Strategies and Challenges of Shipping Supply Chain Operating System under Blockchain Technology

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Abstract. The breakthrough and wide application of cutting-edge technologies such as 5G, cloud computing and blockchain have provided a technical basis for the digital and intelligent transformation of the shipping supply chain. The epidemic environment also puts forward higher requirements for the stability and resilience of the supply chain, so it is also an urgent need to rely on digital and intelligent technology to build and improve the operation system of the shipping supply chain. Based on the analysis of the current situation, this study will consider how the blockchain technology can be better applied to the supply chain operation system with container shipping as the core, and find the defects and possible challenges in practical application. That is to study the strategies and challenges of shipping supply chain operation system under blockchain technology. The study found that by improving the integration of blockchain technology and the shipping industry, it is entirely possible to fully integrate logistics, capital flow and information flow of the shipping supply chain with blockchain and create an intelligent and reliable ecological network of shipping supply chains. At this time, a more complete shipping supply chain operation system under the blockchain technology will also be constructed. However, there are not enough complete typical cases to support the integrated design of this study. Therefore, the supply chain system may have defects and some challenges. It is not difficult to future research directions from these challenges, and future research prospects will also be pointed out.

Keywords: Blockchain, shipping management, digital supply chain, port and shipping logistics, operation system.

1. Introduction

The breakthroughs and extended applications of a range of state-of-the-art technologies, such as 5G, cloud computing and blockchain, have provided the technical foundation for the digital intelligent transformation of the shipping supply chain. The epidemic environment also imposes greater demands on the stability and resiliency of the supply chain [1]. Therefore, it has become an urgent need to rely on mature digital intelligent technology to build and improve the shipping supply chain operating system. Relevant cutting-edge literature introduces some recent works of scholars on supply chain optimization under the background of digitalization and highlights existing issues in applying blockchain technology in the shipping industry, such as the lack of management system in the industry. To solve the problem of pain points in more specific shipping business scenarios, the application expansion of blockchain in the shipping industry can refer to other industries [2].

According to the analysis of the current situation, the current research results are still far from realizing the demand for a globalized and digitalized supply chain service system. We know that we still need to solve the problem of how emerging technologies such as blockchain can be better applied to the traditional shipping industry, and this study will consider how blockchain technology can be better applied to the supply chain operating system with container shipping as the core. Specifically, our research content is the strategy and challenge of shipping supply chain operating systems under block-chain technology. On the basis of previous studies, we expect to further optimize shipping supply chain solutions through case analogy analysis. The rest of this article consists of three sections. In Section 2, the background of this research is introduced in detail, including the academic

background of relevant kinds of literature written by previous scholars. Section 3 will use the method of case analysis to study the construction and optimization of the shipping supply chain system by the existing demand blockchain technology, and briefly state the possible defects and challenges of the supply chain system. Section 4 summarizes the conclusion of this study and the prospect of future research.

1.1. Background

The breakthroughs and extended applications of a range of state-of-the-art technologies, such as 5G, cloud computing and blockchain, have provided the technical foundation for the digital intelligent transformation of the shipping supply chain [1]. The information transmission process of each link of shipping logistics is long and complicated, and the phenomenon of high cost and risk of the traditional shipping industry is also increasingly prominent [3]. Therefore, it has become urgent to rely on advanced technology to build and improve the shipping supply chain system. Among them, blockchain technology has been widely valued by the international shipping industry because of its unique advantages and characteristics. At present, although some shipping companies and enterprises have begun to combine blockchain with traditional shipping and make scattered attempts, the integration of the two is not high. It is still urgent to build a shipping supply chain operating system that fully integrates logistics, capital flow and information flow with blockchain [4].

1.2. Literature review

Yan et al. analyzed the application status and development prospect of blockchain technology in the shipping industry in the process of digitalization, introduced the content structure of blockchain and made use of its technical features such as permanent storage, openness and transparency, which can be applied to solve the low-efficiency problem caused by weak information interoperability in the shipping supply chain. It summarizes the development problems and obstacles to the application of blockchain technology in the shipping industry. There are problems to ensure the security of the consensus system, the management system has not been formed in the industry, and the corresponding laws and regulations are lacking. Future research directions are pointed out according to the problems and challenges. Pain points should be solved in more specific shipping business scenarios on the basis of more objective and practical data. The application and expansion of blockchain in shipping industry can refer to other industries and put forward constructive suggestions to assist the application process of blockchain technology in shipping industry [5].

