Research and Design of Electric Power Engineering Project Management System Bsed on Blockchain Technology

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Abstract—The characteristics of electric power engineering projects, such as multiple types, multiple links, multiple related parties, and decentralized construction have formed complex contracts and employment relationships. Numerous stakeholders make the owner's ability to control all parties involved in the project very limited, and the problems of information islands still exist. Firstly, electric power engineering project management problems, such as qualifications of contractors or subcontractors, subcontracting in breach of contract, lack of transparency in the payment of workers' wages, arrears of wages, withholding and embezzlement of contract funds, and malicious debt collection, were analysed. Then, the data deposit, enterprise and personnel credit management, contract management, project progress management, and funds management based on the blockchain technology were studied. Finally, the blockchian based electric power engineering project management system was designed.

Keywords-electric power project; management system; blockchain

I. INTRODUCTION

At present, there are mainly the following problems in electric power engineering project management, as studied in literatures [1-5]. Layers of subcontracting or affiliation bring project risks. In the traditional engineering contracting methods, the subcontracting or subcontracting methods are mainly adopted. In practice, there are layers of subcontracting, and subcontractors are affiliated with another company due to insufficient qualifications, and use qualified enterprises to bid for construction. As a result, the strength of the actual construction team is uneven, the management organization level and overall quality are very different. It is difficult to implement effective guarantees in terms of quality, safety, and schedule for the contracted projects. At the same time, the market order may be disrupted and the legal authority could be damaged. In term of the funds misappropriation, the proportion of payment before construction is not high in traditional project payment, and the financial pressure is often backlogged on the contractor. Due to the construction materials, facilities, and workers' wages, the second- and third-level contractors have more financial pressure. As a result, most contractors use workers' wages for turnover in other places, causing workers' wages to be in arrears. Even in the process of subcontracting, when the superior contractor paid in full, the actual contractor flees, causing the workers' wages of to be in arrears. Another problem is the lack of full-process supervision during the construction process. even the project implementation process strictly controls and regulates the process data and deliverables, in reality, most of the workers have low awareness, and the contractor lacks quantitative management and supporting records of the construction workers' attendance, and pays wages [6-8]. The lack of prior and in-process control over the wage payment process may cause workers to face difficulties in seeking wages, and some workers may also ask for wages a second time, which will have a bad impact on the project and the sponsors.

As an emerging technology, blockchain has the characteristics of distributed ledger, multi-party consensus, timestamp, anti-tampering, and non-repudiation [9]. At present, the application has been gradually implemented in the financial field, supply chain finance, logistics traceability, and distributed energy resource trading. In this paper, the study of blockchain based engineering project management tried to effectively solve the problems of illegal subcontracting and fund misappropriation in actual construction, and realize the penetrating supervision of project funds and personnel management processes.

II. RESEARCH OF THE BLOCKCHAIN BASED ELECTRIC POWER ENGINEERING PROJECT MANAGEMENT SYSTEM

In terms of data deposit, enterprise credit management, contract management, funds management, project progress management were studied. Each module was designed based on the blockchain technologies

A. The Blockchain based Data Deposit

In a consortium chain system, the project management process, funds management process, contract management process and construction unit information related to the electric power engineering project are recorded on the chain in real time [9]. Project management process information includes important data in the entire process from bidding and signing, on-site construction to project closure. The contract management process includes enterprise general contract, subcontract,

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and contract information between subcontractors and construction personnel [10]. The management process includes various payments, bank transfer records, and construction personnel salary distribution records in accordance with the contract. The construction unit information including general contractors, subcontractors, supervisors, construction personnel and other information are kept for certification. The system will connect the information flow of the industrial and commercial administration department, the judicial department and the talent market. After the project bidding is completed, the information of the construction enterprise and construction personnel will be recorded on the chain.

The blockchain based electric power engineering project management system could open up the information flow channel of the business administration department, the judicial department and the talent market to obtain the project's general contractor, subcontractor, and project participants' qualifications and capabilities, and other administrative information, as shown in Figure 1.

