Research on the circulation of maritime documents based on blockchain technology

Shaokun Liu*

1School of Transportation, Shanghai Maritime University, Lin-gang Special Area, Pudong Special Area, Shanghai, China

*Corresponding author: liushao1999zypd@163.com

Abstract. Maritime goods from the shipper to the consignee will go through cumbersome trade procedures. The traditional paper documents used in this process will cause some damage to the environment. Therefore, it is proposed to introduce blockchain technology in the circulation of shipping documents, and realize paperless customer service by using its characteristics of non-tamperability traceability and trust. This paper first reviews the literature on blockchain in the shipping industry, and then analyses the risks in the circulation of shipping documents and the efficiency of document circulation. Then it puts forward the shipping document circulation system architecture based on alliance block chain, and finally gives policy suggestions.

1. Introduction

In recent years, with the popularity of bitcoin, people began to pay attention to the blockchain technology. As a data sharing technology, blockchain has attracted attention in many different applications. Using blockchain technology in transactions can greatly improve the transparency and robustness of transaction processing. Blockchain is an open-source platform based on the principle of cryptography. It has the advantages of security, transparency, decentralization, intelligent contract and traceability, and provides new development ideas for traditional industries. It is necessary to use a large number and a wide range of documents in the shipping process, and the shipping documents widely used in China mainly include two forms: paper documents and EDI documents. The traditional paper bill of lading has the disadvantages of being difficult to preserve, easy to forge, and low efficiency. It adopts the safe and reliable characteristics of blockchain and intelligent contracts, and ensures the consistency of dispersed book content through transaction signature and consensus mechanism. It provides shipping enterprises with fast, safe and reliable digital equivalent products to replace the traditional paper bill of lading. The combination of block chain technology and shipping documents has important practical significance for the development of shipping enterprises.

2. Risk and efficiency analysis of current shipping documents circulation

From shipper (consignor), consignor, shipper, shipper, bank, carrier (shipping company) to consignee, bill of lading is the most important document in the whole shipping process. Bill of lading performs three duties in this process: evidence of the contract of carriage, receipt of goods, and certificate of ownership of goods. Generally speaking, whoever owns the bill of lading controls the goods. According to relevant data, there are a large number of trade transactions violations each year, involving bill of lading fraud, the use of bill of lading brings risks.
2.1. Risk analysis of shipping documents circulation

2.1.1. Circulation risks caused by reverse signing and advance borrowing of bill of lading
In international shipping, bill of lading is to prove that the carrier has taken over the goods and shipped goods receipt. However, in practice, such a situation often occurs. The ship will be unable to load at the port of shipment at the specified time due to the delay in the shipment period, or the ship has arrived at the port of shipment. However, due to the lack of ready goods, it is impossible to carry out loading and unloading operations, which will lead to the failure of the carrier to issue a bill of lading. In order to meet the requirements of the letter of credit settlement date, the shipper often requests the carrier to issue the bill of lading first. In this way, the shipping date indicated on the bill of lading will be earlier than the actual date. This reverse bill of lading behavior, will cover up the real situation of cargo shipment, belongs to the bill of lading fraud.

2.1.2. Transfer Risk Caused by Moral Quality Problems
Due to the trading process of international shipping trade, there are few opportunities for buyers and sellers to meet offline, and the exchange of documents will run through many links such as stockpiling, shipment and payment of deposit. When some unscrupulous businessmen in the interests of the drive, do not restrict their own behavior, trying to through the bill of lading fraud way to make unjust enrichment, it is easy to succeed. Secondly, the shipping personnel in developing countries have limited business ability and lack of professional knowledge and literacy. In the face of bill of lading fraud, they are often unable to distinguish in a timely manner. When obtaining documents from the bank, they will be vigilant about the subsequent trade activities, which will cause the loss of the interests of the owner.

2.1.3. Transfer Risk Caused by Bill of Lading Loss
In the process of transportation of goods, if the bill of lading is lost, there will be a risk of fraud in the bill of lading, including the use of the bill of lading to extract goods and even the reverse sale of the goods extracted. When the bill of lading is lost in the express delivery process, it will cause the consignee to be unable to extract the goods at the destination port, and the carrier is required to sign the new bill of lading. New documents are often produced for a longer period of time, less than five or six days and more than one month before they can be reprocessed, the process is lengthy and complex, and the issuance and transportation of a paper bill of lading will result in higher costs.

