

Construction of Logistics Information Management Mode Based on Blockchain Technology

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Keywords: Logistics information management mode, Blockchain technology, Implementation path

Abstract: Blockchain technology is considered as a cutting-edge technology that can be widely used. Logistics is the artery of national economic development, and logistics information management is the key area of logistics management. Therefore, the application of blockchain technology in logistics information management has important research significance and practical value. First of all, blockchains, core technologies and their main advantages are introduced, including distributed ledger technology (decentralized and permanent storage data advantage), asymmetric encryption algorithm (security tamper-proof advantage), consensus mechanism (anti-counterfeiting and trustworthiness advantage), time stamp (traceability and verifiability advantage), and intelligent contract (automation and efficient transaction advantage). Then, the research on construction of logistics information management mode based on blockchain technology is carried out, and the typical modes are discussed: first, supply chain logistics information management mode based on blockchain technology to enhance product traceability and information transparency; second, international trade logistics information management mode based on blockchain technology to simplify and speed up the process of trade logistics; third, logistics intelligent contract information management mode based on blockchain technology to achieve automated performance. On this basis, the implementation path of construction of logistics information management mode based on blockchain technology is put forward: creating cooperative relationship and win-win vision, striving to improve the technology level of blockchain, and making reasonable application decision of blockchain technology. Six main implementation steps have been formulated to provide reference for logistics enterprises and logistics management departments, and to promote the level of logistics information management and overall logistics performance.

At present, the logistics industry is changing from the growth of speed and scale to the growth of efficiency and quality, and the transformation and upgrading are accelerating. Logistics information management is the key field of logistics management. Strengthening the innovation of information technology and improving the level of logistics information management are the core support for the transformation and upgrading of traditional logistics to modern logistics. As a new cutting-edge technology, the research and practice of the combination of blockchain technology and logistics field are developing day by day in recent years. In this paper, in view of logistics information management, the typical application mode of blockchain technology in this key field is discussed, and the clear implementation path, success factors and implementation steps are put forward, which has important research significance and practical application value for improving the level of logistics information management and overall logistics performance.

1. Literature Review

In recent years, the application of blockchain technology in logistics information management has gradually emerged. From the perspective of information platform technology development in the field of port and shipping, Xu Kai [1] analyzed the application value of blockchain technology

to port and shipping information platform, systematically analyzed the development trend of blockchain in the application scenarios of port, shipping and international supply chain management, and elaborated the influence of blockchain on the trading mode of port and shipping industry. M Francisconi [2] empirically studied the use and advantages of blockchain technology in port logistics, analyzed the practical application cases of blockchain technology by matching various functions provided by information systems up to the various uses of blockchains and combining various strategies, and evaluated the benefits of applying blockchain technology. Hao Yukun and Zhang Jiyuan [3] designed an intelligent container operation information platform based on blockchain technology, which takes advantage of the technology advantages of efficient information sharing and safety and credibility of blockchain, significantly reduces logistics costs, simplifies cumbersome processes, and real-time monitors the whole process of logistics combined with Internet of Things technology to enhance logistics security. Wang Miaojuan [4] analyzed the problems of blockchain in terms of safety, efficiency, game, and proposed to establish a blockchain system for exclusive express logistics industry and R&D blockchain logistics tokens, so that express delivery can realize the digital management of information flow, physical flow and capital flow, and enhance the traceability of goods, information and funds. Guo Shanshan [5] proposed a three-tier blockchain structure for supply chain logistics: First, in the P2P network at the bottom of the blockchain, each transaction role is traded and verified under the premise of registering as a consensus node; second, each transaction node stores verified block information in the storage layer; third, an interactive interface is provided in the application layer to verify transaction information to prevent tampering and to implement trusted traceability query. Cai Jinhua and Hu Jiamu [6] analyzed the possibility and rationality of applying blockchain technology to the construction of cigarette supply chain system and logistics information platform. They believed that the technical advantages of decentralization, traceability and validation, intelligent contract and so on would help to solve the core problems of high cost, low efficiency and high risk of the existing cigarette supply chain system. Wang Chuanlei and Wan Yidi [7] studied the coupling relationship between blockchain and supply chain logistics information resources in the aspects of subject, transaction mechanism and intelligent contract, and constructed a supply chain logistics information ecosphere model based on blockchain to improve the supply chain logistics information ecology. Wang Juanjuan and Liu Ping [8] studied the applicability of blockchain technology in the Belt and Road regional logistics, whose results show that the blockchain technology helps the Belt and Road region to improve the transparency of logistics information and build an efficient logistics mechanism, and proposed the construction of a logistics security mechanism led by the government. Hu Jie and Ge Changtao et al. [9] drew lessons from the advantages of blockchain technology in decentralization, data tamper-proofing, data confidentiality and other aspects, analyzed the typical application scenarios of blockchain in the field of logistics, and proposed a logistics information management framework based on blockchain.

