Construction of the Supply Chain of Live Streaming E-commerce Based on Blockchain and Internet of Things

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Abstract. This paper aims to analyze the traditional business model of live streaming e-commerce platforms and propose a solution to build the supply chain of such platforms based on the technologies of blockchain and the internet of things. Combined with the systematic analysis of such problems, such as data fraud, information silo, lack of trust, difficulty in after-sales disputes, and supervision existing in the supply chain of live streaming e-commerce, the paper seeks to explain the mechanism of the solution with the help of technologies, like smart contracts, consensus mechanisms, and electronic certificates, characterized by their decentralization, unforgeability, non-real-name transactions, privacy protection, and to analyze specific operation process in terms of production, sales, transportation, and after-sales of the platform.

Keywords: Livestreaming E-commerce · Supply Chain · Block Chain · The Internet of Things

1 Introduction

1.1 New Stage of E-commerce – Live Streaming Marketing

Live streaming e-commerce, an e-commerce form of selling products through live streaming, emerges as a product that integrates live streaming marketing and traditional e-commerce and features a high conversion rate and interaction. Live streaming e-commerce has seen explosive growth since 2019. According to the 2020 Government Work Report released by the State Council at the National Two Sessions on May 22, 2020, emerging industries such as e-commerce, online shopping, online services have played a key role in fighting against the COVID 19, which enjoys new advantages of the digital economy. According to the data in the Statistical Report on China's Internet Development issued by the China Internet Network Information Center (CNNIC) in

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the first half of 2021, live streaming e-commerce has gained popularity among users. It has attracted 388 million shoppers, an increase of 123 million from March 2020, which accounts for 39.2% of the total netizens. And 66.2% of users have purchased products through live streaming. Due to its large user base, live streaming e-commerce has been widely accepted as a new way of consumption.

However, this new form of consumption also faces new problems. According to the Online Survey Report on Consumer's Satisfaction of Live streaming E-commerce released by the China Consumers Association in March 2020, 37.3% of the respondents encounter problems including publicity, merchandise, logistics, and after-sales. In terms of publicity, consumers who are worried about false information lack trust in anchors; in terms of product quality, shoppers may purchase unknown commodities and shoddy products; as for logistics, there are many unstable factors in the circulation of products; concerning after-sales service, consumers having difficulties in returning and replacing goods are dissatisfied with the way their complaints are handled. These problems have harmed consumers' rights and interests, thus influencing the sound development of the sector. Based on the existent problems hindering the development of live streaming e-commerce, the paper studies the combination of blockchain and the Internet of Things from the perspective of the supply chain of live streaming e-commerce, so as to build a supply chain system of live streaming e-commerce based on blockchain and IoT.

1.2 Business Models of Live Streaming E-commerce

Live streaming e-commerce includes three categories of models. The first category is the live streaming services under traditional e-commerce platforms like Taobao and JD.com; the second one is the content communities that allow access to the third-party shopping platform, such as Tiktok, Xiaohongshu; the last one is the emerging live streaming e-commerce platforms, with the development of the industry as their original aspiration, such as Youbo and Tuanbaopin. The business models of the live streaming e-commerce platforms are analyzed from the perspective of the supply chain. And the overall business process consists of four parts: suppliers, sellers, platform channels, and the demand side, as shown in Fig. 1 which respectively illustrates suppliers, e-commerce anchors for live streaming marketing or MCN institutions that cultivate and manage anchors, channels of interactive live streaming platforms and end consumers.

First of all, suppliers, as the beginning of the supply chain of live streaming e-commerce, offer goods for the entire supply chain, they include manufacturers and brands. In the live streaming e-commerce model, the supplier entrusts sellers to promote its products online by paying them commission while providing them with products with reasonable prices. Second, the midstream of the supply chain is composed of sellers and platform channels. Sellers play a key role in marketing in the supply chain of live streaming e-commerce, for they recommend products through live streaming; they will sell and market goods after they are entrusted by the upstream players. The platform channels act as the traffic portal to attract consumers and the interactive platforms for displaying products. The channels help to create and maintain an environment, formulate relevant rules and allocate traffic, cultivate users' new consumption habits, thus monetizing traffic. Finally, live streaming viewers, anchor fans, product consumers, and platform users have multiple identities as downstream demanders.

