



Transparency Enhancement and Trust Mechanism Construction of Global Supply Chain Based on Blockchain Technology

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Abstract

With the development of the global economy and the continuous expansion of supply chain scale, supply chain management has become increasingly important. However, the traditional supply chain management model faces challenges such as information asymmetry, difficulty in tracing, and low efficiency. Therefore, the emergence of blockchain technology has introduced new solutions for supply chain management. This article will delve into the application of blockchain technology in supply chain management and analyze its enhancements in transparency and efficiency. After providing an overview of blockchain technology, the article will examine the key issues in supply chain management, including asymmetric information, lack of transparency, and inefficiency. It will propose strategies for implementing blockchain technology in supply chain management to improve global supply chain transparency and outline a trust mechanism based on blockchain to advance the adoption of this technology in supply chain management.

Keywords

Blockchain; Supply chain; Trust mechanism; Information symmetry

1. Introduction

In recent years, the scale of China's cross-border consumer groups has grown rapidly, and their income, brand awareness, and quality requirements have been significantly improved, in this context, blockchain technology with its decentralization, is not easy to tamper, timing, anti-counterfeiting traceability, security and programmable characteristics, attracted the attention of our government departments and the industry [1]. The integration of blockchain and e-commerce will help solve problems such as security, information asymmetry, product information traceability, and anti-counterfeiting issues, achieve real-time tracking records of goods, reduce trust-building costs and transaction costs, and promote consumers to make consumption decisions, thus bringing fundamental changes to the Internet economy. With the increase of attention, scholars at home and abroad have begun to explore the application of blockchain technology in e-commerce. Richard Dennis applied blockchain technology to the peer-to-peer merchant reputation evaluation system of e-commerce, ensuring the authenticity and traceability of evaluation information. Alexander Schaub proposes a truly decentralized reputation system for privacy protection based on blockchain [2]. Zhang Yanbin (2017) realized that blockchain technology will bring about important changes to e-commerce and even the Internet economy, and can solve the problems of information opacity and lack of information sharing between internal chains in e-commerce enterprises, so he proposed innovative e-commerce solutions and models applying blockchain technology [3]. Chouhan V built a China-Europe cross-border e-commerce ecosystem based on blockchain

technology, which can effectively promote the smooth development of cross-border e-commerce [4]. Throughout the existing research, there are few research results on the integration of blockchain technology, supply chain transparency, and trust mechanisms, and this paper will try to conduct exploratory research. Improving supply chain transparency and building trust mechanisms based on blockchain technology characteristics can provide a valuable reference for the development of cross-border e-commerce.

2. Blockchain technology overview

Blockchain technology is an emerging technology based on cryptography and decentralization, and its working principle can be simply described as storing data in segments among numerous participating nodes and ensuring the security and accuracy of the data through consensus algorithms [5]. One of the characteristics of blockchain is decentralization, where data is not controlled by a single institution or individual but is verified and recorded by multiple nodes on the network. This feature ensures that the blockchain is distributed and cannot be broken by a single point of failure. In addition, the blockchain uses cryptographic algorithms to encrypt the data, so that the data can only be decrypted through the corresponding private key, ensuring the security of the data. The immutability of blockchain technology is one of its most distinctive features. Once the data is recorded on the blockchain, it cannot be deleted or modified, ensuring the integrity and authenticity of the data [6]. This is because each block in the blockchain contains the hash value of the previous block, linking these hash values together to form a chain, so any tampering with the previous block will result in inconsistencies in the data of subsequent blocks, which will be rejected by other nodes. This immutable nature makes blockchain a cornerstone of trust and can solve the problems of asymmetric information, low transparency, and data tampering that exist in traditional supply chain management.

3. Main problems of supply chain management

There are many problems and challenges in traditional supply chain management, which bring a series of risks and uncertainties to enterprises and consumers.

3.1 Information asymmetry

The first is the problem of information asymmetry. Each link in the supply chain often has a different understanding of information, resulting in poor information flow and inaccurate information. For example, it is difficult to share information among suppliers, manufacturers, and retailers, resulting in information faults among nodes of the supply chain, which may lead to some risks, such as too much or too little inventory, product quality problems, etc.

3.2 Low transparency of supply chain

The problem with low transparency of the supply chain is that it is often difficult for consumers to obtain the full life cycle information of the product, and they cannot understand the source, manufacturing process, and transportation of the product. This creates doubts and mistrust among consumers and hinders the normal operation of the supply chain. In addition, there is a risk of data tampering in the supply chain, and the flow of data between thousands of suppliers, producers, and retailers is complex and large, and it is inevitable that bad actors will exploit this vulnerability for data tampering. Data tampering may lead to untrue information in all links of the supply chain, thus affecting product quality and consumer rights and interests [7].

