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Cold Chain Logistics Model of Agricultural Products Based on Embedded System and Block Chain

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Abstract
There is a series of trust problems because most cold chain logistics systems adopt centralized solutions, and data management is completed by logistics enterprises alone at present. In this paper, it proposes a blockchain technology solution for cold chain logistics industry to solve these problems. It designs the cochain system for order data and environment data respectively by taking advantage of the unique characteristics of decentralization and distrust of blockchain. It realizes secure cochain of order data, timely cochain of cold chain environment data and embedded path control mechanism to improve the credibility and data security of cold chain logistics industry. It shows that the scheme can meet the business needs through the implementation and testing of the system prototype, which has an important impact on the cold chain logistics industry.
Keywords: Cold Chain Logistics; Block Chain; Agricultural Products; Embedded

1.Introduction

In recent years, the cold chain logistics market is also developing rapidly due to the continuous improvement of people's living standards and the popularity of e-commerce China. Cold chain logistics generally refers to the mode of logistics and transportation in which some special goods (such as food and drugs) need to maintain a certain temperature in their processing, storage, transportation, distribution, retail so as to ensure the quality of goods.

At present, most of the cold chain logistics systems improve the information level of the logistics system by using the Internet of things technology, for example, it can effectively and quickly monitor the goods in the cold chain through the Internet of things technology, but this method does not solve the disadvantages of data centralized storage, and there are still the following problems: (1) Lack of trust. There are high requirements and high costs in cold chain logistics industry, and distrust behaviors such as data fraud and running away appear frequently, which greatly increases the rate of damage. (2) The transportation process is not transparent. Logistics enterprises cannot maintain the whole cold chain in the process of transportation. In order to reduce the cost, there may be problems such as turning off the refrigerator in the process of transportation and turning on the refrigerator when it is near the destination. (3) Data storage is transparent. At present, it is not convenient for shippers to obtain the data because most of the temperature data are stored in the centralized database of carriers and storage enterprises. The reliability of the central database recording method is not high, and it needs redundant backup of important data. (4) It is difficult to share resources. There are scattered goods in the third-party logistics transportation, especially in the field of agricultural products. At present, it is difficult to realize the maximization of resource sharing and equipment utilization due to the problem of transparent transportation capacity.

2. Definition of blockchain

With the widespread dissemination of electronic money such as bitcoin, blockchain technology, as the underlying core module of electronic money, has become a hot topic in industry and academia [6]. Blockchain technology is a bookkeeping technology, also known as distributed ledger technology, maintained by multiple parties and uses cryptography

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to secure transmission and access, enabling consistent storage, on-tampering and denial prevention [7]. So far, blockchain technology has gone through three development stages [8-10], namely, the blockchain 1.0 era represented by digital currency; the blockchain 2.0 era, which incorporates smart contracts; and the blockchain 3.0 era, which applies blockchain to more industry scenarios. In the blockchain system, all the submitted things are stored in the chain. When a new transaction is confirmed, the length of the chain will be increased without modifying the previous data, thus ensuring the completion of the data.

According to the actual application scenarios and needs, blockchain technology can be divided into three application models: public blockchains, Consortium blockchains, and private blockchains. Public blockchains are the original form of blockchain represented by bitcoin, where any node is free to join and participate in the reading, writing, verification and consensus of the ledger data, and jointly maintain the ledger data. Consortium blockchains are a form of blockchain with access control mechanisms, suitable for organizations or consortia of multiple entities. Private blockchains are a centralized form of blockchain, completely controlled by an organization. They are suitable for internal data management and auditing of specific organizations.

3. The necessity of applying blockchain technology to cold-chain logistics of agricultural products under the new situation

Cold-chain logistics is a logistics activity based on the refrigeration process and realized through refrigeration technology. The main difference between cold-chain logistics and the main logistics methods is that the goods must be controlled under the specified temperature during the whole process from production to sales in order to ensure the quality of goods and reduce the loss of goods. Cold-chain logistics is an activity in the supply chain and a systemic project to ensure the quality of goods. Thus, the refrigeration process can be applied in all stages of production, storage, transportation, sales and consumption, as shown in Figure 1.

