Research on Supply Chain Management Based on Blockchain Technology

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Research on Supply Chain Management Based on Blockchain Technology

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Abstract. Block chain is a decentralized infrastructure that is widely used in emerging digital cryptocurrencies and has received attention and research as Bitcoin has gradually become accepted. Block chain technology is the underlying technology of Bitcoin. Its decentralization, block data cannot be tampered with, and it is trusted, which makes its application in various fields gradually gaining attention. With the deepening of the phenomenon of globalization and division of labor, the supply chain of modern enterprises began to appear fragmentary, complex, decentralized, and other phenomena, which brought great challenges to the supply chain management. First of all, it gives a basic overview of the block chain technology, explains its composition, basic framework and technical characteristics, then analyzes the problems in the current supply chain management, and finally points out that the block chain technology solves the above-mentioned supply chain management problems. The purpose is to help the block chain technology in the field of supply chain related research.

1. Introduction

The block chain first appeared in the text of 《Bitcoin:a peer-to-peer electronic cash system》 published by Satoshi Nakamoto. The article points out that the block chain technology is the basic technology to construct the data structure of Bitcoins and the transmission of transaction information. It can be achieved, and the transaction process of Bitcoin mining. At present, almost all transactions are done with the aid of third party organizations. This way of trading is due to the mutual distrust of both parties. The merchant will ask the customer to fill in the complete but unnecessary information, but still cannot avoid some fraudulent behavior. The existence of the third party institutions has increased the cost of intermediation and expanded the unnecessary size of the transaction [1].

With the deepening of globalization, the supply chain of modern enterprises has become fragmented, complicated and diversified. This also brings great challenges to supply chain management. The most significant example is the food safety problem. Once food pollution occurs, it takes a week or even longer to trace back to the source. Food producers or retailers are likely to pay a heavy price. This situation leads to the opacity of the supply chain, which is more likely to drive up operating costs. This paper expounds the application research of block chain technology in supply chain management from the aspect of technology structure and technology characteristics of block chain technology, so as to provide help for the research of block chain technology in the related fields of supply chain.
2. **Block chain and supply chain overview**

The block chain, as the underlying technology of Bitcoin, which is used to record all transaction records. Essentially a decentralized distributed ledger database. Anyone can participate in the block chain network, and each device can be a node. Each node is allowed to obtain a complete copy of the database. The nodes are based on a consensus mechanism. The whole block chain is maintained through competitive calculation. If any node fails, the remaining nodes can still work properly and solve the defects of traditional centralization mode which is vulnerable to attack and tampering.

There is currently no uniform definition of a block chain. Yuan Yong [2] think block chain technology is the use of encryption the block structure to validate and store data, using distributed node consensus algorithm to generate and update the data, the use of automated script code to programming and operating data of a new kind of decentralized infrastructure and distributed computing paradigm. The definition defines block chain technology as a decentralized technology framework which is organically combined by key technologies such as encryption algorithm and consensus mechanism. It is relatively comprehensive.

Supply chain means all activities related to product flow and processing, and the accompanying information flow, from raw material stage to the last user. The flow of materials and information may flow downstream along the supply chain, or upstream. And supply chain management is an integrated management of these activities, and gains a long competitive advantage by improving the relationship between the parties on the supply chain. The supply chain management is the traditional enterprise between various departments, specific enterprise between various departments each enterprise on the supply chain system, strategic coordination of activities, its purpose is to improve the individual companies, as well as the operating performance of the whole supply chain each link long-term [3].

3. **Block chain technology**

3.1. **Composition of block chain**

The block chain is a data structure formed by the orderly link of the block. The block is the collection of index data, and the relevant information and records are included in it, which is the basic unit to form the block chain. In order to ensure the traceability of the block chain, each block will have a timestamp, as a unique token. Specifically, the block is made up of two parts: 1) the area block is linked to the front block and provides integrity for the block chain; 2) the block body records the updated data information in the network. Figure 1 shows a schematic diagram of the block chain. Each block is linked to the previous block by block header information, thus forming a chain structure.