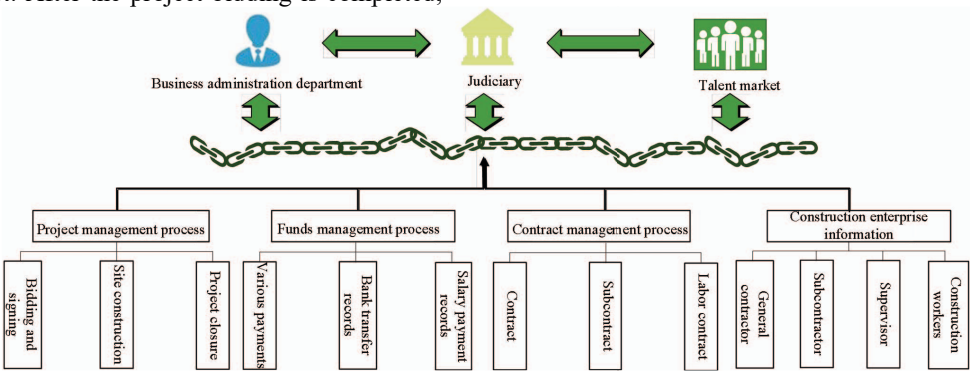

Figure 1. The Blockchain based Data Deposit

B. The Blockchain based Enterprise Credit Management

The credit index evaluation is carried out through the AI system, and the evaluation result is stored in the blockchain system as the initial basis for cooperation, as shown in Figure 2. The blockchain system will evaluate the credit of relevant parties through the AI system based on the problems that occur during the project execution, and the evaluation results will be used as a reference for the bidding of the later project. Corresponding punishments will be imposed on enterprises or individuals that have problems such as qualification fraud, wages in arrears, illegal subcontracting, project quality, and project safety [11]. The system will support credit inquiries on various bid-winning enterprises, construction parties and related individuals, and issue corresponding credit reports to provide references for bidding and construction of later project.

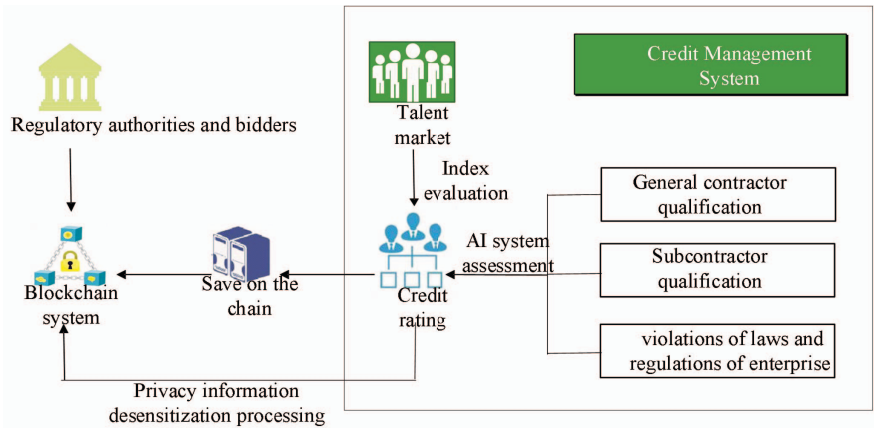

Figure 2. The Blockchain based Enterprise Credit Management

C. The Blockchain based Contract Management

Contracts for various businesses such as construction and installation, survey and design, engineering supervision, power supply services and information communication, including contracts between owners and general contractors, between general contractors and subcontractors, and between subcontractors and construction personnel could be signed in the blockchain based contract management system [10,12]. All contract-related enterprises and personnel have been recorded in the blockchain system and have corresponding digital signature information, as shown in Figure 3. The blockchain system can confirm the authenticity of both parties signing the contract. At the same time, the blockchain system also provides the contract management function, realizes convenient electronic contract signing, and the management and operation of the contract text. During the execution of the electric power project, the blockchain system verifies and supervises the performance based on the project category and contract information. The scope of supervision includes general

contracting, subcontracting, and the execution and payment of labour contracts. The content of the contract, the stage information of the contract execution, the cost distribution information, and the payment settlement information also need to be recorded on the chain to ensure the integrity and reliability of the evidence related to the contract.