Shi et al. analyzed that the challenges facing the global container shipping market put forward the optimization requirements for the container shipping model, and blockchain was considered to be one of the factors to accelerate the shipping informatization and change the status quo of the industry. They proposed the optimization of the existing container blockchain application model, the construction of the cargo traceability system supported by blockchain technology, and the paperless bill of lading to improve the security and privacy. Optimization of supply chain structure, smart contracts accelerate the transparency and flow of trade information [6].

At present, scholars are still in the preliminary stage of exploration in this research field. Based on the open and transparent technical characteristics of blockchain, they can correct the problem of traditional shipping mode and play a promoting role in the construction of a new intelligent system of shipping numbers.

2. Case study

A flower's Trade Journey is a blockchain project previously announced by IBM. Kenya is a flower producer and the Netherlands has the world's largest flower market. When a flower is exported from Kenya to Europe, the supply chain is complicated. From planting flowers to exporting them, flower farmers and exporters first have to borrow money from banks, go through inspection and quarantine before exporting them, and then pass through local customs. During the process, the flowers go

through a logistics company to the Kenyan port of Mombasa. After the containers were loaded on board at the port, Maersk's giant ship with tons of flowers left Mombasa port and arrived at Rotterdam Port in the Netherlands after about 20 days at sea. Once ashore, the same process that took place in Kenya was repeated in the Netherlands [7].

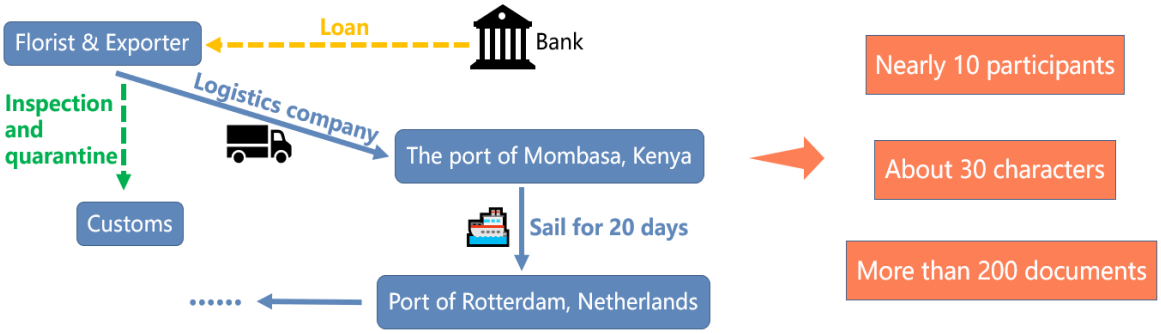


Figure 1. Kenyan flowers are exported to the Netherlands

According to the follow-up research completed by a doctoral scholar, in this case of a transnational supply chain, there are nearly 10 parties involved, about 30 participants, including more than 200 documents or documents, and inefficient and repetitive labor is inevitable. The flow of documents and flowers constitutes logistics and information flow. Because it involves bank loan financing and capital flows, the whole trade process is essential "three flows into one" [7].

In general, the entire supply chain process cycle is long, with many connections and little transparency. For example, when goods arrive at a storage company, the owner may find it impossible to track them because the company's "internal data is not public". At the same time, participants have absolute control over their data, and the risk of data omission or tampering is high. The operation habits of the shipping trade are relatively fixed, and many links still need manual operation. Taking the land transportation terminal as an example, the number of shipments will be checked during warehouse delivery, and the storage and transportation enterprises need to arrange personnel to confirm the shipment date again and inform the customers [7].

Maersk and IBM's blockchain is designed to address these issues: Since data is instantaneously entered into the blockchain, the data of each participant can be shared simultaneously, eliminating a lot of repetitive entry work. What's more, whether it's the florist, trader, or the customs, commodity inspection and the bank, can always grasp the movement of the goods. In this process, based on the natural trust of the participants, the upstream and downstream parties can jointly maintain and update the same shared database ledger, which not only ensures content synchronization but also ensures privacy and non-tampering [7].

