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Quality risk management model for railway construction projects

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Abstract

Information technology has significant potential to enhance the engineering quality of the risk management of railway construction projects. The Shanghai Railway Bureau has promoted a risk management method based on the "A Figure and Four Tables" method (AFFTM) to assess the engineering quality; however, this method still suffers from several problems in railway construction project management. In this paper, we have combined the concepts and processes of the AFFTM with those of information technology and presented the implementation scheme of a new risk management system—the railway construction project quality risk management information system (RCPQRMIS)—that can be used to design and develop workable information tools for quality risk management. The paper analyzes the data standards of RCPQRMIS and creates a model for dynamically tracking the quality risk ("quality risk dynamic tracking" model) for providing pre-warning information on quality risk ("quality risk pre-warning" model) and for automatically generating publicity parameters for quality risk ("automatically generated quality risk publicity figure" model). The proposed system enables the visualization of the quality associated with the risk control, dynamic tracking, automatic pre-warning, and closed-loop management of railway construction projects. In addition, this paper presents the functional modules of the RCPQRMIS and its practical applications. Our application results show that the system successfully realized unified management of risk source information and multi-level sharing. In this manner, by using our system, we were able to significantly improve real-time tracking and pre-warning of the risk state, automatic generation of quality risk publicity figures, efficiency, and risk management levels.

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Keywords: railway construction project; risk management; a figure and four tables method; MIS

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1. Introduction

Engineering products delivered by construction enterprises to owners have various quality attributes. Deviations from the expected values of these attributes can lead to loss of benefits and uncertainties for both the owner and the construction enterprise [1]. Such deviations are typically referred to as the quality risks of the engineering project.

Railway projects are characterized by large-scale operations, modern technology, complex structures, high technical and quality standards, long durations, and collaborative units. These factors make it necessary to perform railway construction project management in consideration of the risks involved. If the risks are not prevented effectively, they may hinder the smooth realization of the construction goals, which may even lead to serious consequences [2,3]. While railway authorities have long attached great importance to risk management, there remain many problems and hidden dangers, mainly caused by irregularities, delays, and lack of management, that affect safety. These problems are mainly caused by unclear duties and responsibilities of each department, lack of risk control measures, untimely risk treatments, etc. [4]. Given the problems existing in the risk management of railway engineering construction quality, it is imperative for builders to employ risk management theories and methods to constantly improve and perfect the quality management systems used for railway engineering and technology.

The Shanghai Railway Bureau has proposed a risk management system for the construction engineering quality of railway projects based on the "A Figure and Four Tables" method (AFFTM) used in railway construction project management practice [5]. The Shanghai Railway Bureau has successfully applied this system to the management of railway construction projects with remarkable results.

The AFFTM involves the application of risk management theory on quality to integrate risk identification, analysis, assessment, treatment, tracking, and post-assessment. In this method, the quality risk publicity figure, quality risk analysis and identification table, quality risk treatment responsibility table, quality risk dynamic tracking table, and quality risk treatment evaluation table are used to achieve improved and comprehensive system optimization [5]. This method smoothens and standardizes the risk management procedures for the construction engineering quality of railway projects. Moreover, risk management becomes more standardized, clear, scientific, accurate, and effective by avoiding and controlling project quality risks. Hence, risk management such as that based on the AFFTM method is extremely useful in railway construction and management [6].

However, in practice, the AFFTM still suffers from several disadvantages in railway construction project management—(1) the production cycle for quality risk publicity figures is long; (2) four tables have to be manually filled, which is tedious and time-consuming; (3) there is a lack of standardization; (4) information sharing and comprehensive utilization of data are difficult; (5) the variation in risk state cannot be analyzed in detail because these problems are constrained its large-scale promotion and scope of application; and (6) difficulties are faced in providing real-time status information of risk pre-warning to the responsible people.

To solve these problems, in this paper, we have proposed a railway construction project quality risk management information system (RCPQRMIS) that is based on the AFFTM. We discuss the data standards of the RCPQRMIS; models for dynamically tracking quality risks, pre-warning quality risks, and automatically generating publicity figures for quality risks; and the functional modules of the RCPQRMIS and its practical applications.

2. Data analysis model for RCPQRMIS

2.1. Source and standardization of data

Four types of quality risk control tables—quality risk analysis and identification table, quality risk treatment responsibility table, quality risk dynamic tracking table, and quality risk treatment evaluation table—and one figure—quality risk publicity figure—were used as the main data sources for building the RCPQRMIS. The standardization of the main data source, including the standardization of the data content, coding system, and update frequency, served as the foundation of computer management. We designed the standardization based on the actual requirements of the AFFTM and the general principles for building computer databases. Fig. 1 shows the standardized structure of the data content of the AFFTM, and Table 1 lists the input units and update frequency requirements of the main data source of the AFFTM.