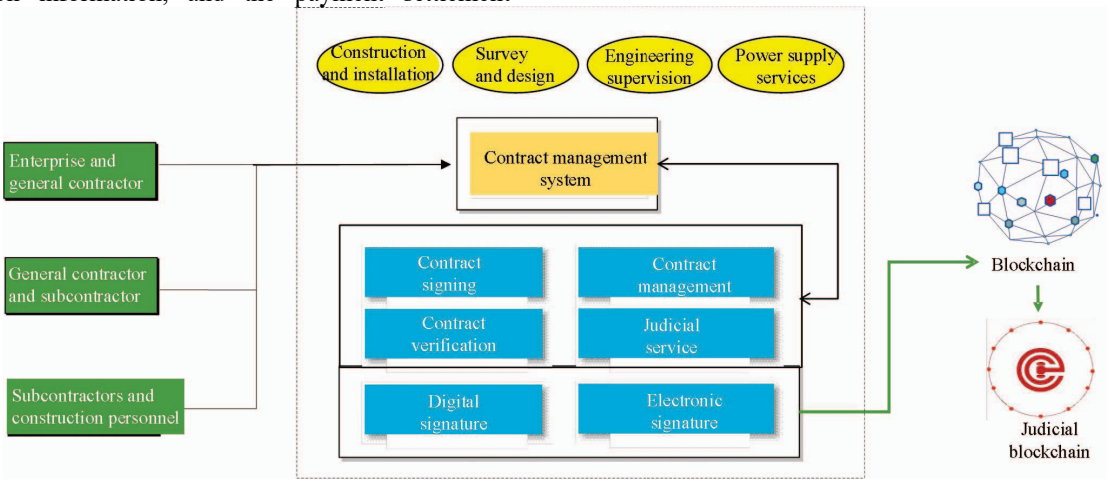

Figure 3. The Blockchain based Enterprise Credit Management

D. The Blockchain based Funds Management

Fund management mainly solves the problems of contract fund payment and construction personnel salary payment [13]. The fund management could be completed through the blockchain based funds management. After the enterprise wins the bid, the owner will set up a worker's wages agency fund account together with the winning bidder, and both parties will inject funds into the escrow account according to a certain proportion, as shown in Figure 4. This account is mainly used for wage payment in case of wage arrears. The blockchain platform will also formulate smart contracts based on the contractual payment plans and conditions. When the agreed rules are met, the blockchian platform will automatically execute the contract for contract payment and wage payment. The blockchain based funds management platform will directly connect the banks and enterprises to realize the coupling of information and funds flow, and the online payment. The normal payment of workers' wages will also rely on the bank's agency. All relevant information related to the payment of wages, such as the amount, time, recipients, and whether the payment is in place, will be recorded on the chain to avoid problems such as fund retention and arrears caused by human factors. If the wages are not paid on time, the system will automatically execute the full payment of wages after a period of time by using the smart contract. Once the funds management performs the payment of wages, it will affect the credit rating of the enterprise (contractors and subcontractors). In the process of blockchain based fund management, through smart contracts, the payment path is confirmed to realize one-click, penetrating payment, and the full cycle of fund issuance, circulation and final appropriation are supervised. As a result, the funds flow is more transparent.

