Analysis of the Application Value of Blockchain Technology in Engineering Audit

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Abstract: With the rapid development of our society, various basic engineering constructions are also increasingly emerging. The importance of engineering audit in the construction process is self-evident. However, in the actual audit process, issues such as information asymmetry, data opacity, and difficulty in tracing responsibilities have always plagued the audit department. Blockchain technology, as a technology with features such as decentralization, immutability of data, and traceability, provides new ideas for solving these problems. This article takes the problems faced by engineering audits in various stages in the current environment as the starting point, and explores the feasibility and value of blockchain technology in engineering audits.

1. The current situation and problems faced by engineering auditing in the current context

With the development of society and the rise of engineering construction, the demand for auditing is also constantly increasing. However, due to the characteristics of large investment amount, complex construction process, and numerous participating units in engineering projects, there are many types of audited objects, complex data, and diverse forms in actual audit work. The increasingly complex business models and advanced information technology have put forward higher-level requirements for audit work.

The traditional audit model and its characteristics have largely constrained the efficiency and effectiveness of audit work, leading to a series of problems. The following is a detailed explanation of these issues:

1.1 Data complexity, confusion, and insufficient transparency

In traditional auditing processes, auditors need to process a large amount of data, which often comes from different departments and systems. Due to differences in data formats, sources, and processing methods, it is difficult to integrate data information, which can easily lead to confusion. Insufficient data transparency makes it difficult for auditors to effectively verify and review data, which affects the accuracy of audit work.

1.2 Difficulty in tracing and ensuring authenticity of data information

Under the traditional audit model, it is difficult to trace and source data information. On the one hand, raw data may be scattered across various systems, making it difficult for auditors to track; On the other hand, the authenticity of data is difficult to guarantee and may be tampered with or forged. This poses significant challenges to audit work and affects the reliability of audit results.

1.3 Difficulty in tracing responsibility

Due to the difficulty in tracing data information back to its original source, audit results and responsibilities cannot be effectively traced back to the specific responsible person. This is particularly prominent in fields such as engineering auditing, where multiple parties are involved, resulting in a blurred definition of responsibility.

1.4 Complex interests lead to compromised independence

Engineering auditing involves multiple stakeholders, including construction units, construction

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units, design units, etc., with intertwined interests among all parties. In situations where responsibility cannot be effectively traced to specific individuals, it can easily lead to the phenomenon of interest transfer. In this situation, the independence and objectivity of engineering audit work are challenged. This has planted multiple hidden dangers for engineering construction, which may lead to issues with project quality, progress, and funding.

To solve the above problems, in addition to continuously improving the existing audit system and processes, enhancing the professional ethics and business capabilities of practitioners, introducing new methods and technologies is also a direction worth exploring.

2. Current status of research on engineering audit optimization

Currently, many experts and scholars have conducted relevant research on engineering audit optimization in construction projects. The relevant research results are as follows:

Shin [1] pointed out that adopting a full process audit model can effectively reduce the error rate of key decisions. Case studies have shown that project scale and audit methods are key factors affecting the achievement of engineering full process audit goals. A predictive model for audit evaluation based on machine learning theory and methods has been established to address the full process audit issues in public infrastructure construction projects. Based on expert interviews and actual work processes, Fang QR [2] establishes a comprehensive evaluation index system for tracking and auditing the entire process. Machine learning theories and methods such as support vector machine, backpropagation neural network, multiple logistic regression, and random forest are applied to the full process audit of "special bonds+PPP", and real case evaluation sample data is selected to train and predict the established model, Comparative analysis selects the RF model with the highest accuracy as the evaluation prediction model. Dimyadi J [3]focused on analyzing the main basis, usage, and issues arising from the entire process audit, describing the process of modeling and coding BCM, CDP, and RKM, proposing independent input components of the compliance audit system framework, supplementing manual input, and exchanging input and output data with external simulation tools to address some more complex qualitative standards, Research and solve two common challenges in computer-aided compliance auditing of architectural engineering design. Hermantha S. B [4]found that conducting a full process audit of construction projects can effectively reduce the occurrence of various problems, fully reflecting the important role of auditing and ensuring project quality. At the same time, it also analyzes the problems that exist in the entire process audit of construction projects, and proposes solutions and suggestions from multiple perspectives to promote the smooth progress of the project's entire process audit work.Michael G.A [5]believes that automation in auditing is driven by the principles of Business Process Reengineering (BPR), systematically exploring the minimum human involvement in auditing to maintain the trust of its stakeholders. He analyzes BPR inquiries on how to remove workers from primarily manual processes and when adding personnel would add value to primarily automated processes, and focus the BPD in the audit on the human/machine interactions during the audit process, identifying their relative strengths and weaknesses.