2.1. System

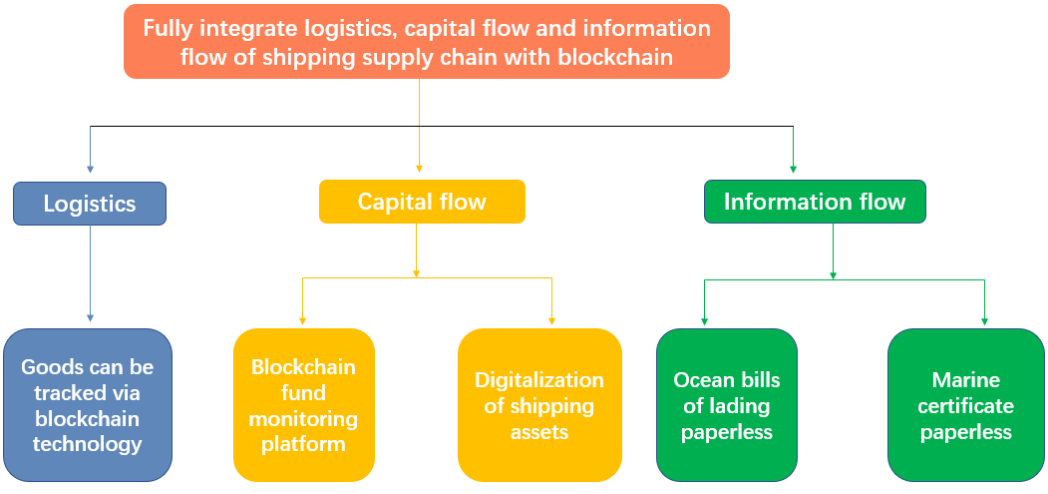


Figure 2. Shipping supply chain operating system under block-chain technology

Although China's traditional shipping industry has grown rapidly in recent years, there are still some problems that have not been solved, such as the lengthy and complicated information transfer process of the various links of shipping logistics, the high cost and risk of the traditional shipping industry, low efficiency, information leakage and so on, leading to the lack of full use of resources [3]. By relying on block-chain technology, logistics, capital flow and information flow can be truly and reliably recorded and transmitted. The shipping supply chain uses the blockchain platform to optimize resource utilization, compress intermediate links and improve the overall efficiency of the industry.

2.1.1. Logistics

Use blockchain technology to realize the supervision and tracking of goods, and build a goods traceability system based on blockchain technology [6].