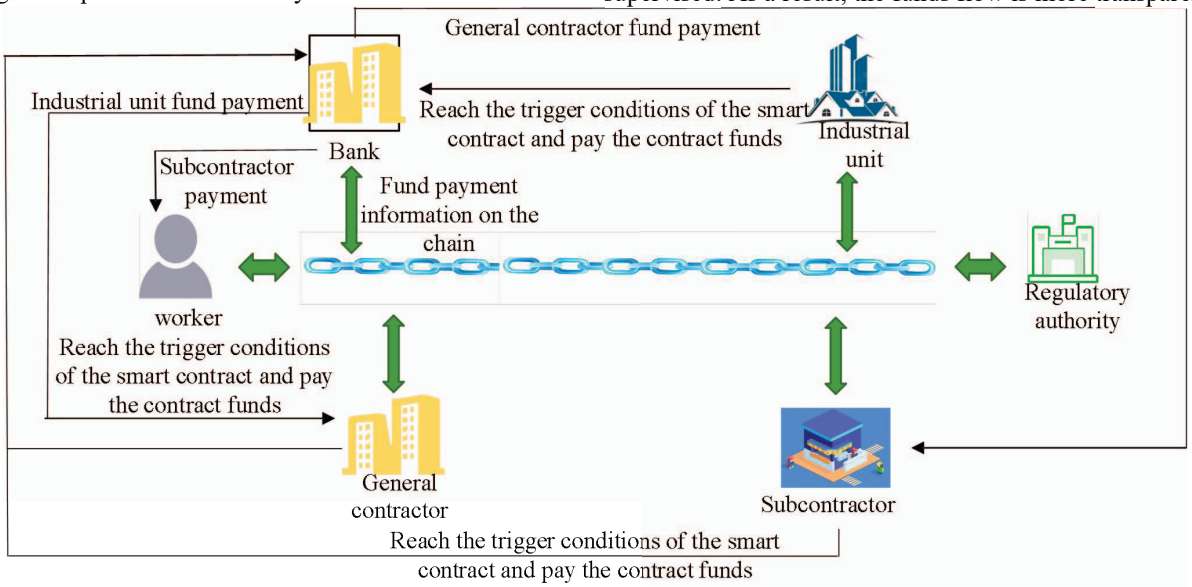

Figure 4. The Blockchain based Funds Management

E. *The Blockchain based Project Process Control*

The platform controls the project progress from the beginning of the bidding process. In the qualification review stage, the blockchain technology is used to assist in verifying corporate qualifications, personnel qualifications and credit. During the construction stage, the safety and progress of the project are controlled, and the workers' safety training and on-site operation records are recorded on the chain to improve the level of construction safety management. Based on the traceability characteristics of the blockchain technology, it can accurately query the source of unqualified process problems and the source of unqualified material defects, and realize real-time supervision of project quality and post-event accountability.