![Figure 1. Organization structure of block chain](image)

3.2. **A Basic structure of block chain technology**

The basic architecture of the block chain consists of data layer, network layer, consensus layer, incentive layer, contract layer and application layer.

According to the operation principle of block chain technology and the application requirement of supply chain management system, the supply chain management system based on block chain is divided into three layers: resource layer, block information layer and application service layer. The bottom layer supports the upper layer, the closer to the user application, the closer to the physical resources, the interdependence of the hierarchical modules, and the interaction of them to form an organic whole to support the normal operation of the entire system function.
3.3. Features of block chain

1) Decentralization

The validation, bookkeeping, storage, maintenance, and transmission of block chain data are based on a distributed system structure. Consensus mechanism is an important foundation for block chain technology to realize distributed storage. The trust relationship between distributed nodes is established by using pure mathematical methods instead of central institutions to form a decentralized and trustworthy distributed system. It needs to be pointed out that distributed and decentralization are different concepts. In fact, distributed can also be centralization, such as multiple exotic rooms of the same company. Centralization can also be centralized, for example, asking all voters to go to the same place for a referendum [4]. Figure 2 shows a schematic diagram of centralization and decentralization.

![Centralization and Decentralization](image)

2) Block chain tamper-proof.

The modification of a single or even multiple node to a database cannot affect the database of other nodes. This is almost impossible unless more than 51% of the nodes in the entire network can be modified at the same time.

3) Traceability of block chain

The traceability characteristics of block chain technology. Each transaction in the block chain is connected in tandem with two adjacent blocks by cryptography. So it can be traced back to the past life of any transaction. The data information recorded by the block chain is stored permanently. At the same time, all transaction information and corresponding trader information in the block chain system are recorded. The route of the transaction is also recorded. All data information recorded and stored by the block chain system cannot be destroyed or tampered. It not only ensures the accuracy of the data, but also makes it easy to trace every transaction. It has a great help in improving the efficiency and quality of trading supervision[5].

4) Block chain transaction encryption.

The security of block chain is guaranteed by encryption technology. The computing power provided by the entire distributed network is staggering. It is not only theoretically impossible to tamper with the data in the block chain, but also the cost of electricity, equipment and so on.

The block chain adopts asymmetric encryption algorithm to solve the problem of trust between users. Asymmetric encryption algorithms require two keys: public key and private key [6]. The public key and the private key are a pair. If the data is encrypted with the public key, only the corresponding private key can be decrypted. If the data is encrypted with a private key, only the corresponding public key can be decrypted. Each participant in the block chain has a private public key and a private key. The exclusive public key is published to all network users. All network users adopt the same encryption or decryption algorithm. The private key is only available to the user. The user encrypts the information with the private key, and other users decrypt the information with the public key. Other users can verify the authenticity of the data source through the public key. At the same time, the running process and rules of the block chain system are safe and transparent, and the network data update needs the common support of multiple users to support [7].
4. Problems in supply chain management.
Because of the limitation of the development level of the supply chain management, the lag of the concept of supply chain management and the restriction of the mode of production in the supply chain management of our enterprises. Some related businesses in the supply chain, such as planning, procurement, production, logistics and other processes, are mostly centralization design and management through chain owners. However, the traditional "independent", "centralization" of supply chain management at the beginning of the existence of limitations.