In terms of auditing theory research, Mahbod and Hinton [6]believe that blockchain, as a new technology, has the characteristics of real-time transaction, tampering and leaving traces, decentralized account books, irreversibility of information preservation, and transparency of transaction records. It has great potential to transform traditional post audit methods into real-time audits, thereby reducing project risks. Liu ML [7] believes that blockchain provides a novel method for recording, processing, and storing financial transactions and information, and has the potential to fundamentally change the landscape of the auditing industry. Therefore, two types of blockchain (i.e. unlicensed and licensed) are introduced, and their technical characteristics are listed. Further discussion was conducted on the impact of blockchain on auditing, and two types of blockchain were elaborated on the opportunities and challenges for auditors. Specific suggestions were proposed for auditors to adapt, adjust, and enhance their role as strategic partners in blockchain implementation.

In terms of auditing practice framework based on blockchain, QiYN [8] uses the dira protocol as

the foundation and adopts the two-step verification method of blockchain to compare and analyze existing IT development audits, and constructs an IT development audit system that integrates users and multi cloud users, and is oriented towards distributed storage and blockchain technology. Wang,Y [9] first proposed a semi centralized system architecture based on system architecture and management requirements. Then, the project should use blockchain networks as self-recording channels to achieve tamper-proof and non-repudiable verification interactions. Simultaneously, the project should design a multi-chain structure and classification node mechanism to meet the auditing needs of multiple communication engineering projects. The project needs to design a semi-centralized blockchain system with multiple chains that is secure, transparent, tamper-proof, and traceable. Li, AT [10] proposed a universal shared audit mechanism based on blockchain in cross user scenarios, aiming to achieve available public audits through non fully trusted TPA, and reduce user audit costs and TPA work pressure by allowing data users to share their audit programs with others. In addition, a novel structure is proposed for cross user auditing scenarios with the same data, which utilizes a password authentication key exchange protocol to achieve shared auditing and deletion of ciphertext duplicate data, reduce data storage and auditing costs for engineering data, and alleviate service pressure on cloud servers and TPA.

It can be seen that many scholars have made certain achievements in the research of engineering audit optimization, especially in the combination of blockchain technology.

3. Feasible application scenarios and value analysis of blockchain technology in engineering auditing

3.1 The Application and Value Analysis of Blockchain Technology in Engineering Data Management

The application of blockchain technology in engineering data management has significant value.

Firstly, the decentralized nature of blockchain technology ensures the authenticity and immutability of data, providing a solid foundation for the reliability of engineering data. In traditional engineering data management, the authenticity and integrity of data have always been difficult to solve. And blockchain technology ensures the authenticity and accuracy of data through multi node verification and timestamp recording, avoiding the risk of data fraud and tampering.

Secondly, blockchain technology has improved the transparency and traceability of engineering data. In the blockchain network, all data is publicly searchable, which enables all parties involved in the project to monitor the progress in real time and improve the transparency of project management. At the same time, blockchain technology records the modification history of each data transaction through timestamps, making data tracing easier and helping to quickly locate problems and responsible parties.

In addition, blockchain technology can also help reduce the cost of engineering data management and improve efficiency. Traditional engineering data management requires a significant amount of manpower and resources for data verification and validation, while blockchain technology can achieve automated reconciliation, reducing manual intervention and error rates. Meanwhile, the smart contract function of blockchain technology can also achieve automatic execution of contract terms, improving the efficiency of project execution.

3.2 Application and Value Analysis of Blockchain Technology in Engineering Progress Monitoring

Blockchain technology has significant application value in project progress monitoring. Through the characteristics of blockchain technology, the problems existing in traditional engineering progress monitoring can be effectively solved, and the accuracy and efficiency of monitoring can be improved.

Firstly, the immutability of data in blockchain technology ensures the authenticity and credibility of project progress, avoiding the risk of false records and information tampering.

Secondly, the traceability of blockchain technology enables each engineering node and progress

to be accurately recorded and traced, providing a complete data link for project management.

In addition, the smart contract function of blockchain technology can also be used for automated monitoring of project progress. Once the preset conditions are met, corresponding operations and warnings can be automatically triggered, improving the automation level of monitoring.

These advantages make blockchain technology have broad application prospects in the field of engineering progress monitoring.

3.3 The Application and Value Analysis of Blockchain Technology in Engineering Quality Management

Blockchain technology has broad application prospects in engineering quality management, and its application value in engineering quality management is mainly reflected in the following aspects:

Firstly, blockchain technology can improve the transparency and credibility of engineering quality. Through blockchain technology, all parties involved can view real-time inspection data and evaluation results of engineering quality, avoiding the problem of information asymmetry in traditional quality management.

Secondly, in engineering quality management, blockchain technology can be applied to material traceability, quality inspection, quality evaluation, and other aspects. Through blockchain technology, the entire process of raw material procurement, processing, transportation, etc. can be traced to ensure the quality and safety of raw materials. Meanwhile, blockchain technology can also be used for recording and storing quality inspection data, ensuring the authenticity and immutability of the data.

Finally, blockchain technology can reduce the cost and risk of engineering quality. The decentralized nature of blockchain technology can reduce the intermediary links and labor costs in traditional quality management, and lower management risks.

4. The Challenges and Countermeasures of Blockchain Technology in Engineering Audit

4.1 Technology maturity and scalability issues

The maturity and scalability of technology are one of the key factors in the application of blockchain technology in engineering auditing. With the continuous development of blockchain technology, its technological maturity and scalability are also gradually improving. However, the application of blockchain technology in the field of engineering auditing is still in the exploratory stage and requires further technological research and optimization.