2.1.4. Circulation risk of information sharing difficulty
The whole process of document circulation involves the participation of multiple subjects. In the process of business connection, the information cannot be shared due to the differences of each subject system, which will bring network security risks and unpredictable data risks to the system.

2.2. Analysis on Circulation Efficiency of Shipping Documents
By using the comparative analysis method, the performance of each mode is analyzed by comparing the three modes of traditional paper documents, electronic documents and document circulation under block chain.

From the comparison table, we can see that the document circulation based on blockchain has advantages in terms of regulatory methods and capital investment. With the help of blockchain platform, documents can be transferred as far as possible in the maximum range. In the field of global shipping management, it can achieve a qualitative leap in document management.
Table 1. Comparison of traditional paper documents, electronic documents and blockchain documents.

|                        | Traditional paper documents | Electronic documents | Blockchain documents |
|------------------------|-----------------------------|----------------------|---------------------|
| Safety                 | Information may be tampered with | Fault problem | Transaction information cannot be tampered with |
| Supervision mode       | Sign a contract, consciously abide by | Shipping enterprise personnel remote supervision | Joint supervision of the whole network nodes |
| Transfer time          | A lot of time wasted | EDI data processing, short transfer time | Using P2P networks to disseminate information takes very short time |
| Circulation efficiency | Low transfer efficiency | Transmission between different systems is inefficient | Real-time data sharing with high efficiency |

3. Construction of Shipping Document Circulation System Based on Alliance Block Chain

Based on Fisco Bcos, the underlying platform of the alliance chain, this paper aims at the problems of low efficiency of traditional shipping documents circulation, bill of lading fraud and difficult information sharing. Through digital electronic encryption, digital certificates are issued to eligible participants, so that they can join the block chain sharing network to upload data information and realize whole process supervision and traceability. The main tasks of documents under block-chain in the transaction process include creating / publishing documents information, verifying data transaction rights, querying documents transaction, and implementing intelligent contracts.

Blockchain is divided into public chain, alliance chain and private chain. Generally, blockchain refers to public chain, which is completely decentralized, and nodes can freely join and view any information on the chain. Alliance chain is partially decentralized, allowing only authorized nodes to join, generally used in an industry between some agencies or companies. Private chain is commonly used in internal work management, similar to a database, does not apply to shipping documents circulation. In the field of shipping documents, alliance chain is better than public chain. Since any node in the public chain can join or leave the network without restriction, privacy cannot be guaranteed for situations involving business secrets. Alliance chain has access system, only join the participants of the alliance, will be distributed to the private key.

Table 2. Three blockchain performance comparison.

| Blockchain options | Influencing factors |
|--------------------|---------------------|
|                    | Basic attribute | cost | flexibility |
| Public chain       | ✥ ✥ ✥             | ✥   | ✥            |


3.1. The role of alliance blockchain in the circulation of shipping documents

3.1.1. The role of intelligent contract
Intelligent contract is a computerized trading protocol, which executes the terms of a contract. Trusted transactions are permitted without third parties, which are traceable and irreversible. Each blockchain node can have one or more smart contracts to ensure that transactions operate in accordance with the rules specified in the contracts, in a prescribed manner to access and manipulate data in the blockchain. Intelligent contract can solve the problem of low efficiency in the circulation of shipping documents. The process of shipping documents circulation is complex. It will cost a lot of manpower and material resources by mailing bills of lading. Intelligent contracts have the function of automatic execution. When there is a transaction to meet the preset contract conditions, new blocks will be generated and the data will be stored in the chain. Therefore, intelligent contracts can realize electronic bill of lading without printing and mailing, timely transfer to banks and consignees, and automatically check transaction data bills, which greatly improves the transportation efficiency of shipping trade.

3.1.2. The function of distributed books
Distributed ledger is a data storage technology, which is a distributed database with the function of reading and writing data. No one has privileges and ensures equal status of the participants. Through distributed records and preservation, once someone tampers with the historical records, they can be found immediately, so that the input data is reliable.

Each transaction data of the blockchain system will be stored in the node for evidence collection. Through the electronic signature technology, the process of bill of lading circulation and receipt will be recorded 3, and there is no need to worry about the loss and leakage of bill of lading leading to the reissue of bill of lading, which reduces the waiting time and greatly improves the efficiency of document circulation.