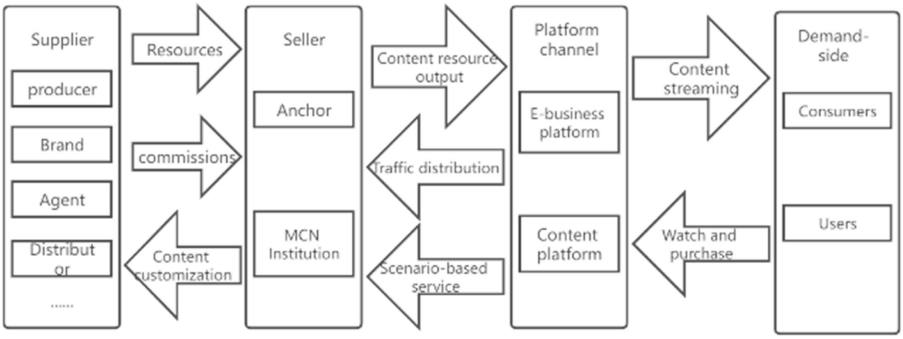

Fig. 1. Supply Chain of Live Streaming E-commerce

The business model of live streaming e-commerce has helped to address such difficulties as problems in the collaborative management of upstream and downstream businesses in the supply chain of traditional products, poor connections between supply and sales, inefficient capital flow, failure to meet market demands. As the supply chain has gone digital, efforts are made to support the supply chain in improving operational efficiency and optimization capability to sharpen competitiveness, which helps the e-commerce sector to break new ground. Its digital supply chain of products can comprehensively improve the efficiency of product design, production, operation, and sales, thus giving rise to the market-driven business model for products and promoting the online and offline development of the supply chain of the real economy collaboratively.

1.3 Problems Existing in the Supply Chain System

1.3.1 Data Fraud

The supply chain of live streaming e-commerce is composed of alliances or multiple entities, that is, enterprises; as the interests of each entity are relatively independent, and it is hard to guarantee whether a party in the supply chain provides true and reliable commodity information, any entity has potential speculative behavior [3] which is often manifested by fraudulent behaviors such as data fraud. According to the report by Red Star-News on May 25, 2021, false data of live streaming can now be bought with money, which makes the live streaming room seemingly popular. Besides, to promote the sales of commodities, some sellers do not hesitate to sell products by falsely labeling commodity information and exaggerating the sales of commodities, which not only leads to wrong decisions by the downstream players in the supply chain, affects the upstream players' choices of cooperative partners as well as their judgment of the reality, but also ultimately results in the loss of interests.

1.3.2 Information Silo

In the supply chain system, information exchange, data sharing, and information flow are required between upstream and downstream players. As this kind of demand will continue to arise between different entities, they need to adjust their configuration according

to the continuous changes in demand in order to meet new requirements by establishing smoother communication channels for each other. However, due to a large number of entities in the entire supply chain, their different development stages, and many steps to exchange information in the information flow, it is arduous to replace it. This leads to the imbalance in information between the supply and demand entities in the information transmission chain, information barriers among players in the supply chain, and problems such as distorted commodity information and wrong publicity.