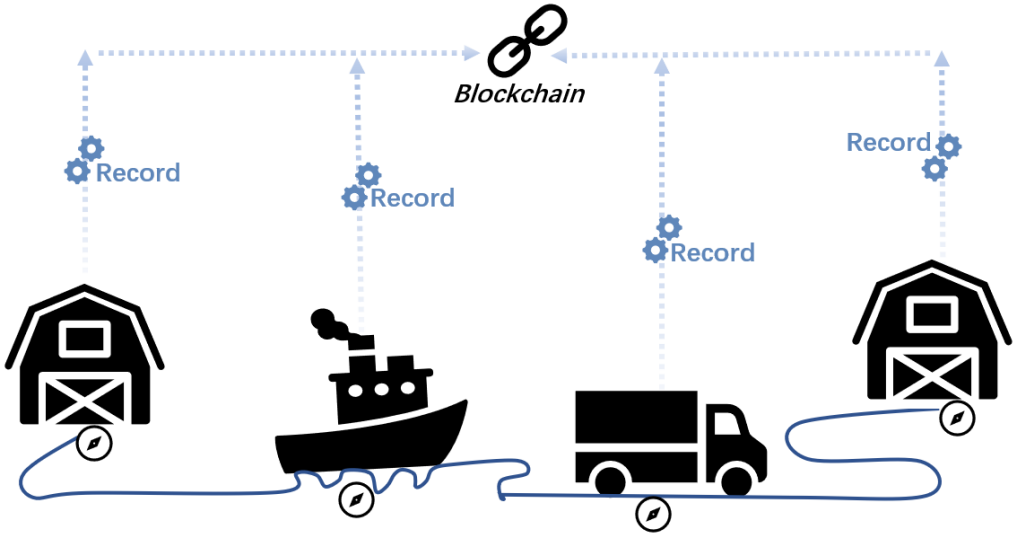


Figure 3. A cargo traceability system based on blockchain technology

The transportation process of goods can be clearly recorded on the chain, and the whole process from loading, and transportation to picking up goods can be clearly seen, so as to optimize the utilization of resources, compress the intermediate links, and improve overall efficiency [8]. All steps in the process of goods from sending to receiving are recorded through the blockchain, which ensures the traceability of information, so as to avoid the occurrence of packet loss and false claim events. As for goods transportation, we only need to check the blockchain, which will prevent people with ulterior motives from forging and claiming goods and also promote the implementation of a real-name logistics system. Moreover, enterprises can also master the logistics direction of products through block-chain to prevent the transshipment of goods, which is conducive to the fight against counterfeiting and guaranteeing the interests of offline dealers at all levels [6].

2.1.2. Capital flow

Blockchain technology is applied to realize the supervision and tracking of funds, and each participant in capital flow forms a blockchain network in the form of an alliance chain [6].

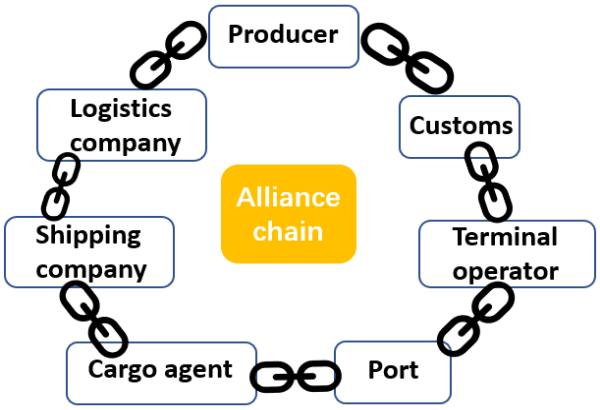


Figure 4. Alliance chain

In the process of capital transfer, there are many parties involved, which leads to low efficiency of capital transfer and opaque information [8]. Especially for regulators, the supervision cost for the actual situation of the underlying capital link is high, the audit efficiency is low, and the phenomenon of material fraud is easy to occur. The blockchain fund monitoring platform forms a controllable closed-loop for all participants through the alliance chain, and uses the immutable, traceable and open and transparent characteristics of blockchain to link core information such as prior information consensus, in-process fund transfer and post effect management, so as to realize comprehensive monitoring of approval flow, capital flow and information flow. Building a block-chain fund supervision platform with "transparent fund supervision, efficient fund flow and unified fund audit", greatly improve the cost of data fraud, reduce the cost of manual supervision, and realize efficient fund flow to speed up the speed of fund operation [6].

2.1.3. Information flow

The use of blockchain technology to eliminate poor information, paperless information transmission safe and reliable [6].

