Research on Safety and Quality Control Intelligent Systems of Engineering Project Based on Blockchain and BIM Technologies

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Abstract. Focusing on the problems of Safety and Quality Control of Engineering Project, research on technologies for safety and quality control of engineering projects based on blockchain and BIM technologies can be investigated. A software intelligent system based on BIM, blockchain, artificial intelligence and data mining technologies is established. The problem of trace and tracking in the safety and quality management process can be solved. The innovation of engineering project safety control models can be promoted.

1. Introduction
Blockchain technology brings about the transformation and innovation of the engineering construction industry. Research on key technologies for safety and quality control of engineering projects based on blockchain and BIM technologies can improve the efficiency and integration of business processing in the process of safety and quality control and facilitate the establishment of complete engineering construction safety & quality responsibility guarantee and early warning and traceability systems. This paper is conducive to promoting the innovation of engineering project safety control models, the improvement of safety and quality management efficiency and the reduction of safety and quality accidents. Besides, it will provide important theoretical reference for the innovative application of blockchain technology in the field of engineering construction and be of great significance for driving the transformation and innovative development of the engineering construction industry.

2. Work program of intelligent systems
We address the problem of trace and tracking in the safety and quality management process with a software intelligent system based on BIM, blockchain, artificial intelligence and data mining technologies, and study and realize an unattended supervision and management mechanism to improve the implementation effect of safety and quality job responsibilities.

A blockchain-based intelligent system requires the support for its subsequent data mining from a professional engineering data architecture. Therefore, we need to study an engineering object-oriented standard data system.

Moreover, it is also necessary to establish a set of rules to describe the analysis principle in the engineering field after the data is organized into a standard architecture. Through the implementation of such rules, we can not only check the compliance of the completed work on the front line with the...
requirements for specialization based on the massive information collected with blockchain, but also conduct data mining and provide guidance on the subsequent implementation of projects with an intelligent system, thereby providing support for the direct participation of artificial intelligence in management in the future.

![Figure 1. Work Program of Intelligent Systems.](image)

2.1. Research on key technologies of blockchain for engineering project safety

We study the use of the distributed architecture of blockchain to create a credible data sharing paradigm among participants, the construction of an encryption mechanism in the process of heterogeneous and homogeneous security data transmission based on blockchain technology, the formulation of a normative data flow model and safety assessment system and a unified and safe data format, interface and transmission protocol under the principle of consensus as well as the multivariate heterogeneous data sharing issue in the context of identification with the rights and interests of interest subjects in engineering safety, thus achieving interactive sharing of project safety-related data and information including structural inspection, personnel status, environmental monitoring and equipment & facilities in the construction process [1].

According to the research on the framework of a unified data format for engineering projects based on blockchain, a blockchain intelligent system is characterized by its messy underlying data composed of basic blocks. To organize the messy information into a data structure available for calculation, a conversion layer is required to achieve low-level independence.
We describe an engineering object with a set of class structure systems by analyzing its required features under the guiding concept of data architecture. With such a practical effective means, we can realize the integration of thinking in software design and architectural engineering fields, design a software intelligent system that conforms to the professional thinking of engineers and then complete more complex professional analysis.

In addition, we can carry out professional calculations based on the general class structure system and develop an alternative workflow so that it can meet the requirements of site construction.
2.2. Research and development of an engineering project safety and quality intelligent system integrating blockchain and BIM technologies

An engineering safety and quality monitoring model is set up with BIM (Building Information Model) as the information carrier. We carry out a standardized and serialized study on static data, texts and other information covered on the BIM platform and a serialized study on dynamic information such as equipment and facilities, operators, management personnel, construction schemes, safety and quality inspections and security risk sources, and then study a blockchain-based encapsulation model of the data above. We set up a consensus mechanism for safety control of all participants in engineering project safety and quality control and ensure that the data and information of construction projects distributed at different system nodes maintain fault tolerance and synchronization [2].