3.1 Characteristics of blockchain technology

Blockchain technology is essentially a set of technology tools to resolve the problem of trust. It is a logistic process that the other participants can access through digital information recording. The main features of blockchain are to achieve data tamper-proof through distributed data storage, implement fast information recording through peer-to-peer transmission, improve information identification efficiency of multiple participants through consensus mechanism, and achieve full access to information circulation through transparent sharing and equality. Combining these technologies in a new way makes it possible to prevent the stored data from being tampered with, make the data traceable, and reduce the cost of trust for multiple parties. Blockchain gives a low-cost trust solution for the Internet of things and real data. It provides a basis for the construction of data infrastructure, so that multiple parties can complete their interaction in trust.

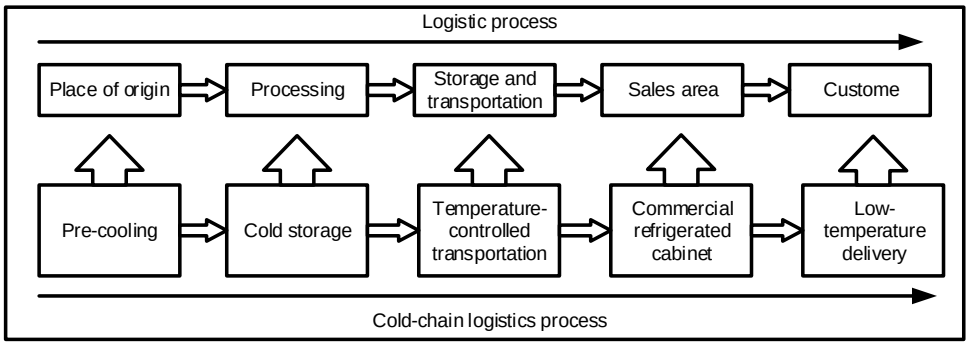

Figure 1 Cold-chain logistics process

The core significance of blockchain lies in the use of a technology system composed of several technologies to realize the trusted circulation of value. Blockchain achieves data trust at minimal cost by building a decentralized ecosystem with consensus. Blockchain has a tamper-proof and traceable data storage method coupled with a trusted transmission mechanism, an effective approach to storing and quantifying value.

3.2 The feasibility and necessity of applying blockchain technology to cold-chain logistics

Rural commerce in the context of "Internet Plus" has been ever-growing. According to the data of the Ministry of Commerce, the national rural online retail sales in 2018 achieved nearly 1.37 trillion yuan in revenue. The national online retail sales of agricultural products reached 230.5 billion yuan, indicating the rapid development of rural e-commerce. As a member of the industrial Internet, the agricultural Internet still needs to be improved in terms of the quality of agricultural transactions, agricultural equipment leasing and product sales. Industry leaders are actively looking for new ways to develop rural areas. Using the Internet as the basic means to promote agricultural construction, industry leaders have been building rural e-commerce systems and accelerating the implementation of e-commerce into rural areas. With the help of an e-commerce platform, the rural-related Internet sales network has been established and the new marketing model of agricultural products has been transformed from traditional sales mode to an e-commerce supply chain model.

At present, cold-chain logistics of agricultural products also has its own shortcomings, making it the only way to transfer and upgrade the logistics system. The shortcomings of the cold chain of agricultural products are mainly reflected in the following two aspects: First, the cold-chain logistics for agricultural products is less marketized. The cold chain market in developed countries has been relatively mature. Outsourcing services have been developed in the industry to contract perishable agricultural products to high-quality cold-chain logistics companies, making the market division of labor increasingly refined and specialized. To a large extent, it ensures the freshness and safety of agricultural products and reduces the logistics process's loss. Secondly, the regulations and standardization of domestic cold-chain logistics for agricultural products need to be improved. It realizes the full traceability of fresh produce logistics process, which can effectively protect all parties' interests. Domestic support for cold-chain logistics of agricultural products is very strong, but there is a lack of perfect guarantee mechanism. In order to ensure the food quality and safety of cold-chain logistics, a complete cold-chain logistics system for agricultural products should be established.