In summary, some ideas, strategies and schemes of applying blockchain technology to logistics information management have been put forward, but the research focus is relatively scattered. In most literatures, logistics information management is used as one of the aspects of blockchain technology in logistics field, which leads to weak pertinence and difficult research. Although a few papers have made special research on the application of blockchain technology in logistics information management, they have not put forward specific application modes, nor have they provided implementation paths or steps for guiding practical application.

2. Core Technology and Main Advantages of Blockchain

Blockchain originated from the founding paper *Bitcoin: A Point-to-Point E-Cash System* [10] published by the cryptographic email group in 2008 by scholar alias Satoshi Nakamoto. Therefore, the concept of blockchain is considered to originate from the digital currency, Bitcoin, which is a data structure that combines blocks in a chain way. At present, there is no recognized definition of blockchain. In a narrow sense, it refers to the de-centralized sharing of general ledger, which combines data blocks into specific data structures in a chain manner and in chronological order, and

guarantees the prevention of forgery and tampering with cryptography. In a broad sense, it is a distributed computing paradigm and de-centralized basic framework that uses distributed node consensus algorithm to generate and update data, uses encrypted chain block structure to verify and store data, and uses automated script code (intelligent contract) to operate and program data. There are five core technologies and main advantages of blockchains.

2.1. Distributed Accounting Technology: Decentralization and Permanent Storage of Data

Based on distributed structure and distributed bookkeeping technology, the process of data accounting, validation, storage, maintenance and transmission is completed. Instead of relying on the central organization, the trust relationship between distributed nodes is established by mathematical method to form a trusted decentralized distributed system. Transaction bookkeeping is accomplished by multiple nodes distributed in different places. Unlike traditional database technology, which records and stores data by central administrator, copies of real accounts can be copied among many nodes in point-to-point network. Data is backed up among nodes, and each node maintains the system function in an equal position. Therefore, the system operation and information recording will not be affected by any node's damage or abnormality, thus realizing the permanent storage of transaction records and data.

2.2. Asymmetric Encryption Algorithms- Security and Tamper-proofing

The principle of asymmetric cryptography is applied to encrypt data, and with the help of the powerful computing power of consensus algorithm to resist attacks from outside, the blockchain data cannot be forged and tampered with. By means of public key, private key and digital signature, the security and accuracy of stored information are ensured, and access rights of accounts are controlled, so as to ensure the security and reliability of transaction records and information data.

2.3. Consensus Mechanism: Anti-counterfeiting, Authenticity and Credibility

In order to effectively authenticate the validity of transaction information and ensure the authenticity and reliability of data, the blockchain relies on all nodes in the network to form a consensus on authentication principles, rather than the central organization of traditional database technology. Moreover, the special economic incentive mechanism guarantees that many nodes in the distributed system participate in the verification process of data blocks (Bitcoin "mining" is a typical example). Only when the number of agreed nodes exceeds 51%, the transaction data can be considered true and effective.

2.4. Time Series Data (Timestamp) - Traceability and Verifiability

Blockchains store data through a chain block structure with a timestamp, and generate time series for data. And any two blocks are related by cryptography, which can be traced back to the data information of any block, so it has strong traceability and verifiability.

2.5. Intelligent Contract-Automation and Efficient Completion of Transactions

Blockchains provide flexible script code systems for users to build advanced intelligent contracts, which are equivalent to digital contracts for business rules, and automatically execute pre-defined rules and procedures as transactions proceed. The transparent script code of the intelligent contract can be executed automatically under the supervision of each node and in accordance with the conditions. The performance process of the transaction can not be interfered, manipulated or tampered with to ensure the reliability of the results of the automatic operation of the predefined program.