1.3.3 Lack of Trust

The supply chain of live streaming e-commerce, as a model for partnership with enterprises, acts as an open organization as a whole. It is not restrained by organizations as well as upstream and downstream entities to make decisions by themselves, which fails to build mutual trust among players. At the same time, the lack of trust in the supply chain will have an impact on transaction efficiency and benefit distribution. For example, when consumers as the demand side fail to trust the marketing words of the seller, doubt the products provided by the supplier, and even worry about the issues of after-sales service and rights protection of the platform, they will be slow to place orders; when the supplier chooses a seller for cooperation, due to the failure to sign a contract in time or the lack of a standardized contract to clarify the rights and responsibilities of both parties, this will lead to a breach of contract, unclear rights and responsibilities in the process of cooperation, or a lack of trust generated by dishonest behavior of some entities when they perform their responsibilities and obligations. These problems hinder the stable and continuous operation and development of the supply chain of Live streaming e-commerce.

1.3.4 Difficulty in Safeguarding Rights in After-Sales Disputes

On March 17, 2021, the Rule of Law Daily reported a number of live streaming e-commerce incidents concerning consumer rights protection. Among them, sellers refuse to return goods or delay after-sales service, which makes it difficult for consumers to protect their rights. The reason why they have problems protecting their right is partly because of unclear channels for rights protection of live streaming e-commerce, imperfect after-sales system, and difficulty in obtaining evidence of infringement. In addition, the diversified supply chain entities of live streaming e-commerce make it harder to divide responsibilities, thus resulting in the inability to combine responsibilities and rights in the process of after-sales rights protection.

1.3.5 Difficulty in Supervision

The supply chain of live streaming e-commerce, involving production, sales, logistics, and after-sales, is characterized by a large geographical span and long length of time. The production process and the qualifications of the entities handled are yet to be transparent, and there are hidden dangers in quality and safety in all aspects of the supply chain, which makes it difficult and inefficient to supervise the supply chain. The supply chain of live streaming e-commerce is a multi-party combination of the Internet, live streaming,

and e-commerce. The main body of its supervision involves multiple institutions or departments, such as the Cyberspace Administration of China, the National Radio and Television Administration, the Consumers Association, and city supervisors, which lead to the supervision by multiple parties. Yet, in addition to the low efficiency of supervision, this brings about additional risks such as consuming a large number of resources and delaying information transmission.

1.3.6 Logistics Risks

Logistics, an indispensable link in the supply chain of live streaming e-commerce, involves the shipment of commodities or raw materials from the place of origin to the place of consumption. During the process, as the goods are stored in an unstable environment, this often results in safety problems such as damage and deterioration of the goods. In addition, owing to numerous players involved in the logistics process, various types of services, and frequent transmission of information, there are other potential risks such as information leakage, aging risks, package loss, and packed warehouses. If there is a problem in logistics, it will affect the way the supply chain of live streaming e-commerce deals with the response, shipping, and distribution of goods. How to effectively control the logistics process and enhance its capacity to handle goods has become a big challenge to control logistics risks.

1.3.7 Privacy Security

Various types of information are involved in the production and transaction of the supply chain of live streaming e-commerce. In addition to the necessary public information such as the key raw materials for production and the production date, the data of participants in the supply chain also include the value of goods (the total value of production, sales, and other business products and goods in monetary terms), highly sensitive business information like financial information, production process, production cost, transaction information. When confidential information is involved, but a reliable transaction environment is lacking, it is difficult to guarantee data security. Thus, the entities in the supply chain are less willing to share information that can only be accessed by certain stakeholders. As a result, to build the supply chain system of the live streaming e-commerce, while the openness and visibility of information are secured, it is necessary to distinguish between various groups of people and data, to protect the confidentiality of sensitive data, and to avoid risks concerning privacy security.

2 Development of Live Streaming E-commerce Driven by New Technologies

2.1 Blockchain Technology

Blockchain technology is a decentralized, distributed database whose bookkeeping and maintenance are shared by all nodes of the network. Its data structure is utilized to verify and store data; distributed nodes are used to generate updated data, cryptography to

ensure data security, and smart contracts to program a new distributed architecture and computing paradigm for operating data.

