Research on the Application of Blockchain in the Quality Traceability of Power Resources and Materials

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Abstract. At present, power material companies have less quality information about key components of power materials. The quality information of these key components is stored in the centralized database of all parties in the power material supply chain. Any party in the supply chain can tamper with the quality information of a certain circulation link of key components by modifying the content of the database. Therefore, the centralized database recording method cannot guarantee the authenticity of relevant quality information of important components, and cannot trace the quality of key components. Blockchain technology has the characteristics of decentralization, data security, anonymity and data integrity, which can solve the above problems of supply chain quality traceability. The application of blockchain technology in the supply chain system increases the transparency of circulating information and ensures that the traceability information cannot be tampered with. Manufacturers, distributors and consumers join the blockchain network to jointly maintain the whole supply chain and ensure the transparency of data. The emergence of blockchain technology will greatly promote the development of power material supply chain.

Keywords: Blockchain · Edge Computing · Power Supplies · Quality Traceability · Data Security

1 Introduction

At present, power material companies have less quality information about key components of important power materials. The relevant quality information of important power materials and their components is recorded in the centralized database in the form of discrete data lines. The stored information cannot be traced back and the flow of materials and components cannot be observed. Any party in the power material supply chain can tamper with the information of a link in the supply chain by modifying the content of the database, which cannot guarantee the authenticity of the information. In addition, the centralized database will also be attacked [7].

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In addition, paper documents still account for a very large proportion of documents, and paper documents often face problems such as circulation, damage, counterfeiting and loss; Electronic documents avoid the problems of damage and loss, but the circulation and counterfeiting of electronic documents are still very prominent. Due to the large scale of power enterprises, many power materials will be applied, and the categories are also very complex. It is necessary to build a power material quality supervision system to integrate the purchase, storage, transportation and application of power materials into the system for information management [5].

The premise of quality traceability of key components is to ensure that the quality information of power materials is true and reliable. This paper creatively puts forward to bring the quality information of key components of power materials into the scope of power material quality traceability. Blockchain technology is used to store and trace the information of key components of power materials throughout the life cycle [2]. Through the combination of theory and practice, this research can effectively improve the quality management level of power materials.

2 Materials and Models

2.1 Block Blockchain

Blockchain technology originated from a paper bitcoin: a point-to-point e-cash system in 2008. This technology is a new distributed infrastructure and computing paradigm that uses block chain data structure to verify and store data, generates and updates data through distributed node consensus algorithm, uses encryption technology to ensure the security of data transmission and access, and uses intelligent contract of automated script code to program and operate data Traceability and programmability [8].

It is generally believed that the development process of blockchain technology can be divided into three stages. The first stage, represented by bitcoin, realized the circulation and transaction of virtual currency; In the second stage, represented by Ethereum, programmable smart contract was introduced and applied in the financial field [1]; The third stage is to extend the blockchain application to all walks of life, meet more complex business logic and application scenarios, realize information sharing, reduce trust costs and improve the operation efficiency of the whole system.

The key technologies of blockchain include block data, P2P network communication technology, encryption algorithm, consensus mechanism, smart contract, cross chain, fragmentation, etc.

At present, blockchains can be divided into three types according to the access rights of their nodes: public chain, private chain and alliance chain, Each node on the public chain can join and obtain the data on the chain at any time, and can exit the blockchain at any time. The private chain controls the access permissions of all nodes, and the read-write permissions are partially opened and authorized by the management according to the business needs. Alliance chain is a type of blockchain between public chain and private chain. Each node in the alliance chain usually corresponds to several entity organizations and serves the transactions of multiple organizations. Each node needs authorization to join and exit the blockchain network. By formulating access rules and

access rights, it ensures that its data is only allowed to be read and updated by institutions in the system to ensure system security.

Hyperledger, a blockchain commercial platform, is the first attempt of relevant enterprises to develop the commercial value of blockchain. The project proposes a distributed ledger platform for alliance chain scenario for the first time to improve the efficiency of commercial transactions and reduce the cost of multi-party cooperation. As the first top-level project added to the super ledger, hyperledger fabric is a development framework of private chain/alliance chain.

Nodes in the hyperledger fabric network must be authorized and authenticated before joining, so as to avoid POW resource overhead, greatly improve transaction processing efficiency and meet the demands of enterprise applications for processing performance. At the same time, in order to meet the flexible and changeable application scenarios, hyperledger fabric adopts the highly modular system design concept, and separately deploys the authority authentication module (MSP), the ordering service module, the endorsing GPRS module and the committingpeers module, so that developers can replace modules according to specific business scenarios, the plug-in/plug-out management of modules is realized.