3. Construction of Logistics Information Management mode Based on Blockchain Technology

At present, blockchain technology has huge and potential application value in the field of logistics. On the one hand, the logistics industry is characterized by resource fragmentation and fierce competition. On the other hand, logistics management involves many stakeholders and is

prone to problems such as low information transparency, irregular information flow and uneven application level of information technology. In addition, many links of logistics information management are also constrained by regulations and manual processing by management agencies. For example, many enterprises still rely on manual data input and production of paper documents to complete customs clearance, commodity inspection and payment settlement processes, resulting in difficult traceability of goods sources and difficult inquiry of logistics information. Blockchain technology is helpful to solve the above problems in logistics information management, such as improving the transparency of logistics information in supply chain and traceability function of goods, simplifying and speeding up the international trade process, and realizing the automation of performance. In this paper, the typical application modes of blockchain technology in information management in supply chain logistics, international trade logistics, intelligent contract logistics and other fields are discussed, and then the implementation path and steps are put forward. The typical application modes of blockchain technology in logistics information management is shown in Figure 1.

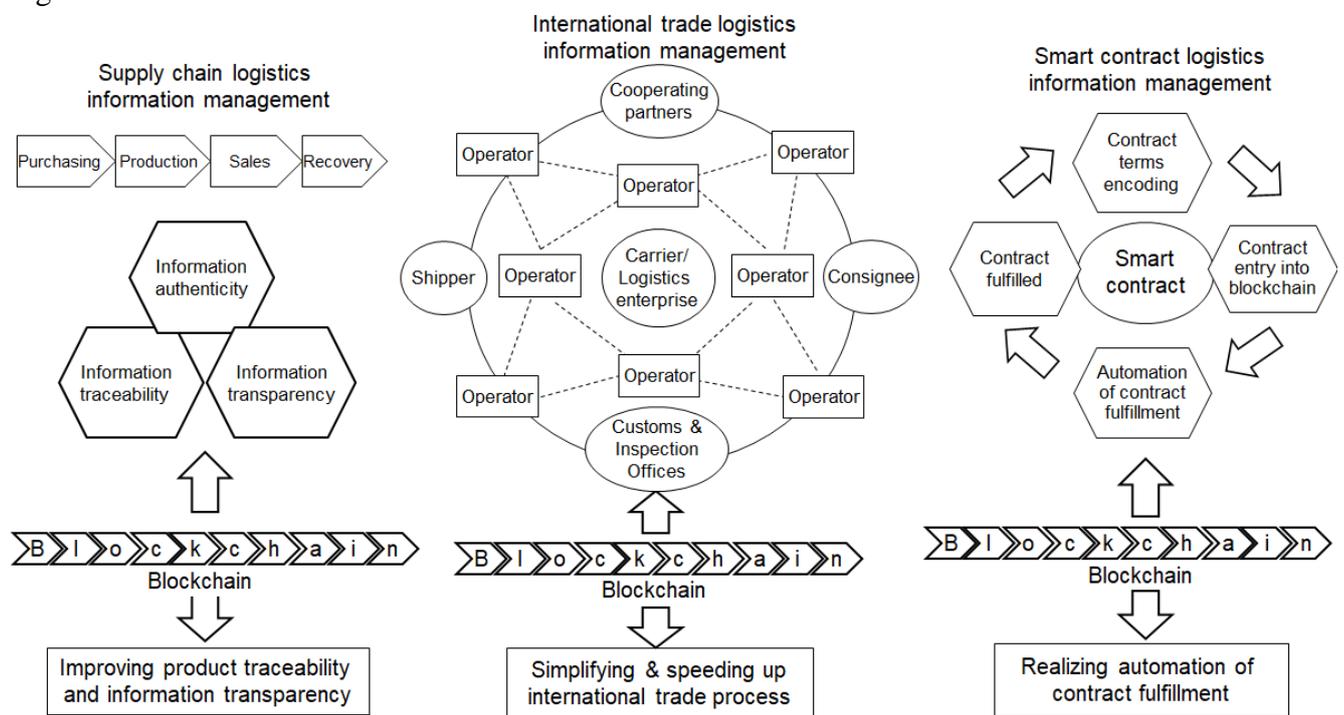


Figure 1 Construction of Logistics Information Management mode Based on Blockchain Technology.