Thanks to distributed storage, point-to-point communication, and highly autonomy of each node, blockchain technology features decentralization and trustless intermediaries; because of the chain structure and timestamp, all transaction ledgers on the chain are set in a time dimension, which makes the whole process traceable and tamper-proof. As for the mechanism of blockchain, the principle of asymmetric cryptography is adopted to encrypt information to ensure the security of data [8]; the digital signature scheme ensures the reliability of point-to-point transactions and prevents transaction records from being forged, tampered or denied so that the transactions are complete and reliable; hash functions that are immutable guarantees the data cannot be changed. Based on the characteristics of decentralization, trustless intermediaries, unforgeable nature, uneditable records, non-real-name transactions, and transparency, blockchain is being used to create a trust service system.

In addition, blockchain helps to provide a reliable environment for access control. As today's IoT devices, with low computing power, have weak storage capabilities and fail to protect against malicious attacks and to act as a safe decision-making entity, a trusted third-party organization is urgently needed to meet the needs of computing and storage [1]. Due to its immutable nature and privacy protection, blockchain can enable all participants to act with integrity in terms of technology, so as to prevent data from being tampered with and privacy leaked [9]; meanwhile, blockchain can also render the decentralization of IoT and build trust consensus of the entire network without trusting a single node [11], thus avoiding the pressure of central computing of large-scale data and reducing the cost of system operation and maintenance; therefore, with the help of blockchain, there will be no super device that controls other devices in the Internet of Things, which can prevent the entire network from being paralyzed and hijacked to a certain extent, reduce the possibility of malicious attacks on the system, and ensure the reliability of the Internet of Things.

2.2 IoT Technology

According to its definition, the Internet of things (IoT) allows physical objects that are embedded with sensors, radio frequency identification (RFID), GPS positioning, barcode equipment, monitoring equipment to have access to the Internet according to the agreed protocol and to collect information of items or processes [5]. It can exchange information and communicate through network access, intelligent perception, identification, and management of items.

The platform equipped with IoT acquisition devices, by inputting data through such devices, reduces the cost of manual inventory, and lowers the possibility of data errors and forgery, thereby ensuring the objectivity, accuracy, and integrity of the data as well as visibility of the information on the chain from the source. Besides, the IoT technology can more accurately track and manage the flow of goods in the supply chain, and reduce inventory record errors caused by theft and operational mistakes. When commodities circulate in the supply chain, IoT devices can scan multiple items at the same time, thus reducing waiting time and improving circulation efficiency. By optimizing the overall supply chain through the technical equipment commonly used in the Internet of Things,

enterprises can make better decisions, lower their cost of loss generated by damage, misplacement, theft, etc., and reduce the impact on the performance as well as efficiency of the supply chain, to increase profits [7].

Additionally, the Internet of Things also helps to address noticeable problems in the blockchain: The authenticity of data input from the source of information cannot be guaranteed. If there is something wrong with the input data, even the data that has already been on the chain will be negatively influenced. Therefore, it is necessary to avoid artificial data deviation as much as possible through IoT devices to ensure the authenticity of the data source.

3 The Supply Chain System of Live Streaming E-commerce Based on Blockchain and IoT

3.1 Technical Architecture

Blockchains are divided into public chains, private chains, and alliance chains according to their level of openness. As individuals in the public chain share the same authority and join in nodes participating in bookkeeping, the security of the system and the privacy of key data fail to meet the needs of enterprises. The private chain is less centralized and its nodes have limited reading and writing permissions as well as the consensus process, so the system transparency cannot meet the needs of users. Therefore, this paper focuses on the alliance chain with the multi-center structure as the underlying blockchain technology. The alliance, consisting of entities in the supply chain of live streaming e-commerce, jointly formulates rules through negotiation and pre-designates bookkeepers and super nodes which determine the generation of blocks. The access rights of participating nodes are controlled through CA authentication. The supply chain architecture of live streaming e-commerce based on blockchain and the Internet of Things is shown in Fig. 2. Each entity equipped with IoT devices (including sensors, GPS positioning devices, radio frequency identification, smart devices, QR codes, etc.) or mobile smart terminals (scanning QR codes, using mini-programs, logging in to websites, public accounts, etc.) can upload or query information through relevant interfaces, protocol, a communication network. The system is also driven by professional logistics service providers who are responsible for the overall logistics, offer integrated services regarding warehouse and distribution, and thus a complete logistics network is built to meet the needs of the supply chain of live streaming e-commerce. As government regulators can access the supply chain system of live streaming e-commerce through the interface, they can conduct real-time dynamic supervision, bridge the gap in supervision information, easily collect evidence, and conduct targeted management and adjustment.