2.2 Supply Chain Traceability

Supply chain traceability means that in all links of the product supply chain, the information related to product production and transportation can be traced to ensure that the whole circulation process of products has been effectively monitored and can be located to the responsible unit or person in time.

At present, the traditional supply chain traceability system has the following problems: first, the supply chain is a multi-party participation and multi-party maintenance system. In the whole supply chain system, the information asymmetry between manufacturers, intermediate distributors and consumers [4]. There are different logistics systems between manufacturers and distributors, distributors and consumers. Different systems are isolated from each other, and the information is stored in different databases, forming an information island, which makes it difficult to track down the responsibility of products; Second, the traditional supply chain system uses a centralized database, and there is room for human operation. Due to the extremely low cost of counterfeiting, it may tamper with the data at will or focus on fabricating data afterwards because of relevant interests, which further increases the difficulty of product accountability [3].

2.3 The Role of Blockchain in Power Material Supply Chain Traceability

Firstly, as a distributed transaction ledger, blockchain is distributed in recording and storage. When a blockchain records data, all active nodes on the entire blockchain network need to agree on the data transactions to be recorded, rather than a single central node, which greatly enhances the authenticity of the recorded data. At the same time, the storage of blockchain data is also distributed. All blockchain nodes in the blockchain network have complete blockchain copies, and blockchain 4 data is jointly maintained by all nodes. Since the blockchain is encrypted by hash algorithm, when the data in the blockchain is changed, the hash hash function of the block will change greatly, which

will be easily found by other nodes, and the node will be kicked out of the blockchain network.

Secondly, the problem of data redundancy is that all enterprises in the supply chain use the same blockchain platform to store data and use the same smart contract to complete operations, which can effectively establish the material traceability information file and avoid the human and material resources consumption caused by different data formats in the process of data transmission.

Finally, when new transactions and blocks are produced in the blockchain, the blockchain will stamp them to ensure that the material information is traceable in time. At the same time, the use of public-private key encryption enables the traceability system to accurately find the specific node of the published transaction according to the only supporting decryption key, so as to realize the owner traceability of the material information.

2.4 System Design

According to the business characteristics of the material quality management scenario, this paper constructs a material quality traceability service based on blockchain technology based on hypeledgerfabric and edge computing [6]. The main objectives are as follows: first, design a system architecture that supports the interaction between mobile devices (such as smart phones and tablets) and the blockchain system. The system uses mobile devices as the client, which can easily and quickly generate traceability data and upload the traceability information to the blockchain; Second, an upgradeable smart contract applied to the supply chain traceability system is designed to realize the functions of adding and reading traceability data in the blockchain. The functions included in the system are summarized in the Table 1.

2.4.1 Interaction Layer

The interaction layer mainly includes mobile terminal equipment, mobile terminal application and QR code for recording power material information. The QR code is specifically divided into unified physical ID and GGT QR code. The unified physical ID is used to identify materials and their raw materials; GGT code (i.e. gene geographic time) is used to store material ID, geographic longitude and latitude information and time information during material registration. The mobile application is mainly provided to users for use. Users scan QR codes through the terminal device to generate product traceability information. The application will call the interface provided by the smart contract layer to write the traceability data into the blockchain.

2.4.2 Smart Contract Layer

This layer mainly includes an upgradeable smart contract. The contract defines the storage structure of traceability data, realizes the read-write interface called by the mobile application, and completes the data interaction between the application and the blockchain system. At the same time, this layer will also complete the compilation, deployment and maintenance of smart contracts to complete the possible subsequent upgrade operations.

Table 1. This caption has one line so it is centered.

Level 1 Function Point	Level 2 Function Point	Function Description
Material Quality Data Management	Raw Materials Data Management	Put the raw material information on the chain service, and identify the material and raw material related information through a unique ID, and then depositing to the blockchain.
	Equipment Manufacturing Data Management	Compare the relevant information of the raw materials involved in the production process of power materials with the final product information. The raw material ID is mapped to the physical ID of the material, and the physical ID is used as the material identification, and the relevant data is stored in the blockchain.
	Logistics Data Management	Use the physical ID as the unique identifier to store the relevant data during the transportation of power supplies in the blockchain.
	Quality Inspection Data Management	Use the raw material ID and the physical ID as the identification to store the relevant data during the qualification inspection process of the electric appliance in the blockchain.
	Material Traceability Management	Participants in the supply chain material flow are set according to their authority, and the physical ID is used to inquire about the power material flow involved in the process. And the quality data and related contract documents.
Contract Documents Digital Depository	Contract Documents Data Management	Store the hash value of the contract documents in the blockchain, and store the original text of the contract documents in the distributed storage.