4.1. Delay in information transfer
The current supply chain has a wide range of upstream and downstream enterprises, and there are many enterprises involved. The core enterprises have limited management ability and influence on the whole supply chain, and the management efficiency is greatly reduced and the management costs are rising. The general enterprise can manage the supplier of 1 to 2 at most. With the continuous refinement of the global division of labor, the number of suppliers has multiplied, extended and spread all over the world. For example, the Apple Corp supply chain system is registered with up to more than 800 suppliers. Encapsulated from a chip circuit to a display test. Maintenance from the camera clean room to the battery explosion-proof requirements. From the frame mould, then to the final assembly, the logistics, the agent and the seller. Because many suppliers are not only managed by one core enterprise. It adopts hierarchical management. Therefore, information transmission is often delayed and occurs when both parties cannot obtain the same information. The core enterprises cannot control the flow of goods to the upstream and downstream enterprises in real time. In the age of big data, information asymmetry will put enterprises at a disadvantage and even reduce the value of whole supply chain ecosystem. Incorrect or inconsistent information will lead to the decision error of the core enterprise, or the decision to be delayed because of the need to be readjusted. The fundamental reason for the shoddy and tampered goods in the supply chain transportation transaction is the asymmetric information between the central authorities, producers and consumers, which leads to the trust problems between the two sides. This is also one of the core issues of the authenticity of goods. When there is a dispute, the process of proving or being responsible is very time-consuming and sometimes difficult to achieve. The channel of information circulation is unobstructed and the transmission of information is not timely, which makes the transmission of content distortion. The whole process of supply chain management relies on the highly accurate transmission of information within the system. The untimely and distorted information transmission in the supply chain brings a series of problems. For example, the bullwhip effect, the result of this phenomenon is that the inventory of manufacturer's products is piled up, the cost of products is increased, and the survival period of the enterprise will be reduced. In addition, the risk of the traditional supply chain information technology is also large. Cyber crime, hacker attacks, identity theft and other technical risks are on the rise. These can damage the corporate brand image and lead to higher cost of supply chain management.

4.2. Lack of transparency
In recent years, despite the supply chain management, different industries in China are constantly striving. Taking retail as an example, there are still problems that need to be solved from standardization implementation, technical personnel training, equipment standardization and information unification. The key is that the logistics standard system of supply chain management is not in place and the "information island" is serious. The lack of transparency in the supply chain, such as the relationship between the price of a customer's transaction and the real cost of the product. So there is a lack of an effective and reliable way for buyers and sellers to verify the true value of the products they buy and sell. It is difficult for each participant in the supply chain to understand the current situation and the existing problems. The efficiency of the supply chain is therefore affected. The invisible increase the overall cost of the supply chain. And there is no account book or system that records a series of transactions that occur throughout the supply chain. The problem of information error and tampering will appear. The supply chain is still unable to trace the source of illegal activities such as fake commodities, illegal labor and money laundering.
4.3. Weak traceability

Depending on the centralized central database, data can be tampered with in some links such as storage, transmission and display. The tracking system of goods is still in a manual operation in many links. The information provider can selectively shield the underlying information against itself. The tracking of goods depends on the strength of the supervision measures of the central institution, and the system has human operating space, and there is no effective restraint on the rights of the supervisor. In the food industry, traceability is particularly important. In the wake of the food safety issue, the rapid response can not only clearly define the responsibility of relevant subjects in different stages of the food supply chain, but also reduce the consumers' doubts and fears.

5. Block chain is applied to supply chain management

First, block chain technology enables the data to be transparent between the parties. Thus forming a complete and fluent flow of information on the whole supply chain. This ensures the participation of all parties in the timely detection of problems in the operation of the supply chain system. And targeted to find a solution to the problem. And then improve the overall efficiency of supply chain management. Secondly, the characteristics of the data that the block chain can not be tampered with and the existence of time stamps can be well applied to solve the disputes among the participants in the supply chain system, so as to achieve easy proof and accountability. Finally, the data cannot be tampered and the transaction can be traced back to the two major characteristics to eliminate the problem of counterfeit and shoddy products in the process of product transfer in the supply chain [8].

5.1. Supply chain information tracking query

By using block chain techniques, a complete information collection and delivery process can be recorded. And the transaction information in these processes has the characteristics that collective participants maintain and cannot be tampered with. It effectively prevents the loss of logistics information and other related problems. When adopting the multimodal logistics mode, the transaction data generated during the process of logistics transportation will be easily lost if there are multiple carrier transfers. However, if the block chain technology is applied, the transaction sharing and information integrity between different carriers can be guaranteed. When carrying out the express business process, the block chain technology is applied, and the customer signs the receipt with the private key. This signature is not repudiable and verifiable, which is of great value for the postage of valuables.