3.2 Action Mechanism

3.2.1 Reducing Fraud with Smart Contract Automation

Smart contracts are contract clauses written in advance for automatic execution through a specific programming language that undertakes the main transaction logic, and they can be self-executed and self-verified once deployed. Their specific content needs to be

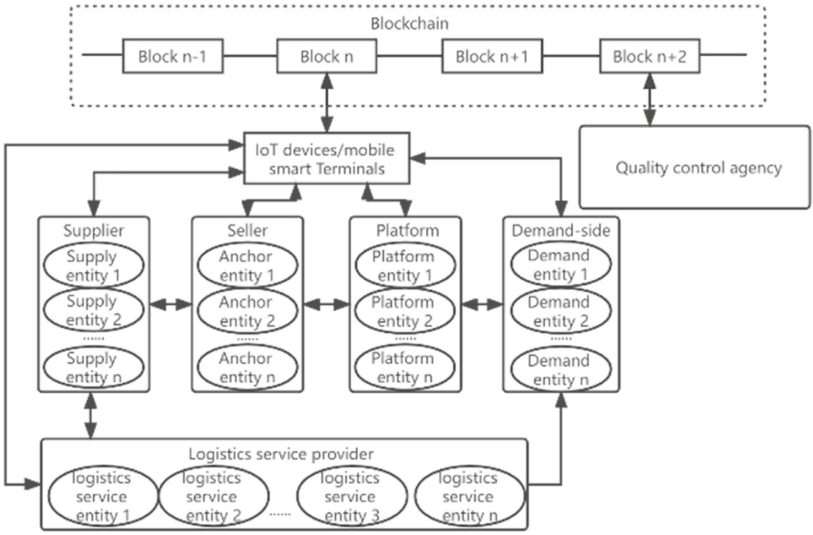

Fig. 2. The Supply Chain System of Live streaming e-commerce Based on Blockchain and Internet of Things

agreed upon by all entities in the live streaming e-commerce supply chain, and after the rights and obligations of the standard contracts are clarified, the contract code with the same legal effect can be obtained through programmatic verification. Smart contracts deployed on the blockchain are shared resources in the supply chain system, enabling entities to continuously verify the status and enforcement of contracts during the interaction process and increasing the transparency of data. At the same time, they can be used with IoT devices to track the flow of assets and commodities in the supply chain, reducing the risk of theft [2].

3.2.2 Establishing a Traceability Information Acquisition and Sharing Mechanism to Curb Information Silo

If a large amount of data flow in the supply chain of live streaming e-commerce enables information to be traced and shared, this can promote the balance of information flow among supply chain entities, and solve the problems of information transmission distortion caused by information silo. The IoT devices and technology are used in necessary terminals to collect and read the data generated during the production, sales, transportation, and warehousing of commodities to ensure the accuracy of the information. Then, the key data on the chain are stored in the block to form a forward data transmission. Besides, by recording the hash value of each piece of data generated in the block, each piece of data of each entity can be traced back to form reverse traceability of data information. On top of that, access control is implemented through blockchain, so that access to any data is recorded in the blockchain through transactions to allow traceability and information sharing and to improve communication and overall coordination among

entities. This eliminates blind spots of information in the supply chain of live streaming e-commerce.