4. The construction of the cold-chain logistics model for agricultural products under blockchain technology

4.1 Blockchain adds new value to cold-chain logistics

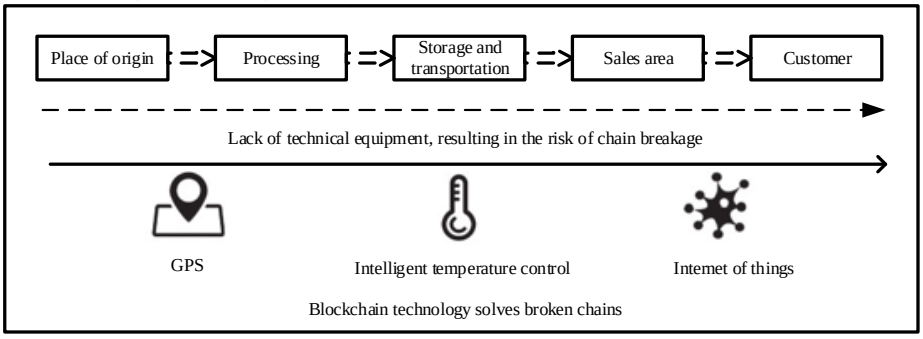

Figure 2 Blockchain adds new value to cold-chain logistics

In order to guarantee the quality of agricultural products in cold-chain logistics, the sustainability of the low-temperature environment and the dynamics of data transmission, blockchain will give this project some new technologies and new models. The first is the global positioning system. When blockchain technology applies a positioning system to cold-chain logistics, it can record the data information in real time and ensure that the location information of the product is reliable during transportation. Thus, real-time location queries of transportation vehicles can be achieved, and data traceability can be effectively carried out, so that the investigation in the later period can be effectively guaranteed in time. The second is an intelligent temperature control technology. In order to achieve high-quality assurance of products, it is necessary to control the temperature in the whole process. With the whole-process cold chain circulation technology, the goods can be in a dormant state to preserve quality. Through the whole-process blockchain quality monitoring, the loss of products can be avoided and the high cost caused by transportation loss can be reduced. Finally, there is the Internet of Things (IoT).

IoT technology gives network value to products. In the network, products can be visually managed to control the low-temperature and fresh status of products to the maximum extent, and temperature information can be collected at any time. In addition, we can use blockchain technology to implement an alarm processing mechanism to reduce the loss caused by the uncontrollable situation in the shipping process and reduce the logistics cost, as shown in Figure 2.

4.2 Occupy "The first kilometer"

In the whole logistics supply chain, "The first kilometer" refers to the distance between raw material suppliers and manufacturers in upstream of the supply chain. The first kilometer is the cornerstone of the whole cold chain supply chain system. In rural areas, it is difficult to guarantee the freshness of agricultural products due to the poor construction of cold storage and other infrastructure. Therefore, the graded storage of perishable agricultural products after harvesting is an important guarantee for the subsequent circulation of agricultural products. The front-end construction of cold chain has become the most important concern for traditional logistics enterprises and self-operated e-commerce companies, as shown in Figure 3.

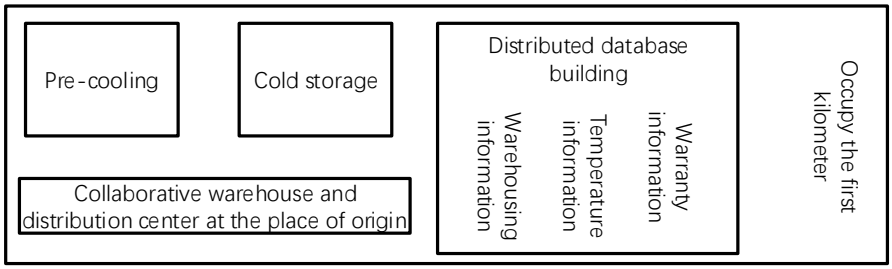

Figure 3 Blockchain technology supports "The first kilometer"

At present, the prevailing solutions to front-end problems are mainly reflected in the commercialization of cold storage and the product collection and distribution center and other infrastructure, so as to promote the commercialization of agricultural products from the field. The blockchain has the property of distributed ledger, which can keep the information of each agricultural product itself. Once an agricultural product is stored, it forms a piece of product information, which cannot be tampered with. The temperature information of the products in the cold storage will also be retained. If problems are encountered during storage, they can be effectively investigated and detected. Moreover, the data structure in the blockchain subsequent verification mode constantly reinforces the previous data content, which will enhance the credibility to the ledger. Blockchain gives special properties to agricultural products, and the authenticity of the naturally formed information can be effectively guaranteed.

