

Blockchain-Based Traceability Study of Chinese Herbal Medicine

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Abstract—Chinese medicine has a pivotal position in China and the world, and Chinese herbal medicine, as an essential part of it, naturally attracts much attention. The monitoring and management of the supply chain of Chinese herbal medicine is an important link to maintain the healthy development of the Chinese herbal medicine industry. At the present stage, the supply chain supervision of Chinese herbal medicines still has problems such as information asymmetry and difficulty in traceability and accountability, which cannot guarantee the quality and safety of Chinese herbal medicines. In order to improve the quality of safety supervision of Chinese herbal medicines by relevant departments and improve the operational efficiency of the Chinese herbal medicine supply chain, we analyzed the factors affecting the traceability of Chinese herbal medicine supply chain in China and constructed a traceability system of Chinese herbal medicine supply chain using the process trustworthiness and decentralization features of blockchain to provide solutions for the traceability of Chinese herbal medicine quality and safety.

Keywords—Chinese herbal medicine; blockchain ; traceability ; supply chain

I. INTRODUCTION

Since the reform and opening up, China's Chinese medicine industry has continued to develop. As the basis for the development of Chinese herbal medicines, the standardization of the quality of Chinese herbal medicines has become an obstacle to the further development of the Chinese medicine industry. It is imperative to use advanced scientific and technological means to strengthen the quality control of Chinese medicines, establish and improve the standards and norms for the cultivation, research and development, production and sales of Chinese medicines, ensure the quality and safety of Chinese medicines, and track and supervise the quality of Chinese medicines throughout the whole process[1]. However, due to the scattered data, opaque information and lax supervision of the nodes in the supply chain of Chinese herbal medicines, it is difficult to trace the responsibility once the quality and safety of Chinese herbal medicines appear in the market. The traditional product traceability system has problems such as reliance on centralized storage, low data credibility, easy tampering and difficulty in locating the responsible person [2]. Therefore, in order to trace the root node of product quality, there is an urgent need to establish a safe, reliable and easy-to-trace herbal traceability system. The decentralization, openness

and transparency of blockchain technology and the lack of trust accumulation provide the possibility to solve the problem of traceability of Chinese herbal medicines. Based on blockchain technology, constructing a traceability system for the Chinese herbal medicine industry can provide regulatory authorities to improve the information supervision of each node in the supply chain of Chinese herbal medicines to reduce unlawful acts. This promotes the healthy development of the Chinese herbal medicine industry by providing data support.

II. RESEARCH OVERVIEW

The domestic research on the supply chain of traditional Chinese medicine management mainly focuses on supply chain model exploration, logistics management and procurement. Sun Yamin[3] believes that the supply chain model can improve the efficiency of enterprises and has a significant effect on the procurement process of agriculture and livestock-related enterprises. Taking the feed supply chain in Gansu Province as an example, Chunman Yao[4] systematically explored the problems of this supply chain and initially constructed the feed supply chain management model. To improve the feed supply chain management, the Shu-Ling Zhang[5] applied the near field communication IoT technology to the feed supply chain information management system, which greatly enhances the node information interoperability. However, as the sales and production scale of Chinese herbal medicines continues to expand, higher demands are placed on logistics. How to reduce logistics costs, protect the quality of Chinese herbal medicines and enhance economic benefits is an important issue facing Chinese herbal medicine manufacturers at present[6]. In recent years, product quality and safety incidents have occurred frequently, therefore, it is necessary to establish a transparent, credible and safe product quality traceability system to assist to assist regulators in industry management. However, the traditional traceability system faces problems such as non-standard information collection, insecure data storage, central system vulnerable to attack and the privacy of information exchange process between enterprises cannot be guaranteed, etc[7]. The creation of blockchain provides the possibility to optimize the traceability system.

III. PROBLEMS OF TRACEABILITY OF SYSTEM

The supply chain of traditional Chinese medicine mainly consists of manufacturers, manufacturers, distributors, logistics providers and consumers. Due to the large number of

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participants in the Chinese herbal medicine supply chain and the poor interoperability of each node, it is difficult to supervise the Chinese herbal medicine industry, and it is difficult to trace the source of product problems.

A. *Weak Awareness of the Responsibility*

The production of Chinese herbal medicines is the key link to ensure the safety of Chinese herbal medicines, but now there is a production process quality control is not strict phenomenon.

From the production, processing, sales of traditional Chinese medicine to the user terminal, every link can not be separated from the logistics link. Changes in temperature and humidity will affect the quality of traditional Chinese medicine products. However, at present, it is impossible to supervise the whole chain of traditional Chinese medicine, resulting in difficulties in the final traceability.

B. *Opaque Information in the Supply Chain of Chinese Herbs*

The supply of traditional Chinese medicine needs to go through multiple circulation links such as upstream raw material suppliers, manufacturers, distributors, and consumer terminals. Due to the opaque information of each node in the supply chain and the asymmetric information among regulators, enterprises and consumers, it is difficult to supervise. Once problems occur, it is difficult to trace back to the source, which leads to low trust in the overall quality of traditional Chinese medicine among consumers

C. *Insufficient Regulation*

On the one hand, due to lax supervision, insufficient investment and lack of professional supervision personnel in China's traditional Chinese medicine industry, some Chinese herbal medicine enterprises took advantage of loopholes in the regulatory system to sell unqualified traditional Chinese medicine; On the other hand, there will be a certain time limit for the review of the results of the random inspection of Chinese herbal medicines by the regulatory authorities. Some Chinese herbal medicine enterprises will use the review period to find ways to get rid of their responsibilities and avoid punishment, rather than changing or destroying the problematic products.