The whole process of complete record of transaction information is realized by block chain technology. It can fully grasp the transaction information of each link in the process of the supply chain transaction. Grasp the direction and quantity of the goods, to stop selling behavior. China Post has a high level of logistics, such as electronic products, which has high requirements to prevent any changes in the information of the goods on the supply chain. For example, when a cell phone is sold, it needs to record the complete channeling information. The medical logistics also needs to record the complete information of each transaction link, and there should also be an emergency recall function. Block chain technology can meet the needs of users.

5.2. Information sharing on the chain.

Because the block chain is transparent, centralic, non tamperable and traceable, it is naturally suitable for multi parties to build information sharing platform. To help realize the openness and democratization of information data in the supply chain, the fragmented database is connected to the network. The encryption algorithm can also be used to protect the privacy information of the enterprises on the supply chain. If the core enterprise can inform the supplier of the required goods, it will not disclose the specific name of the supplier to other enterprises in the ecosystem. In the process of product delivery, the enterprise can master the detailed information of the delivery process in the logistics environment, such as pressure and temperature. And when the product arrives at the port, ready to load and transfer to the truck, it will produce a new transaction record. The transport transaction between the logistics providers will also be recorded in the block chain for enterprises to consult. That is to say, based on block chain technology, any participant can get the same transaction
data at the same time, which means that the whole transaction process is completely transparent. In addition, due to the block chain broke the data island companies, so there will be more big data based on supply chain, the data source, stock and thus greatly improve the data quality, that big data can play its role better. At the same time, the non tampering of block chain data also improves the credibility of data, making it possible for enterprises to credit data, which will further promote the establishment and prosperity of big data trading market.

5.3. Information tampering
The concrete practice of block chain technology tamper is to include manufacturers, suppliers, distributors, retailers and end users in the system application of block chain. The block chain technology requires that the node that has the right of account must add a timestamp in the current data block header to indicate the write time of the block data. Therefore, the blocks on the main chain are arranged in sequence in order of time. Timestamp technology itself is not complicated, but its application in block chain technology is an important innovation. The timestamp can be used as the existence proof of the block data (Proof of existence), which helps to form a database of block chain that cannot be tampered and not forged. Before the market is officially sold, producers first record the product in the block chain network, and then record the transaction in every transaction step by step in the market transaction process. When a user finds something wrong with a commodity, a dealer in the middle link wants to escape responsibility. Deleting your own illegal records can only delete information recorded on your computer, and you can't change the transaction information stored by other participating members. Supply chain includes all links from commodity production, distribution to the end user. It can cover hundreds of stages and across many geographical areas, so it is difficult to track the initial source of commodities. In addition, the information of commodity data transaction in the supply chain is distributed in the hands of each participant, and the information of production, logistics and sales is divided. Manufacturers cannot get the flow of goods out of the warehouse and customer feedback. Consumers do not have access to the source and process of the goods. So you can inject the goods into the only nonreplicable identifier and store the goods in the block chain network. It makes every product have a digital identity. The participants in the network jointly maintain the digital identity information of the goods themselves. Finally, the validation results are realized. The block chain technology is defined as a distributed database, and it is maintained by the participants in the chain through its decentralized and trusted technical features.

6. Conclusion
In the past two years, the research and application of block chain technology has shown explosive growth trend. The fifth subversive innovation of computing paradigm followed by mainframe, PC, Internet, and mobile networks. It is the fourth milestone in the evolution of human credit history, following the credit of blood, precious metals and central bank notes. Block chain technology is the embryonic form of the next generation of cloud computing, and it is expected to reshape human social activities like the Internet. And realize the transformation from the current information internet to the value Internet. The supply chain will be the typical application field of block chain technology in the future. Block chain can change the information flow, logistics, capital flow sharing and interaction. Changing the whole chain of products from production to consumers. Thus the supply chain will become more transparent and large-scale collaboration becomes easier. More can accumulate enterprising credit, building trust, improving security. Thus, a profound change in the supply chain industry has been set off in the world.

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