Firstly, technological maturity is an important foundation for the application of blockchain technology in engineering auditing. The maturity of technology determines the stability and reliability of blockchain technology, as well as whether it can meet the actual needs of engineering auditing. In engineering auditing, the security and accuracy of data are crucial, therefore mature blockchain technology is needed to ensure these requirements. For example, by introducing advanced encryption algorithms and security mechanisms, the security of blockchain technology can be improved, ensuring that engineering audit data is not tampered with or leaked.

Secondly, scalability is another key factor for the application of blockchain technology in engineering auditing. The amount of data involved in engineering audits is usually large, so blockchain technology needs to have sufficient scalability to meet practical needs. With the continuous development of technologies such as cloud computing and big data, the scalability of blockchain technology is also gradually improving. For example, by introducing sharding technology, sidechain technology, and other means, blockchain technology can be horizontally and vertically expanded, improving its processing capacity and storage capacity.

4.2 The balance between data security and privacy protection

In the practical application of blockchain technology, the balance between data security and privacy protection is an important aspect that cannot be ignored. With the popularization of blockchain technology, more and more engineering audit data is stored on the blockchain, and the

privacy protection and security issues of data are becoming increasingly prominent. How to protect privacy while ensuring data security has become an urgent problem to be solved. On the one hand, through encryption technology and decentralized mechanisms, blockchain technology can effectively protect data privacy and prevent data from being illegally obtained and tampered with. On the other hand, in order to ensure the authenticity and transparency of data, some data needs to be publicly visible, which also involves the risk of privacy leakage. Therefore, in the application of blockchain technology, it is necessary to find a balance point that can ensure the security and privacy protection of data, as well as meet the needs of engineering auditing for data authenticity and transparency. For example, anonymization processing technology can be used to desensitize sensitive information, ensuring data security and meeting audit transparency requirements. At the same time, it is necessary to strengthen the construction of laws, regulations, and standard norms, clarify data ownership and usage rights, and prevent abuse and infringement of privacy.

4.3 The lack of laws, regulations and standards

In the analysis of the application value of blockchain technology in engineering auditing, the lack of legal regulations and standard specifications is an undeniable challenge. With the popularization and widespread application of blockchain technology, corresponding laws, regulations, and standard specifications urgently need to be improved. The lack of clear laws, regulations, and standard specifications may lead to doubts about the legitimacy, standardization, and sustainability of blockchain technology in engineering audits.

Firstly, the lack of laws and regulations may lead to an unclear legal status of blockchain technology in engineering audits. The lack of corresponding laws and regulations to regulate and manage blockchain technology may result in restrictions or prohibitions on its application. For example, some countries or regions may not be able to incorporate blockchain technology as a legitimate tool for engineering audits due to the lack of corresponding laws and regulations.

Secondly, the lack of standard specifications may affect the popularization and application effect of blockchain technology in engineering auditing. Without a unified standard specification, it may lead to differences in the application of blockchain technology between different regions and enterprises, making it difficult to achieve interoperability and data sharing. This not only increases the implementation cost of blockchain technology in engineering auditing, but may also affect its large-scale promotion and application.

To address the lack of legal regulations and standard specifications, a series of measures need to be taken. Firstly, the government and relevant departments should accelerate the formulation and improvement of laws, regulations, and standard specifications for blockchain technology, providing clear legal and institutional guarantees for its application. Secondly, international cooperation should be strengthened to promote the standardization process of blockchain technology on a global scale, and to promote interoperability and data sharing between different countries and regions. In addition, it is necessary to strengthen the research and development of blockchain technology and talent cultivation, improve the maturity and scalability of the technology, and provide better technical support for its application.

5. Conclusion

The application and value analysis of blockchain technology in engineering quality management, as well as the challenges and countermeasures it faces in engineering auditing, demonstrate the enormous potential of this technology in the field of engineering construction. By improving the transparency and credibility of engineering quality, reducing costs and risks, blockchain technology has brought unprecedented opportunities for engineering quality management. However, the balance between technological maturity and scalability, data security and privacy protection, as well as the lack of legal regulations and standard specifications, also pose certain challenges to the widespread application of blockchain technology.

In the future, with the continuous development and improvement of blockchain technology, we can expect it to play a greater role in engineering quality management. By overcoming existing

challenges, blockchain technology will better serve engineering audits, improve engineering quality,reduce risks, and contribute to the high-quality development of the construction industry. At the same time, governments, enterprises, and all sectors of society in various countries should work together to promote the widespread application of blockchain technology in engineering quality management, injecting new vitality into the prosperity and development of the global engineering construction field.

In summary, the application and value analysis of blockchain technology in engineering quality management provide us with a beneficial inspiration: only by keeping up with the trend of the times and constantly innovating, can we stand invincible in the fierce market competition. With the widespread application of blockchain technology in engineering quality management, we believe that our engineering construction industry will shine with even more brilliance.

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