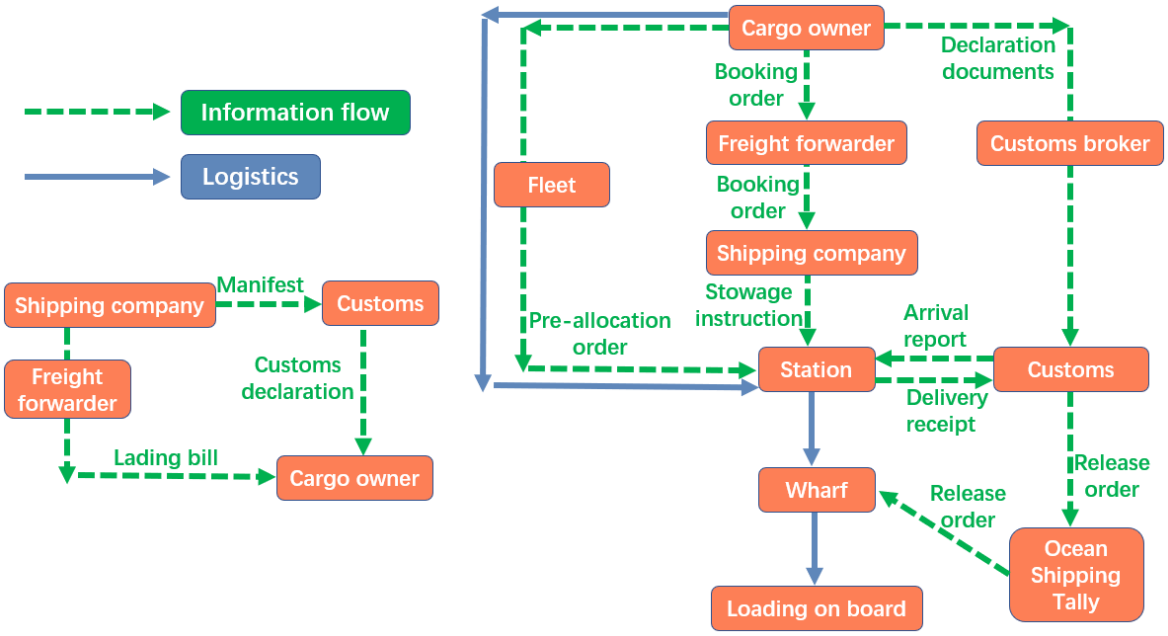


Figure 5. Marine export process

First, blockchain technology makes shipping bills of lading paperless [6]. In import and export trade, there is a large amount of supply chain information around the bill of lading, including a series of information such as trade, customs inspection, transportation and logistics, as well as dozens of business documents, involving a series of principal roles such as sales, procurement, traders, carriers, port departments, ports and warehousing. Currently, GSBN, a global maritime transportation network

established by CargoSmart, and TradeLens, a platform led by Maersk and IBM, both focus on electronic load declaration. Such application has obvious value, such as reducing the circulation cost of paper documents, speeding up the bill of lading transfer, facilitating the development of financial services including the promise of bills of lading, enhancing supply chain transparency and reducing the risk of concealment [9].

Second, blockchain technology makes shipping certificates paperless [6]. In the context of global maritime trade, ship's certificate, crew's certificate, cargo certificate and other documents often need to be inspected by ports of various countries. Take port state inspection, for instance. Ships of various countries sailing on international routes need to transport a large number of paper certificates as well as vessels for inspecting governments of different countries, including the nationality certificate of the ships, international tonnage certificate, international load line exemption certificate, minimum safety manning certificate, crew certificate, health certificate, etc. A large number of paper certificates not only put forward the requirements and burden of carrying and keeping the certificates on the operating ships but also put forward the requirements of the governments to carry out the inspection on board the ship to check the originals, which makes the human cost of law enforcement remain high. If a co-operative platform for e-certificates can be developed on the basis of blockchain technology, and the electronic certificate maintained by the platform is acknowledged by the signing of the agreement as having the same legal effect as the original paper certificate, and the electronic certificate can be used in the inspection process itself to put an end to the current state of affairs [9].

2.1.4. Three streams

Blockchain technology opens up the logistics, capital flow and information flow, integrating the originally relatively independent three streams into one [4]. With the integration of the three streams, blockchain technology can build an intelligent and trusted ecological network of shipping supply chains, realize mutual recognition of supervision, mutual trust in law enforcement, and deal with fraud and deception [8].

The issue of mutual recognition of surveillance and mutual confidence in the application of the law can be seen at two levels. One level is how to recognize and trust each other between multiple government functional departments. For instance, the Marine Authority has information on vessel registration and the Marine Transportation Office has information on port operations. Both parties are authoritative information centers in their respective domains, but during each other's call for information, chain block can be used to ensure trust. On the other hand, the problem of mutual trust in law enforcement between governments from different countries without subordination is also prominent. If an attempt is made to establish A blockchain network to link the law enforcement of Country A's random inspection, supervision, punishment and other matters handled in accordance with the law, the regulators in country B can timely share and recognize such law enforcement behavior, judgment or random inspection results, even if A and B do not belong to each other. In this manner, if someone conceals the goods sent from Europe to China, the European port authorities or customs authorities can take into account the conclusion of the law enforcement inspection made by relevant Chinese authorities and punish the consignor who conceals the goods in Europe, and vice versa. Similarly, companies can use blockchain to realize mutual recognition and trust. For example, in shipping finance and insurance business, risk control, operation and other aspects will affect the efficiency and business model of the insurance business. If insurance claims are placed in an unchangeable blockchain environment, it will help eliminate fraud [9].