3.1. Supply Chain Logistics Information Management mode Based on Blockchain Technology: Improving Product Traceability Function and Information Transparency

The information platform of supply chain logistics based on blockchain technology can collect the important information in the process of supply chain logistics such as commodity source, manufacturing, distribution and retail completely and accurately, and store it permanently in the information platform of blockchain for sharing and not tampering with it, which significantly enhances the convenience of members of the supply chain (including end users) to query and track products, and improves the traceability and information transparency. For example, pharmaceutical companies can use platform information to prove the legitimacy of the drugs transported, high-value commodity manufacturers can provide authentic certificates. It is also conducive to consumers to effectively identify whether the goods are authentic.

A typical application scenario is the application of blockchain technology to effectively address a major challenge in today's world - drug counterfeiting. According to Interpol statistics, millions of people worldwide die from counterfeit drugs every year. In order to meet this challenge, a serialized drug logistics information management platform based on blockchain technology is constructed to

enhance the ability of product query, tracking and traceability for pharmaceutical enterprises. Serialization refers to the process of assigning the unique identification of a drug (e.g. serial number) to each sealed drug unit and linking it to key information such as product source, batch number and expiration date, so as to ensure that each unit can be effectively tracked at any time and can be located at any stage of its life cycle. The key to serialization is to maintain information transparency and traceability, especially in the logistics process where drug units are repackaged or aggregated into trays and then decomposed into units for consumption. The information management platform of serialized drug logistics blockchain records drug information in every step of supply chain logistics, including manufacturing, logistics warehouse receiving, picking and packaging, delivering and shipping, receiving operations and so on. The blockchain information management platform can efficiently process a large number of drug serial numbers and transaction orders. By closely monitoring the drug logistics activities from the supply chain, the information can be tamper-proof, safe, reliable, transparent and real-time, ensuring that consumers effectively verify the legality and identify the authenticity of the drug so as to effectively protect personal health and life safety. The information management platform based on blockchain for drug supply chain logistics is shown in Figure 2.