3.3 Low efficiency of supply chain management

In the traditional supply chain management model, product traceability is very difficult. In the entire supply chain, each enterprise may be involved in the processing, packaging, transportation, and other links of the product, resulting in the source and destination of the product is unclear. In this case, once there are quality problems or safety risks, it is difficult to trace the responsibility of the product. In the traditional supply chain management model, information exchange and coordination usually need to be carried out manually, which is inefficient and prone to errors. At the same time, due to the large number of enterprises in the whole supply chain, it is very difficult to collect, integrate and analyze information, resulting in low efficiency of supply chain management.

4. Apply blockchain technology to improve supply chain transparency

4.1 Transparency of supply chain information sharing

First, blockchain technology can achieve the sharing and transparency of supply chain information, thereby reducing the problem of information asymmetry. Through the use of distributed ledgers and smart contracts, various participants in the supply chain can share data in real time, ensuring that accurate information is available at every step. For example, suppliers can share order information, inventory information, and logistics information with producers and retailers to better adjust capacity and inventory and provide more accurate delivery dates.

4.2 Logistics traceability verification

Second, blockchain technology can achieve traceability and verification of logistics. In traditional supply chain management, it is difficult for consumers to get the whole life cycle information of the product, and they do not know whether the source of the product is legal or whether the manufacturing process is standardized. The blockchain technology can record the operation and transaction of each link, and generate immutable blockchain data to ensure the traceability of the supply chain and the authenticity of the product. Consumers can scan the blockchain QR code on the product to obtain detailed information about the product, such as origin, production process, transportation process, etc., thus improving consumer trust in the product [8].

4.3 Improve contract management and payment verification

In addition, blockchain technology can also improve the process of contract management and payment verification. In traditional supply chain management, the performance and payment of contracts often face problems of trust and dispute. By recording contract contents and payment information on the blockchain, it is possible to ensure the enforceability of contracts and the authenticity of payments. Once the terms of a contract are agreed upon and recorded on the blockchain, none of the parties can tamper with them, thus reducing the occurrence of contractual disputes. The most important point is that blockchain technology has strong anti-fraud capabilities. Due to the decentralized and immutable nature of blockchain, fraud in the supply chain is difficult to occur.

For example, if a supplier intentionally provides false information or tampers with an order, other participants can verify its authenticity through the data in the blockchain, find the problem in time and take corresponding measures, thus ensuring the normal operation of the supply chain and the rights and interests of consumers. By applying blockchain technology to supply chain management, it can improve the transparency and anti-fraud capabilities of the supply chain, reduce problems such as information asymmetry and data tampering, and increase the operational efficiency and product quality of the supply chain. The introduction of blockchain technology will bring revolutionary changes to traditional supply chain management, bringing better experiences and guarantees to businesses and consumers.

4.4 Sharing data reduces supply chain management costs

First, the introduction of blockchain technology can improve the efficiency of supply chain management. Because blockchain technology realizes decentralization and distributed ledger, the various participants can share data in real time, avoiding the problems of information diversification and information asymmetry. In this way, the flow of information in the supply chain is smoother, and the obstacles of complicated communication links and data transmission are reduced, thus improving the efficiency of supply chain management. The application of "smart contract" technology also makes the process of contract management more efficient, and the automated execution of contract content reduces friction costs and disputes.

Secondly, the application of blockchain technology can reduce the cost of supply chain management. Traditional supply chain management consumes a lot of human and material resources, such as information collection and verification, contract execution, and payment verification. Blockchain technology reduces the waste of human and material resources through automation and digitalization, thus reducing the cost of supply chain management. At the same time, by improving the efficiency and transparency of the supply chain, additional costs due to information asymmetry and fraud can be reduced. In addition, the application of blockchain technology can also increase trust in supply chain management. Due to the immutability of blockchain and the characteristics of information sharing, the data and information in the supply chain have a high degree of credibility and authenticity. This credibility can help consumers more accurately understand the source, quality and manufacturing process of the product, and enhance

trust in the product. At the same time, blockchain technology can also ensure that all parties in the supply chain abide by the contract and pay on time through the process of contract management and payment verification, and increase the reliability and stability of supply chain management.

4.5 Digital Upgrade Exchange trusted data

The reason why blockchain is considered as a technology to enter the level of "production relations and governance" is very important because it has advantages such as traceability, easy tampering, data transparency, and natural participant incentive mechanism. In the continuous evolution of blockchain technology, the existing trust system will be optimized and reshaped, and the efficiency and benefits of industrial digitalization will continue to improve. Facing industrial digitalization, building a new digital trust system will become an important driving force to promote the digital transformation and upgrading of the industrial field and enable the development of the digital economy, and has important strategic significance for China's construction of a network power and a digital China. With the help of blockchain technology, between enterprises and enterprises, between government agencies and enterprises, it can be realized to build a special communication channel, integrate secure and trusted cryptography technology, and promote the "co-construction, co-governance, and sharing" of cross-subject data. At the same time, in the industrial alliance chain built based on blockchain technology, the regulatory department as a node on the chain, can make the whole industry chain process visible, real-time monitoring, and achieve efficient approval of administrative nodes, effectively solving the traditional industry chain process cumbersome, inefficient problems.