3.2.3 Building Mutual Trust Through Decentralization and Consensus Mechanisms

IoT devices combined with the consensus mechanism of blockchain help to transmit information transparently and build mutual trust. First, massive data collected through IoT devices, relevant data submitted by various entities, and encrypted private data are saved in the blockchain, so those data, respectively corresponding to the commodities and their source entities, act as the data source of the supply chain system of live streaming e-commerce. Then, with the help of blockchain technology and the irreversibility of its consensus mechanism [6], the data cannot be forged and tampered with, which promotes the mutual trust of each entity in the supply chain system. Blockchain, as a decentralized distributed database, stores information in a distributed way in the live streaming e-commerce supply chain system, and builds trust among nodes through a consensus mechanism, thus maintaining the consistency of nodes in the distributed database. Additionally, since this can improve information sharing, integrity as well as transparency of data, mutual trust can be established between entities in the supply chain system of live streaming e-commerce.

3.2.4 Addressing the Supervision Problems in the Operation of the Supply Chain System Through Joint Supervision of Society

It is essential to create a regulatory synergy among government regulators, suppliers, platform channels, sellers, and demand-side consumers. Through the data input in IoT devices, the whole process of production, sales, logistics, and after-sales is supervised in real-time. The focus of the supervision process has shifted from subsequent investigation to pre-warning and in-process control. While each entity is self-monitoring and consumers on the demand side interact with each other, joint social supervision can be carried out to deepen the supervision of the supply chain system. In the design module of the supervision, smart contract interfaces are adopted, and the module interface for government regulators enables them to obtain public and private data so that they can provide evidence, traceability, and claim responsibility when necessary; in terms of the internal supervision of the supply chain of live streaming e-commerce, different keys are obtained according to different permissions, and data of different permissions are monitored; the public query module designed for the demand side can query the public data in the system, so that the behavior of each entity in the supply chain can be adapted to the overall goal of the supply chain, thereby reducing costs and improving the efficiency of supervision of the supply chain.

3.2.5 Eliminating the Difficulty of After-Sales Disputes and Rights Protection Through On-Chain After-Sales E-vouchers

Blockchain e-vouchers help to standardize and eliminate the difficulties in the after-sales service of live streaming e-commerce. In the after-sales process, a variety of core documents are involved, including initial orders, after-sales work orders, sales and refund

orders, re-shipment orders, and electronic after-sales vouchers. After-sales service is initiated based on the initial order. When the after-sales process starts, the block on the chain records the after-sales work order uploaded by the platform, and the after-sales records of the work order include information concerning after-sales status such as return, acceptance, reissue, arbitration, as well as communication of the after-sales service department. These after-sales e-vouchers update their after-sales service by linking and synchronizing with the initial order. Due to a large number of consensus entities in the supply chain system of live streaming e-commerce, joint supervision is adopted when the demander must apply for online arbitration by extracting and depositing certificates on the chain. After-sales e-vouchers facilitate the way online cases are handled, which reduces consumers' costs of protecting their rights and makes it easy for them to safeguard their interests. At the same time, government agencies and entities related to market supervision, industry and commerce, and taxation can also simultaneously obtain dynamic information on after-sales service, which ensures more targeted management of the supply chain [10].

3.2.6 Preventing Logistics Risks with Traceability and Division of Responsibility

Blockchain and Internet of Things technology guarantee the security of the circulation in the logistics process, the stability of the transportation environment, and the timeliness of the operation process. In this regard, logistics can fully play its role in transferring goods in the supply chain of live streaming e-commerce. Logistics service providers, as a bridge for the circulation of goods between the supplier and the demander, include logistics carriers, subcontractors, trunk line transporters, terminal dispatchers [4], and they join in the supply chain of live streaming e-commerce in the form of logistics alliances to accept system management and supervision. In the logistics process, the circulation status of the commodity is confirmed through the information updated by the terminal IoT equipment, and the current responsible entity is identified at the same time. After the authenticity of the data is confirmed by digital signatures, the obtained information is uploaded to the chain and dynamically recorded, shared, and monitored.