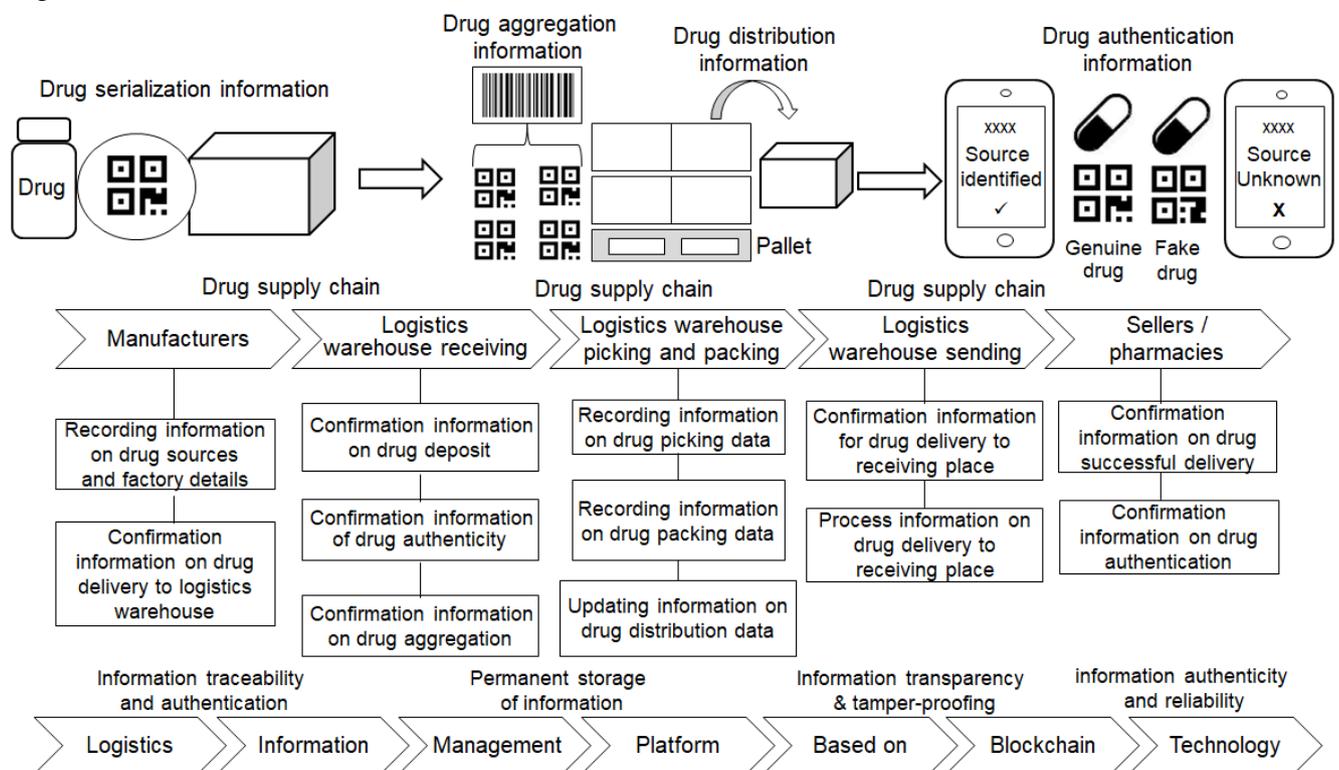


Figure 2 The information management platform based on blockchain for drug supply chain logistics.

Another typical application scenario is the retail industry where the blockchain technology is applied to improve the transparency of logistics information and enhance the traceability of goods in the retail supply chain. Among them, retail food is one of the most representative examples, and it can use blockchain technology to improve its information management and improve food safety. In this application model, on the one hand, the core organization of supply chain (such as large retailers) must build a blockchain information management platform with various partners to effectively trace the exact source of food and monitor the whole process of food processing. The production and factory information of each specific food is recorded in detail. If food contamination occurs, retailers can quickly respond to and deal with it. On the other hand, information feedback mechanism is established to identify and correct the improper operation of food from farm to store in time. For example, meat food should not exceed a certain temperature. Food sensors should acquire temperature data regularly and transmit them to the blockchain information system.

Automated quality assurance programs should notify relevant parties in real time in order to prevent abnormalities in food logistics process. In addition, large retailers can work with supply chain members to build a Blockchain Food Security Alliance, a broad-based organization for tracking, traceability and security of food supply chain logistics information.

3.2. International Trade Logistics Information Management mode Based on Blockchain Technology: Simplifying and Accelerating the Trade Process

Logistics is regarded as the lifeblood of international trade, and most of international trade is completed by shipping logistics. However, the shipping logistics supporting international trade is quite complex, involving a large number of stakeholders. There are often conflicts in the priority of interests. The information management systems for tracking and inquiring goods are different, resulting in heavy trade barriers, inefficient logistics, and even trade fraud. A new shipping logistics test shows that the single transport of refrigerated container cargo from East Africa to Europe needs to be operated and handled by nearly 30 people from different participants and institutions, and more than 200 interactions and communications have been generated between participants in the whole process [2]. The information management of international trade logistics based on blockchain technology is helpful to alleviate many frictions in the aspects of purchase, transportation management, customs cooperation, information tracking and inquiry and trade financing of trade goods, optimize shipping logistics documents and information processing, save operation costs and processing time, and ultimately simplify and accelerate the trade process. In this application mode, participants can transmit electronic data and digital documents point-to-point, efficiently and securely on the decentralized blockchain information platform, improving shipping logistics efficiency and shortening trade processes. At the same time, the business records of all blockchain information platforms are authentic, permanent and non-tamperable. The operational information of the parties in each link can be traced and verified, and the trade fraud can be effectively prevented to the greatest extent. Participants can check the logistics progress of the goods at any time, track the position of the container in real time, keep abreast of the continuously updated data, understand the dynamics of customs clearance, and take timely remedial measures for logistics accidents, thus greatly reducing the delay in transportation delivery.

On the other hand, blockchain technology can be applied to facilitate the digitization of ocean bills of lading. Bill of lading is one of the most important documents in shipping trade. As the document of title, contract of carriage and receipt of trade goods, the information stored in the bill of lading is very important, including all the important details of the consignee, the place of loading and unloading, the specific name and quantity of goods, the handling of goods and the settlement of expenses. Through the information management of trade logistics based on blockchain technology, the information platform of de-centralized blockchain enables the direct interconnection of information between the parties concerned in the bill of lading and eliminates the dependence on the central entity or intermediary. Core organizations (such as logistics enterprises or shipping companies) and participants send, transmit and receive digital bills of lading through decentralized network point-to-point, efficiently and safely to ensure that the goods are delivered to the consignee accurately and accurately, while achieving significant cost reduction, zero-error documents and rapid transmission.