2.4.3 Data Storage Layer

This layer mainly completes the consensus and storage of data. On the basis of Ethereum platform, build an alliance chain composed of multiple nodes, which can communicate with each other, reach consensus through consensus algorithm, and provide services for the verification and storage of system transactions. The node of hyperledger fabric is similar to the database of traditional system, and its main function is to store traceability data; The difference is that the nodes in the blockchain are decentralized. All nodes in the alliance jointly manage the stored data, ensure the effectiveness of the newly added data through the RAFT consensus algorithm, complete the data storage, and use a variety of cryptography technologies to ensure that the data cannot be usurped.

By chaining the power material quality data, the uniqueness and accuracy of relevant data are ensured, and the verification of material quality information by each node company is reduced. By chaining the quality data of power materials, the whole process traceability of components procurement, processing and production, quality inspection, procurement warehousing, use records and other links of power materials is realized, and all parties can query the traceability information in the platform, so as to ensure the authenticity of traceability information, improve work efficiency and reduce costs.

3 System Implementation

In the blockchain based power material quality traceability system, the data generated by the Internet of things is uploaded to the storage platform through the sensor system and RFID card reader system in the acquisition platform for storage; Material manufacturers, material transporters, quality inspection institutions and other participants obtain data from the storage platform.

The collection platform uploads the IOT data of the whole traceability system. These data are generated from a large number of IOT sensing nodes installed on the shelves of production plants, transport vehicles and warehouses (such as wireless sensors for collecting environment and location information, RFID card readers for reading identification, etc.). The collection platform completes the upload of basic information data by calling the data upload interface of the storage platform. The application platform relies on the blockchain based traceability information storage platform to build various applications and provide web data services.

The whole system mainly includes the following modules: identity authentication module, QR code scanning module, equipment positioning module, map module, account generation module, intelligent contract interaction module, registration module, tracking module and traceability module.

The traceability Query Web page adopts browser server mode (B/S architecture). The software under the C/S architecture needs to be downloaded and installed by the user, and the user needs to update the software after each software change. The main reason is that the request sending, business logic processing and response display under the C/S architecture are completed on the client side, and the client software is completely bound with the business logic, so the client side needs to download and update the software. B/S architecture is an evolution of C/S architecture. It uses browser instead of client-side program to realize business logic on server-side. In the material supply chain traceability system, the blockchain and mapping data-base are used as the data access layer, the interface program deployed on the server is the business logic layer, and the browser is the three-tier B/S architecture of the presentation layer, so that the enterprise can complete the software update only by adjusting the web interface program. For users, there is no need to download new software, just log in to the designated website page to obtain traceability information [9] (Fig. 1).

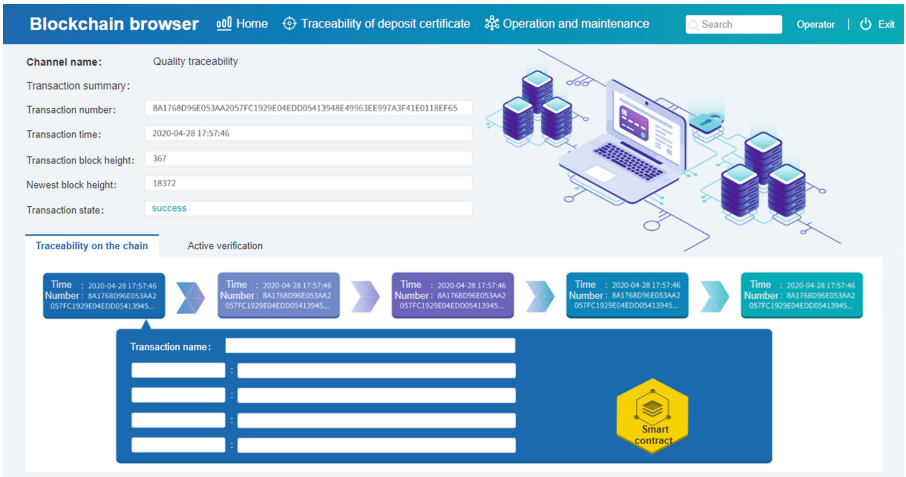

Fig. 1. System display

4 Conclusions

Blockchain technology has developed rapidly in recent years. With its advantages of decentralization and data tamperability, blockchain has a huge application space in many industries. Especially in the field of supply chain traceability, the traditional supply chain traceability system has many problems, such as asymmetric circulation information and tampering of traceability data. Therefore, this paper proposes a supply chain traceability oriented blockchain system. Using blockchain technology to solve the problems existing in the supply chain traceability system has high research value and practical significance.

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