2.2. Challenges

Although it is not difficult to reach the purpose of this study by deducing the views and conclusions mentioned in the previous literature. But that doesn't mean the study wasn't flawed. At present, although blockchain technology has been proven in various scenarios, it can minimize the participation of intermediate links, reduce costs while ensuring the efficiency and transparency of the process, and improve the security of data. However, there are not enough complete typical cases to support the idea of this study, so the supply chain system may have defects and some challenges.

2.2.1. Large resistance to system reform

In terms of international logistics, the traditional shipping industry composed of inland waterway shipping and ocean shipping accounts for 80% of the international logistics market. The characteristics of low transportation costs and huge transportation volume make it have an absolutely huge volume in development over the years. In terms of the world economy, the capital injection density of the shipping industry is high, and its transportation services have made significant contributions to the country's foreign trade, which is an important guarantee for promoting the evolution of international trade. But at the same time, due to its huge size, high investment cost, and long payback period [5], the efficiency of responding to changes in information construction is low, and the process of digital intelligence lags behind [10].

2.2.2. Difficult to establish the regulatory system

The blockchain emphasizes that each node operates equally under decentralization. Traditional shipping itself is an industry with obvious centralization characteristics [5], and the Maritime Safety Administration and the International Maritime Organization are the core of its industry model operation. The trend of decentralization will affect its ability in maritime supervision, ship supervision, navigation management and unification of laws [10].

2.2.3. Risks of transaction disclosure

As the guarantee and basis for smart contract generation, blockchain has the characteristics of being non-tamperable, irreversible and non-forgeable. But all this is based on stable nodes, normal operation and no loss of secret keys [5]. If there is a risk attack, the smart contract representing a huge amount of digital assets will become a breakthrough for malicious attackers, and at the same time, the loss caused by all shipping parties will be irreversible due to irreversibility. With the development of new computer technology, the loopholes in its encryption algorithm technology may be further expanded in the future, thereby exacerbating the risk of blockchain [10].

3. Conclusion

By collecting and sorting out relevant pieces of literature on the application status and development prospects of blockchain technology in the shipping industry at the academic frontier and combining with the background, this study aims to improve the integration degree of blockchain technology and the shipping industry, and fully integrate logistics, capital flow and information flow of the shipping supply chain by using blockchain. On the logistics side, goods can be tracked via blockchain technology. In terms of capital flow, it supervises capital flow through the alliance chain. As for information flow, it is paperless to eliminate poor information. Finally, blockchain technology can realize the integration of logistics, capital flow and information flow, and create an intelligent and reliable ecological network of shipping supply chains. A more complete shipping supply chain operating system based on blockchain technology has also been built. At present, although blockchain technology has proved the feasibility of the above strategies in various scenarios, there are not enough complete typical cases to support the integrated design of this study. Therefore, there may be defects and some challenges in the supply chain system, such as irreversible losses caused by malicious attacks on immutable blockchain networks, difficult supervision due to the characteristics of decentralization, and great resistance to reform due to the sheer size of the shipping industry. From the challenges encountered in this study, it is not difficult to find some future research directions. This study believes that future research directions should tend to be integrated. At present, there is a lack of operational system cases formed by integrating various technologies. Therefore, it is hoped that future research should focus on the connection between various technology platforms and tend to be integrated on the basis of specific blockchain technology to solve a problem. At the same time, the future research direction should pay more attention to case support, seek more practical objective data in more specific shipping business scenarios, specifically present technical cases that can reflect the characteristics of the local shipping industry under different business models, seek more objective

and practical data support in the process of research, and constantly seek to integrate cases and put forward targeted opinions. Promote the intelligent transformation of the shipping supply chain. After overcoming all difficulties, the vision of building and improving the shipping supply chain operating system under blockchain technology will also be realized.

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