3.3. Intelligent Contract Logistics Information Management mode Based on Blockchain Technology: Realizing Automation of Performance

The intelligent contract technology of blockchain is applied to embedding all kinds of digital documents and real-time data of goods into the system of blockchain information platform, so as to start the intelligent contract logistics. In this process, once the contract terms are implemented and the previously agreed delivery conditions are met (e.g. the delivery personnel send the confirmation information of successful delivery), the system can automatically fulfill the intelligent contract. In the process of settlement, digital currencies such as “logistics currency” similar to blockchain bitcoin can be set up to realize settlement automation. All participants can purchase “logistics currency” to pay freight and complete settlement. In addition, the combination of blockchain and

Internet of Things can further promote intelligent contract logistics. For example, when delivering goods, related pallets automatically send delivery confirmation, delivery time and status information to the information system, the system automatically verifies delivery, checks whether the goods are delivered in accordance with the conditions stipulated in the contract (such as temperature, humidity, etc.), and then accurately pays to the relevant parties.

Among them, the digitization of letters of credit is one of the classic examples. At present, the business process of many international trade letters of credit takes time ranging from several days to several weeks, and digital letters of credit are designed to significantly speed up the standard process of paper letters of credit. Intelligent contract logistics information management based on blockchain technology introduces blockchain intelligent contract technology into paper-intensive letter of credit process, which enables exporters, logistics enterprises, importers and related banks to efficiently transmit digital letter of credit and safely exchange data of letter of credit on blockchain information platform, so as to speed up the process of letter of credit significantly and effectively prevent letter of credit fraud. Participants can also display relevant information on mobile terminals in real time and check all the operations that have been performed in time. When the documents such as Bill of lading, invoice, packing list and certificate of origin all conform to the stipulations of the letter of credit and payment is completed, the system can automatically implement the terms of the letter of credit (performance automation), thus saving a lot of time, promoting paperless documentation and reducing related costs for the subsequent logistics delivery process.

4. Implementation Path of Construction of Logistics Information Management mode Based on Blockchain Technology

The implementation path of applying blockchain technology in logistics information management includes three main success factors and six main implementation steps.

4.1. Creating Cooperative Relations and Win-win Vision

When logistics enterprises or logistics departments decide to apply blockchain technology in information management, they should first create a close cooperative relationship and a win-win vision, which will involve multilateral trust and in-depth cooperation, including cooperation among various partners, industry organizations, customs inspection agencies, other relevant departments and even competitors, corporate entities and public institutions. Taking the fiercely competitive financial services industry as an example, competitors have constructed a collaboration platform to jointly study the application of blockchain technology. Although cooperation between competitors is contrary to common sense, when more cooperative members are willing to use the same blockchain solution, each party can gain higher value and achieve greater goals. Therefore, in the field of logistics, the alliance or organization of logistics blockchain can also be constructed accordingly.

4.2. Striving to Improve the Technology Level of Blockchain

New technology is the key support for the organization to realize the value of new operation mode. Logistics enterprises, logistics departments and participants must invest sufficient resources and time, adopt effective personnel training and technical training methods, establish an effective incentive mechanism, and all participants should synchronously improve the technical level of the blockchain of employees at all levels to ensure that they fully grasp the relevant knowledge and ability, and make due contributions to the implementation of each blockchain application project.

4.3. Making Reasonable Decisions on Blockchain Technology Application

The immeasurable application value of blockchain technology and the application potential to be tapped have formed a consensus at home and abroad. However, the current blockchain technology has not been applied on a large scale, and it is still in the early stage of the technology life cycle. The application goals and value expectations of blockchain technology in logistics information management should be realistic, and the application decision of blockchain technology should be

made following the reasonable principles and ideas, which can be completed by means of a decision tree, as shown in Figure 3.