3.2.7 Strengthening Privacy Security Through Privacy Protection Mechanism

Blockchain technology features non-real-name transactions in which virtual addresses are used to separate user identities from data; with decentralized architecture available, there is no need to store sensitive information such as account numbers and passwords on the central server, which avoids the risk of privacy leakage caused by the server being attacked in the traditional centralized management; the communication mode of relay and forwarding is adopted between nodes, so information is continuously forwarded through neighbor nodes and broadcasted in the network. This avoids the problem of discovering the source and destination of information by eavesdropping on network traffic in traditional networks [12]. If the system has requirements for higher-level privacy protection, schemes such as currency mixing strategies, asymmetric encryption, multi-signature, and restricted release can be adopted to further strengthen privacy protection according to specific needs.

3.3 Operation Process

3.3.1 Production Process

Suppliers, as the source of goods and upstream players in the supply chain of Live streaming e-commerce, use a variety of Internet of Things technology as the physical carrier of information from the beginning of purchasing raw materials into the warehouse to track, record the production process of goods, and accurately grasp the detailed information of raw materials, which reduces the uncertainty of raw material procurement and improve processing efficiency. As a result, manufacturers can more easily trace the source of raw materials, confirm the quality and quantity of raw materials, and strengthen the control of upstream source channels. During the production process, the IoT device automatically can collect and track the status of the raw materials, semi-finished products, and finish products of the same production batch in the production workshop, so as to accurately understand the requirements of the current processing procedure and avoid errors. When the product is packaged, the traceable source code will be affixed to the outer packaging of the smallest sales unit, and the product information will be entered and uploaded to the system. When a product needs to be processed multiple times by a multi-level processing plant, the traceability source code is circulated to the processing enterprises at all levels along with the product to be processed, so that the traceability information can be updated with the advancement of the processing.

3.3.2 Sales Process

After being entrusted by suppliers, sellers promote products through live streaming in the platform channel which first generates a payment order from the demander and uploads it to the chain. The supplier generates a delivery list based on the buyer's order backstage. Then, after the goods are packed by warehouse packing workers, information of such goods can be uploaded by scanning the traceability source code, so the inventory is checked to complete the delivery. After the logistics service provider carries out packing and transportation, the order number is bound to the express order number, and then the logistics information is uploaded to the blockchain storage synchronously for traceability. When unpacking the goods, the demander can obtain the traceability source code to update the traceability information through the mobile smart terminal and can gather the traceability information of the traceable goods within the query authority, including raw material in and out of the warehouse, product processing, storage date, logistics situation, receipt of goods time, time of each inspection, etc.

3.3.3 Logistics Process

In the logistics network, when the traceability source code is circulated to the manufacturers or logistics warehousing nodes of processing enterprises at all levels, the traceability source code is used as the key value according to the function of the chain code that needs to be installed on each different entity node. By using the authenticated accounts within each entity that has the authority to update data, the data collected by IoT devices in various links of products or raw materials are uploaded to the block of the system through relevant interfaces, protocols, and communication networks. During

this process, IoT devices keep the circulation environment stable as much as possible by locating the means of transportation and goods, and monitoring the storage status of the goods, to reduce product loss in the circulation process. When goods are put into storage, the IoT device automatically identifies them, records information such as name, category, specification, production location, storage time, etc., to generate warehouse e-receipts and updates them to the blockchain. During the storage process, the storage environment is monitored in real-time to ensure that the dynamic state of storage can be controlled by the supply chain entities.

3.3.4 After-Sale Process

In the after-sales process, the platform channel collects the return and exchange application issued by the demander and uploads it synchronously, and the after-sales department of the supplier will verify whether it meets the standards according to the reasons for the return put forward by consumers. After the refund is received by the warehouse, the after-sales department will accept and inspect it and complete the corresponding operations according to the requirements of the demander. If the goods are returned or exchanged due to poor quality, products will be traced to check whether there are abnormal conditions in the supply chain of the goods that lead to such problems, and will hold the relevant entity responsible, to ensure the quality of the goods and prevent greater losses as much as possible. If the goods are exchanged for other reasons or no reason, the after-sales department will check if the returned product is in good condition or meets the sales standards. If the product does not meet the information submitted in the return or exchange application, the after-sales specialist will continue to follow up with feedback and re-send it according to the requirements of the demander.

