmaohai Link fully enhances the digital construction level of the project, and pushes the engineering design, construction, and management level to a new height. This paper establishes a large-scale sea-crossing bridge construction management assessment and evaluation framework based on the Huangmaohai Link management platform, which provides a new method for modern project management.

Figure 1. Overview of the Huangmaohai Link Project

III. THE ASSESSMENT AND EVALUATION FRAMEWORK FOR LARGE-SCALE SEA-CROSSING BRIDGE CONSTRUCTION PROJECT

According to the characteristics of large-scale sea-crossing bridge construction projects, this paper establishes a project assessment and evaluation management framework, as shown in Figure 2. The key evaluation indicators include progress management, quality management, safety management, and office management. The assessment system will automatically evaluate each participating unit based on the business data generated by the management platform.

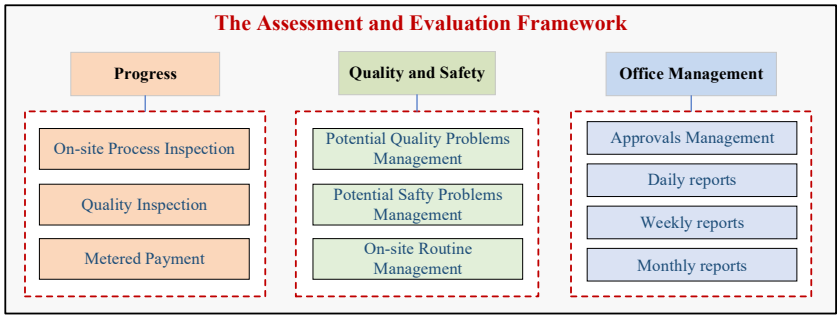

Figure 2. The assessment and evaluation framework for large-scale sea-crossing bridge construction project

A. *Progress assessment*

Progress is one of the key objectives in construction management. The progress of highway construction projects can be divided into three aspects: production progress, quality inspection progress and investment progress. The construction unit and the supervision unit conduct on-site production process inspection management through the platform. The assessment system will automatically obtain the overall, annual, and monthly sub-project completion status, as shown in Figure 3.

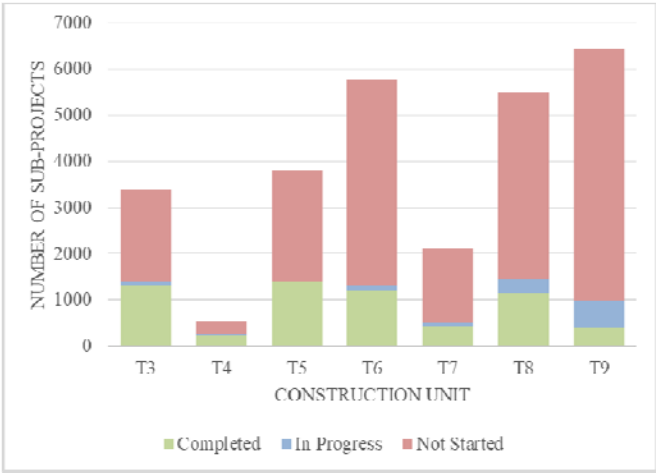

Figure 3. Overall sub-projects completion status of each construction unit

In bridge construction, the omission of quality inspection documents is a common management problem. In this project, the platform automatically tracks the completion progress of the quality inspection documents of each sub-project. The system automatically alerts the sub-projects whose quality inspection documents are about to expire. The system imposes fines on sub-projects that are seriously lagging behind, as shown in Figure 4. Through the above methods, the timeliness of quality inspection documents has been well guaranteed.

Figure 4. Quality inspection status of each construction unit

B. *Quality and safety assessment*

The platform establishes key quality and safety management processes. Through the analysis of relevant management data, the quality and safety management status of each participating unit can be evaluated. For example, managers carry out closed-loop management of quality and safety hazards through the platform. Managers initiate quality and safety hidden issues through the system. Then the construction unit rectifies the problem. At last, the supervision unit conducts inspection and acceptance, as shown in Figure 5.

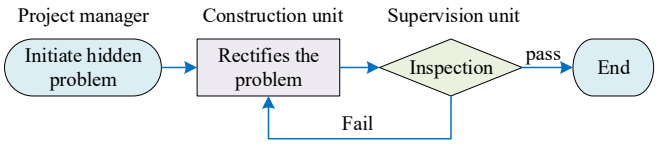

Figure 5. Quality and safety hazards management

By automatically analyzing the quality safety rectification ratio of each participating unit, real-time supervision of quality and safety is realized, as shown in Figure 6.

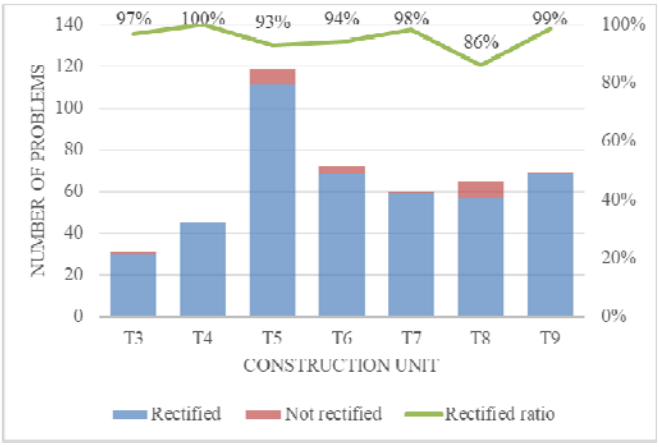

Figure 6. Statistical analysis on rectification of quality and safety issues

C. *Office management assessment*

The project conducts routine management work through the platform, including management approval, report submission, on-site image uploading, etc. By integrating the management processes into the platform, the management efficiency and quality are greatly improved. Taking management approval as an example, a total of 3,623 management approval processes have been completed in Huangmaohai Link Project. The assessment system conducts statistical analysis on the approval behavior of each unit, each department, and each person. Management issues are fully exposed, as shown in Figure 7.

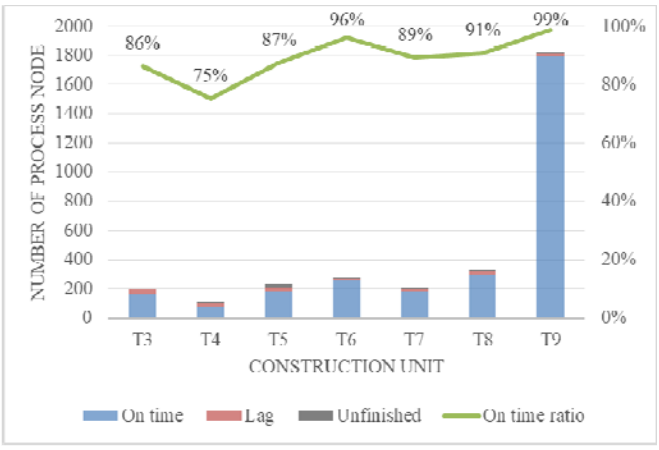

Figure 7. Statistical analysis on the approval behavior of each construction unit

IV. CONCLUSION

Based on the construction management needs of large-scale sea-crossing projects, this paper establishes an assessment and evaluation framework. The framework covers the key objectives of project management, including progress management, quality management, safety management, and office management. Each indicator is divided into several evaluation items. Then, an automated assessment system is established based on the assessment framework. Finally, the sub-projects completion status, quality inspection status, quality and safety issues rectification status, and the approval behavior status are revealed. The establishment of the assessment and evaluation framework has effectively improved the construction quality and management efficiency.

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