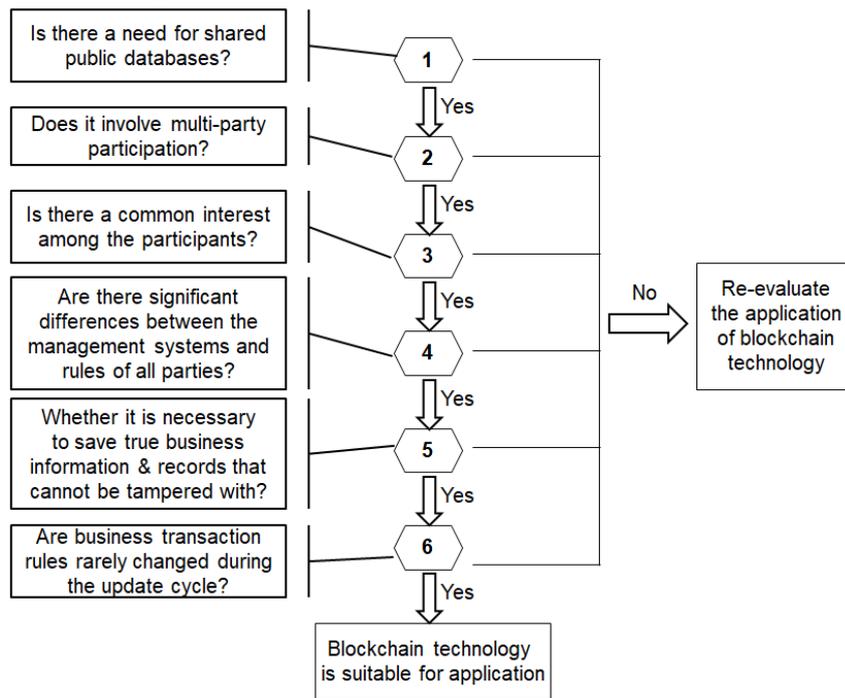


Figure 3 Application Decision Tree of Blockchain Technology.

4.4. Implementation Steps

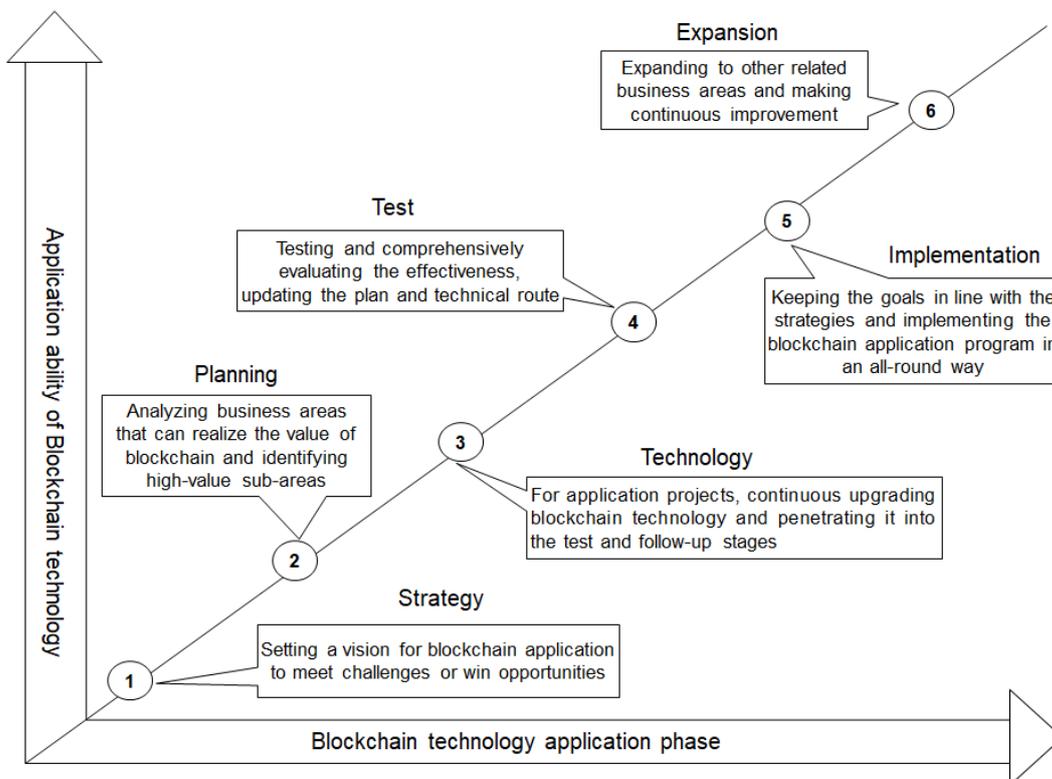


Figure 4 Implementation steps of blockchain technology application.