4 Evaluation and Results

The scheme proposed in this paper was simulated, and a blockchain simulation platform was built using Hyperledger Fabric. The network was started by referring to the first-network case in the official fabric-Sample. Channel and genesis block are created, and four peer accounting nodes and an order sorting node are deployed.

All four accounting nodes are added to the channel, and they are divided into org1 and org2. Meanwhile, one peer node is set as anchor node. The final Fabric network structure is shown in the Fig. 3.

Performance evaluations are carried out using Caliper tool on a Lenovo Notebook (Intel Core i5, 2.3 GHz, 16 GB memory). Caliper is a blockchain performance benchmark framework that allows users to test different blockchain solutions with predefined use cases and obtain a set of performance test results. Caliper currently supported performance indicators:

$$\text{Throughput} = \text{Total read operations/total time in seconds} \tag{1}$$

$$\text{Latency} = \text{Time when response received} - \text{submit time} \tag{2}$$

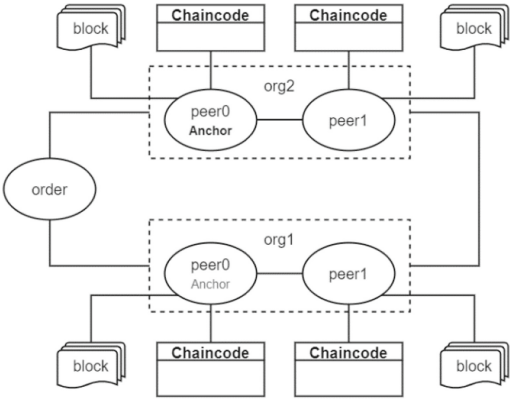

Fig. 3. Blockchain network structure

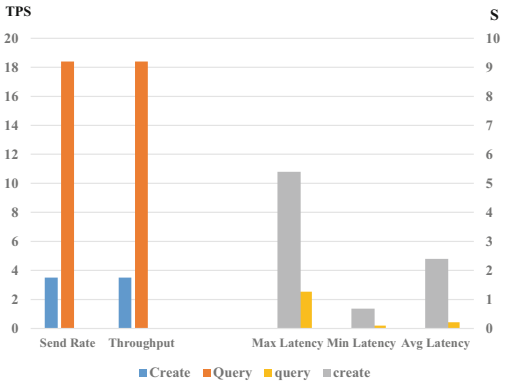

Fig. 4. Performance test results

Next, we present the latency and throughput performance evaluations, Fig. 4 show the results.

As can be seen from Fig. 4, the average Latency of create block is about 2.4 s and TPS is about 3.5. The average Latency of query block is 0.43 s and TPS is 18.4. Considering that the experimental platform is an ordinary laptop, TPS is relatively low. TPS of blockchain networks can be improved by improving the chain code, consensus, or hardware configuration.

5 Conclusions

This paper, based on the status quo of Live streaming e-commerce, introduces the structure of the supply chain of live streaming e-commerce to conclude the practical problems in this sector. In addition, blockchain and Internet of Things technology are combined with a live streaming e-commerce supply chain system to build a new supply chain which helps to break bottlenecks in the current supply chain and improve its efficiency.

The supply chain is managed and controlled in a smart way to make the information in the chain safe and reliable, to facilitate information sharing, and to improve its efficiency of supervision and operation. The detailed solutions are explained respectively to resolve listed practical problems, and the specific operation process is described. However, conclusions drawn from practice are lacking when blockchain and IoT technology are applied to the live streaming e-commerce supply chain, which will be the focus of future research.

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