3.1.3. The role of consensus mechanism
The consensus mechanism enables all distributed nodes in the centralized system to reach a consensus that the transactions of any two nodes on the network are notified to all other nodes on the network and updated and validated on all other nodes. Blockchain is based on consensus algorithm to ensure that the database books of each participant and related party on the network can maintain the consistency of stored data and transaction data when accounting.

Consensus mechanism can solve the problem of information privacy protection in centralized platform. The traceability of alliance block chain is used to ensure the authenticity of information and avoid network security risks. Secondly, the records of document circulation are maintained by multiple participants. To modify a transaction information, it is necessary to modify the information of the block and all subsequent blocks, so as to achieve high transparency of information. Moreover, the alliance block chain can be traced back to the historical transaction records of the participants, which will greatly reduce the occurrence of bill of lading fraud and indirectly improve the overall quality of industry practitioners.

3.2. Architecture Design of Shipping Document Circulation System Based on Alliance Block Chain
The framework of shipping document circulation system based on alliance blockchain includes application layer, interface layer, service layer, core layer and basic layer. In the process of shipping document circulation, carriers, shippers, consignees, customs, financial institutions, freight agents and other parties participate in the process of shipping document circulation to realize the information
sharing of bill of lading application, bill of lading forwarding and bill of lading transaction. The smart contract framework details are as follows:

![Smart contract framework diagram]

(1) Base layer: The base layer is at the bottom of the entire architecture and is mainly used to provide blockchain algorithm libraries and basic data structures. The algorithm library includes cryptography algorithm and privacy algorithm. The basic data structure includes database-driven and virtualization technology. The database mainly stores the transaction data of each supplier in the alliance chain during shipping transactions and ensures its unchangeability and traceability, while ensuring the privacy of participating enterprise information.

(2) Core layer: the core logic of blockchain is realized, including intelligent contract, consensus mechanism, P2P network, blockchain management and other functions. The core layer is responsible for writing the block data, block information, system tables and block execution results of the group into the underlying database. At the same time, the core layer will also manage the blockchain network, including the member management function to verify and authorize the membership in the network. Contract management functions are responsible for the installation, deployment, update and destruction of contracts. Channel management function is responsible for managing the join and exit of nodes and the creation and closing of execution channels.

(3) Service layer: As the middle zone of the core layer and interface layer, through the interaction between RPC interface and interface layer, the operation instructions such as modification, acquisition, new construction and deletion are identified, and then the Node SDK is used to interact with the block chain network of the service layer, and the instructions of the application layer are fed back to the block chain network of the service layer to perform, so as to realize the generation and circulation of bills of lading, query bills of lading, trace goods information, inventory query and other functions.

(4) Interface layer: for blockchain users, RPC interfaces, SDKs and interactive consoles with multiple protocols are provided to enable blockchain to adapt to various application scenarios. The interface layer includes three modules: transaction pool, block chain and block actuator. The transaction pool module interacts with the application and service layers to store transactions broadcast by clients or other nodes. Blockchain module mainly interacts with the core layer, query the specified block through the block link port, and submit the block. Block actuator module executes the blocks from the application layer.
4. Conclusion and Discussion

As one of the main transportation modes of China's transportation industry, maritime transport has complex processes and various documents. In theory, with the help of blockchain, the whole process of documents can be open and transparent in terms of information sharing and traceability, and the paper cost can be reduced. However, China's transportation industry is huge, relying solely on one or two industry giants to adopt blockchain is not enough to promote the landing of the whole blockchain industry. How to make the public accept and recognize blockchain has become an urgent problem.

4.1. The government introduces incentive policies

Therefore, the government can consider intervening in the field of blockchain innovation, introduce incentive policies, and provide innovative soil for small and medium-sized enterprises. At the same time, the government should cooperate with the international judicial department to jointly build a global regulatory justice system, safeguard the interests of participants, and facilitate the active participation of the industry.

4.2. The Government creates a fair and orderly market environment

Digital shipping is the current trend of the development of the shipping industry. The government should crack down on unfair competition and avoid restricting the chain of small companies due to resource monopoly. At the same time, customs ports should provide digital interfaces for shipping enterprises so that enterprises can overcome the obstacles and find their own future development space.

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