From the application concept of blockchain technology in logistics information management to the implementation of landing, enterprises can deploy according to the steps shown in Figure 4. It is worth emphasizing that at the planning stage, participants need to have a thorough understanding of all the details of using blockchain technology in application projects. In the test stage, the technical application scheme is tested in a small business scope first, then the test results and effectiveness

are comprehensively evaluated, the business scale is enlarged on the basis of the successful test, and then the implementation of the scheme is re-tested. The later stage of application implementation includes expanding the application of the scheme and expanding the comprehensive benefits. The success of application implementation depends to a large extent on the level of cognition and collaboration of all participants, the degree of collaboration of all parties and the level of application of blockchain technology. For the logistics field with a wide range of links and stakeholders, the collaborative implementation of the whole staff is crucial to the success of the application of blockchain technology. The implementation steps of blockchain technology application are shown in Figure 4.

5. Conclusions and Prospects

At present, the application and practice of blockchain technology in logistics information management and related fields are developing day by day. New technology is an important support to promote the sustainable development of logistics industry. It is of great significance and practical value to combine blockchain technology with logistics field. Typical modes of logistics information management based on blockchain technology are as follows: first, supply chain logistics information management mode based on blockchain technology to enhance product traceability and information transparency; second, international trade logistics information management mode based on blockchain technology to simplify and accelerate the process of trade logistics; third, intelligent contract information management mode based on blockchain technology to achieve automation of performance. There are three main success factors in implementing construction of logistics information management mode based on blockchain technology: creating cooperative relationship and win-win vision, striving to improve the technology level of blockchain, making reasonable decision on application of blockchain technology; and on this basis, formulating six stages of implementation steps: strategy, planning, technology, test, implementation and expansion.

Despite the specific application model and implementation path, in this paper, theoretical discussion is the main part, and empirical research needs to be strengthened. The follow-up research can improve the application of blockchain technology in logistics information management in terms of breadth and depth, introduction of practical cases, empirical research. Next, on the basis of logistics information management, the scope of application research should be expanded. The technical characteristics and advantages determine that the blockchain has broad application prospects in the field of logistics. It can be expected that the future blockchain technology will be deeply integrated with new technologies such as the Internet of Things, artificial intelligence and big data to promote the development of intelligent logistics and improve the overall performance of logistics while improving the level of logistics information management.

Acknowledgements

This study was supported by foundation Project of 2017 Provincial Key Platform and Research Project for Universities of Guangdong Province “Research on Cross-border Logistics Service Guarantee System Supporting Cross-border E-Commerce Development —— Based on the ‘Belt and Road’ Perspective” (No.2017GWTSCX016).

References

- [1] Xu, K. (2016) Application Trend of Blockchain Technology in Port and Shipping. *Port Economy*, 12, 5-8.
- [2] Francisconi, M. (2017) An explorative study on blockchain technology in application to port logistics. Delft University of Technology,
- [3] Hao, Y.K., Zhang, J.Y. (2017) Logistics Operation and Management System Based on Blockchain Technology. *Information Technology & Standardization*, 12, 20-24.

- [4] Wang, M.J. (2017) Thoughts on Application of Block Chain Technology in Logistics and Express Delivery Process. *Logistics Technology*, 36(3): 31-34.
- [5] Guo, S.S. (2017) Implementation of the Supply Chain's Trusted Traceability Query on the Blockchain. Dalian Maritime University.
- [6] Cai, J.H., Hu, J.M. (2017) Application of Block Chain in Construction of Cigarette Supply Chain System. *Logistics Engineering and Management*, 39(06): 89-90.
- [7] Wang, C.L., Wan, Y.D., Qin, Q., Wang, N.N. (2017) A Model of Logistics Information Ecosphere of Supply Chain Based on Block Chain. *Information Studies: Theory & Application*, 40(07): 115-121.
- [8] Wang, J.J., Liu, P. (2018) Research on the Application of Block Chain Technology in "the Belt and Road" Regional Logistics. *China Business and Market*, 32(02): 57-65.
- [9] Hu, J., Ge, C.T., Sun, Y., Ma, H.B. (2018) Research on Block Chain Based Logistics Information Management Architecture. *Logistics Sci-Tech*, 41(10): 34-36.
- [10] Nakamoto, S. Bitcoin: A peer-to-peer electronic cash system. <https://bitcoin.org/bitcoin.pdf>, 2008.