IV. DESIGN OF SUPPLY CHAIN TRACEABILITY SYSTEM

A. *Hierarchical Technical Structure Design of Traditional Chinese Medicine Traceability System*

Due to the two characteristics of process credibility and decentralization, the blockchain can build a trust foundation in a low-cost way under the background of multi stakeholder participation[8], thereby effectively improving the operational efficiency of supply chain logistics[9]. Therefore, the blockchain technology can be used to build the traceability system of Chinese herbal medicine supply chain.

The traceability system is divided into network layer, data layer, consensus layer, control layer and application layer using the general blockchain architecture. The network layer

is based on network technology to complete data transmission between nodes, and is the basis of blockchain information interaction. The data layer is the core layer of the blockchain. By encrypting the data of each account, it ensures the strong correlation between data and the efficiency of verification, so as to achieve the anti tampering and security characteristics of data. The consensus layer includes various algorithms, so that all kinds of ledger data can be unified across the network in an untrusted environment, and the programmable characteristics of the consensus algorithm can be achieved. The control layer consists of three modules: processing model, control contract and execution environment. It is the central organization of data layer and application layer. The application layer mainly provides a Chinese herbal medicine quality and safety traceability query platform for regulators, consumers and participants in the supply chain of traditional Chinese medicine

B. *Construction of traceability system for quality and safety of traditional Chinese medicine*

The data of each node in the supply chain of traditional Chinese medicine is an account. It can be seen that the account data is numerous, scattered and lacking in systematicness. However, the blockchain technology can integrate all accounts together, and improve the efficiency and accuracy of quality safety traceability on the Chinese herbal medicine chain by using the characteristics of blockchain technology, such as process credibility and decentralization. As shown in Figure 2, the supply chain of traditional Chinese medicine mainly includes five data accounts of production, manufacturing, processing, sales, logistics and consumers. The blockchain technology can be used to encrypt and integrate account information to ensure data security.

C. *Decentralization*

At present, the supply chain management of traditional Chinese medicine is generally centralized. With the increase of access management nodes, centralized management needs to build more infrastructure, consume more energy, and require more managers. The operation and maintenance costs are increasing, which easily leads to the unsustainable development of the traditional Chinese medicine industry. Blockchain technology has a decentralized attribute, which can enable the blockchain supply network supervision equipment to achieve self-management and maintenance, effectively reduce the cost of Chinese herbal medicine supply chain management input and maintenance, and improve the efficiency of Chinese herbal medicine supply chain management.

D. *Certificate Keeping and Traceability*

There are many links in the supply chain of traditional Chinese medicine, covering a wide range of areas. A large amount of data will be generated before, during and after the production of traditional Chinese medicine. The tamper proof, open and transparent characteristics of blockchain technology enable various types of data to be stored and traced, thus effectively avoiding the risk of product related data forgery or tampering in the process of production, quality

inspection, warehousing, processing, sales, transportation, etc.

E. De-trusting

Traditional transactions are based on trust between transaction subjects. Although a large amount of information can be obtained from third-party credit institutions, the information is not targeted and practical. The blockchain technology can record the information of different nodes of the supply of traditional Chinese medicine, including enterprise information, transportation product status, etc. The recorded information is permanent and no longer depends on third-party organizations. It can effectively reduce the operating costs of all parties and solve the problem of product security and integrity.

V. CONCLUSION

From the perspective of all participants and regulators in the Chinese herbal medicine supply chain, the problems in the Chinese herbal medicine supply chain supervision and traceability are analyzed. The specific problems are: (1) The links of the Chinese herbal medicine industry chain are poorly interconnected, and the participants lack the awareness of quality and safety responsibility; (2) The information recorded in each link of the Chinese herbal medicine supply chain cannot be tampered with to achieve effective traceability of the herbal supply chain. (3) Lack of responsibility of the regulatory authority.

In order to effectively solve the problem of blaming the safety supervision of traditional Chinese medicine, a Chinese herbal medicine quality and safety traceability system is built based on blockchain technology to achieve the following requirements: (1) Decentralization. Reduce the cost of supply chain supervision of traditional Chinese medicine and improve the efficiency of supply chain management of traditional Chinese medicine. (2) Certificate keeping and traceability. The information recorded in each link of the Chinese herbal medicine supply chain cannot be modified, so that the Chinese herbal medicine supply chain can be effectively traced. (3) De-trusting. All links and data of the Chinese herbal medicine supply chain are open, so as to avoid mutual deception among various entities.

Although the characteristics of the blockchain technology, such as decentralization and non tampering, can make it play an important role in the supply chain of traditional Chinese medicine, with broad application prospects, the blockchain technology still faces many challenges in practical application.

First, the user's adaptability is not strong. The blockchain in the supply chain of traditional Chinese medicine has the characteristics of decentralization, but at this stage, the popularity of blockchain technology in the traditional Chinese medicine industry is not high, users do not know much about it, and the risk is high. Therefore, in the current supply management of traditional Chinese medicine, third-party institutions will still be used to serve users.

Second, there are challenges to data consensus. The data on the supply chain of traditional Chinese medicine is huge and

complex, and the establishment of consensus standards is challenging. In the blockchain, each node has a large number of system records. With the operation of the supply chain, if there is no appropriate consensus standard, the data stored in each node will become more and more, which will lead to an increase in the burden of storage and computing, resulting in a large number of useless data. When new users join, they must synchronize with the existing information of the system before they can implement the audit and tracking functions of the blockchain, which will increase the cost of new use. Therefore, for new users, the cost of using the system is high.

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