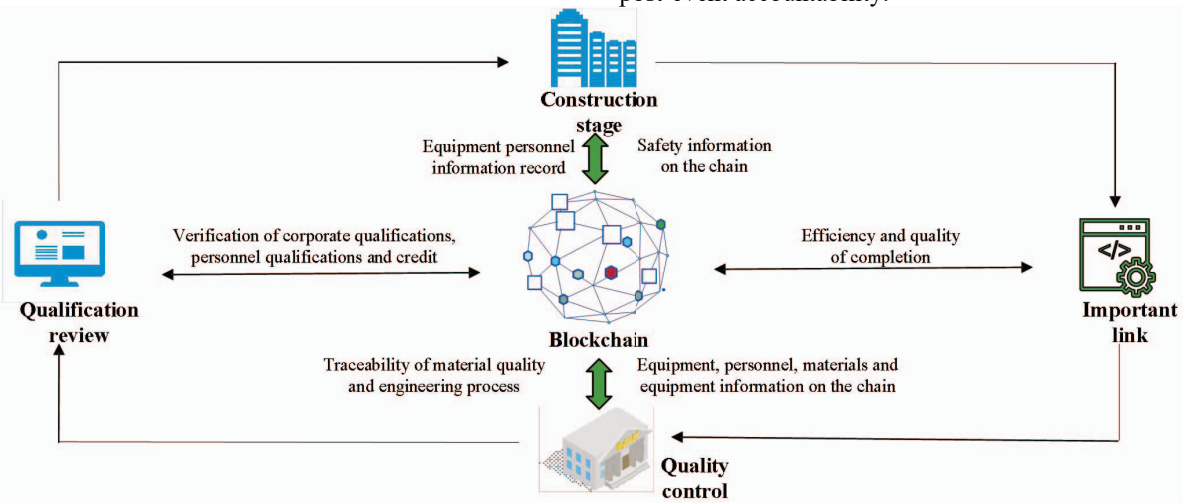

Figure 5. The Blockchain based Project Process Management

III. DESIGN OF THE BLOCKCHAIN BASED ELECTRIC POWER ENGINEERING PROJECT MANAGEMENT SYSTEM

This paper designs a blockchain based electric power engineering project management system, including credit management, contract management, funds management, and project process management modules to support the scientific management, control of project management and capital flow. The management system through the whole process management of the project, recoding the data of related parties and the unified management of the contract on the chain, to realize the transparency of enterprise credit, the contract relationship, and the performance of the project. The system will be the first to be piloted in a power industry management company. According to its performance, it can be promoted and applied to other companies with similar needs in the future.

The construction of the blockchain electric power engineering system needs to complete the development of the bottom chain, smart contracts and the upper-level function. The information that needs to be interacted with external systems will be interfaced with the banking, industry and commerce, judicial, and talent market departments in the form of interfaces.

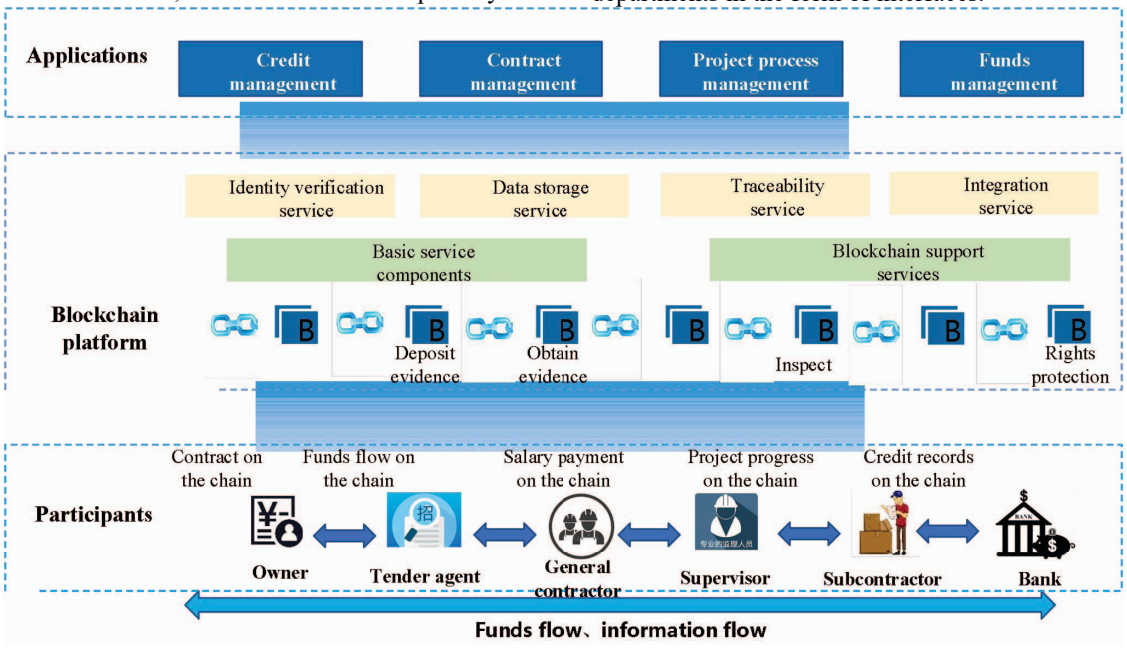

Figure 6. The Blockchain based Project Management System

IV. CONCLUSIONS

The electric power engineering project is a kind of complex system engineering, and some problems existed for a long term, such as funds misappropriation, layers of subcontracting, multi-specialty cooperation, and wide supply chain. In this paper, a proposed project management was studied based on the advantages of blockchain. Some essential modules, such as data deposit, enterprise and personnel credit management, contract management, project progress management, and funds management, were designed.

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