According to the research on the blockchain-based professional engineering data analysis module, the professional analysis module (EPAM) is a data analysis system based on the general data code (GDC), which can provide suggestions and opinions on site management by analyzing safety and quality data. Its architecture is an implementation method of configurable rules. We transmit information that conforms to the general data code to the module and obtain data analysis results through its calculation rules to provide support for the upper module [3].

![Figure 4](image)

**Figure 4.** The Blockchain-based Professional Engineering Data Analysis Module.

2.3. Research and development of engineering project safety and quality control intelligent systems integrating blockchain and BIM technologies

2.3.1. Research and development of an engineering project safety control intelligent system integrating blockchain and BIM technologies. We develop a distributed engineering safety control intelligent system based on blockchain and BIM technologies and multi-source engineering safety data collection, analysis and encryption modules based on BIM, blockchain, Internet of Things (IoT) and 5G technologies, and collect the ways of cooperation of all participants in engineering project management and the data exchange and processing procedures involved to design a set of safety control blockchain and block models acceptable to all parties. We study the data paradigm, encryption
method and block chaining method in the block models, and design and develop rules for the addition, deletion, modification and verification of safety control blocks.

We study the method of infrastructure integration in safety control blockchain and BIM intelligent systems as well as the data transmission, sharing and processing mechanism between systems; study the BIM-based engineering project safety control architecture under the blockchain technology architecture, build a BIM-based scenario library and early warning library of engineering project safety events and develop a visual engineering project safety control intelligent system that integrates blockchain and BIM technologies.

2.3.2. Research and development of an engineering project quality control intelligent system integrating blockchain and BIM technologies. We develop a distributed engineering quality control intelligent system based on blockchain and BIM technologies and multi-source engineering quality data collection, analysis and encryption modules based on BIM, blockchain, Internet of Things and 5G technologies, and collect the ways of cooperation of all participants in engineering project management and the data exchange and processing procedures involved to design a set of quality control blockchain and block models acceptable to all parties. We study the data paradigm, encryption method and block chaining method in the block models, and design and develop rules for the addition, deletion, modification and verification of quality control blocks.

We study the method of infrastructure integration in quality control blockchain and BIM intelligent systems as well as the data transmission, sharing and processing mechanism between systems; study the BIM-based engineering project quality control architecture under the blockchain technology architecture, build a BIM-based scenario library and early warning library of engineering project quality events and develop a visual engineering project quality control intelligent system based on blockchain and BIM technologies.

2.3.3. Basic architecture of an integrated system of engineering project safety and quality control integrating blockchain and BIM technologies. The integrated system of engineering project safety and quality control integrating blockchain and BIM technologies collects all kinds of structured and unstructured data in the process of project safety and quality management, and classifies and stores such data through the integrated data processing module after data collection, labelling, cleaning and normalization through the Internet of Things and BIM application modules. The integrated data processing module releases the data to the bus module based on specific requirements. The bus module stores real-time streaming data. The blockchain transaction translation module based on distributed ledger technology (DLT) of all project management parties extracts all ongoing project activities and events from the bus module, translates them into transactions that can be understood and processed by the blockchain intelligent system and signs for verification. Transactions are routed to the blockchain management module through a logical application connector specific to the ledger based on their type and signature. The blockchain management module transfers transactions to the project safety control blockchain and the project quality control blockchain for storage after verifying their authenticity and the validity of the signature.

Local and cloud databases and various terminals such as mobile phones and computers of project organization participants are connected to the data release module which sends transactions to business applications and off-chain databases of all participants in real time. All project participants can analyze and use the information through data visualization tools or business programs. The basic architecture of the integrated system is shown in the figure below.
3. Conclusions
The basic theory, key technologies and intelligent system research and development for engineering project safety and quality control based on blockchain technology in this paper can facilitate the improvement of safety and quality management efficiency and the innovation of engineering project safety and quality control modes. This paper studies the application of blockchain technology in the field of engineering construction, which can provide power and support for engineering safety and quality control and is of great significance for promoting the transformation and high-quality development of the engineering construction industry.

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