5. The path of building trust mechanism based on blockchain

5.1 Grasp blockchain technology

Cross-border e-commerce manufacturers should better grasp the development opportunities in the improvement of blockchain technology, actively apply blockchain technology, and solve the current problems in the dissemination of product quality, information traceability difficulties, and asymmetries. Consumer demand for cross-border goods has expanded from the pursuit of product quality and safety alone (such as milk powder and diapers) to diversified needs. Based on the blockchain, the establishment of an open and shared, immutable, traceable cross-border e-commerce consumer trust environment, so that consumers can get comprehensive, true, effective, timely information, make accurate and true subjective judgments on the quality of goods and services effects, can gradually improve consumer satisfaction, resulting in more frequent consumption and recommendation behavior. This provides strong support for manufacturers to plan enterprise internationalization strategy, enhance their credibility, build their own cross-border marketing platform, expand target consumer groups, and improve consumers' re-purchase intention and behavior.

5.2 Provide accurate and true data analysis results

Cross-border e-commerce platforms should apply blockchain technology as much as possible, provide accurate and real background big data analysis results, grasp the real needs of consumers, provide consumers with a variety of communication channels, attach importance to and encourage consumers to evaluate the real use and experience and deepen interactive exchanges and recommendations. At the same time, make full use of data encryption technology and perfect management measures to protect the confidentiality and security of consumers' personal privacy and personal information (such as credit card account number and password, ID card, etc.), prevent leakage, ensure the security of the transaction process, gain trust, and enhance consumers' trust in the e-commerce platform.

5.3 Distributed ledgers reduce risk

Because blockchain technology uses a distributed ledger, it can avoid the intermediary and cumbersome formalities in traditional centralized transactions and achieve fast and secure transactions. Improve the security and transparency of data, avoid data tampering and fraud in traditional transactions, and improve the security and credibility of data. Due to the decentralization and consensus mechanism of blockchain technology, it can avoid the trust problem in traditional transactions, establish a more reliable trust mechanism, reduce risks, promote the rapid development and innovation of the digital economy, promote industrial upgrading and transformation, and promote more efficient social governance. The unique advantages and characteristics of blockchain technology make it one of the key technologies for the development of the digital economy, which can effectively solve the problem of value transmission

in the digital world, promote the integration and innovation of industrial ecology, and achieve the underlying foundation of efficient governance of the digital economy.

5.4 Build a trust mechanism based on third-party payment

The trust mechanism of the electronic supply chain based on third-party payment is constructed. Third-party payment is not only a payment method, but also a trust mechanism. Due to the non-face-to-face nature of online transactions, the electronic supply chain needs to rely on a third party as a communication bridge between transaction entities to convey transaction information and transfer payment. It also analyzes the three major problems that any mechanism needs to solve in the electronic supply chain transaction: ensuring the transaction between transaction subjects, ensuring that the goods are sufficient and timely logistics delivery. In order to verify the effectiveness of the trust mechanism based on third-party payment, a two-stage complete information game model is constructed, and it is found that the two transaction parties reach Pareto optimality after joining the third party, that is, the trust mechanism based on third-party payment in the electronic supply chain has good performance.

5.5 Consensus mechanism opens up a new perspective on incentive distribution

In the public chain, the rules are written with smart contracts and are not easy to tamper with, which is called the consensus mechanism. Nodes can get the bookkeeping right through the consensus mechanism, and then synchronize the ledger to each node. The incentive mechanism and the consensus mechanism complement each other, and the nodes are encouraged to obey the consensus principle through the reward mechanism. In the alliance chain, the formulation of rules is discussed by the participants, and the participants can discuss with each other before the final decision, which is called the consensus game of nodes. After the rules are formulated, the smart contract is written into the chain, and more than 2/3 of the people agree that it can be modified (that is, the Byzantine algorithm). In view of the limited number of participating nodes, although there is still the possibility of multi-node joint fraud risk, the consensus game mechanism based on blockchain technology will bring about the reshaping of the pattern of each node in the industrial chain, and the organizational relationship between nodes will also undergo deconstruction and reconstruction.

6. Conclusion

In summary, blockchain technology is driving the development of the supply chain field in a more transparent, efficient, and secure direction. Increased transparency, enhanced traceability, and reduced risk enable supply chains to better address challenges and improve operational efficiency. In the future, with the continuous progress of technology and the accumulation of application experience, the application of blockchain in the supply chain will gradually expand, bringing more innovation to supply chain management.

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