5. Path for agricultural enterprises to acquire high-quality resources in producing areas

5.1 The necessity of establishing the embedded relationship between agricultural enterprises and suppliers of origin

The production resources are limited, and the quality production resources are the focus of competition among all players in the agricultural industry (including head agricultural enterprises, non-head agricultural enterprises and agricultural intermediaries). Therefore, in the later part of this paper, we will discuss the head and non-head agricultural products e-commerce as agricultural products e-commerce. It is of great significance to agricultural enterprises, high-quality suppliers of origin and the welfare of society as a whole by reconnecting (for non-head agricultural enterprises) or strengthen (for head agricultural enterprises) the linkage (a1, a2) between agricultural enterprises and high-quality suppliers of origin. The embedded relationship is concerned with the economic behavior embedded in a certain social structure. Before the introduction of embedded relationships, the analysis of economic theory on transaction behavior used to be based on the transaction itself, but ignored the social relationship between the parties in the transaction, as well as the process of establishing, maintaining and dissolving the relationship. The establishment of embedded relationships can enable the parties to move from a narrow economic rational goal of immediate gain and exploitation of others to the goal of fostering long-term cooperative relationships and mutual benefit and win-win results. Therefore, establishing embedded relationships can change the cooperation mechanism between agricultural product enterprises and origin suppliers.

In the process of cooperation with origin suppliers, agricultural enterprises should identify high-quality origin resources and change their perspective, establish strategic alliances with origin suppliers, and develop trust-based embedded relationships(lines e1 and e2 in Figure 4).Moreover, they should change from a zero-sum game to a non-zero-sum game, and transform their cooperation from the traditional market price mechanism to a relationship-based cooperation mechanism, in order to seek a longer-term development for both sides. In this way, they will be able to stand out in the competition with agricultural intermediaries for resources of origin.

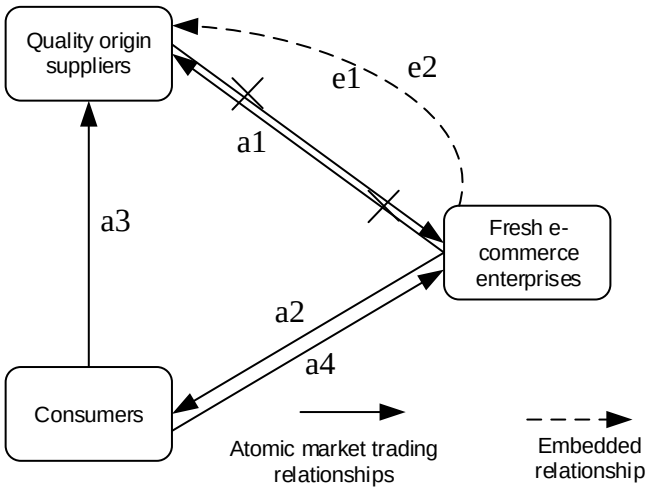

Figure 4 Access to quality resources of origin for agricultural companies under embedded relationships

5.2 The path to build an embedded relationship

In order to help agricultural enterprises, obtain better quality origin resources and better complete the layout of direct harvesting in the origin, besides clarifying the importance of embedded relationship in the process of cooperation between agricultural e-commerce and origin suppliers, they should also give actionable paths for how to establish embedded relationships. Granovetter divided the embedding into two dimensions: structural embedding and relational embedding [18]. Agricultural enterprises can consider how to build the embedded relationship respectively from these two dimensions.

5.2.1 Structural embedding path

Structural embedding focuses on the overall structure of a network and the position of network members in the overall network structure, and these two characteristics are closely related to the competitive advantage of network members in the whole network [18]. Different origin suppliers have different social networks and their positions vary in the network. Not all origin suppliers are the target of embedded relationships for agricultural enterprises. Therefore, agricultural companies need first to identify the location of the origin suppliers they should work with. Many scholars have evaluated network members' position in their social network structure from two aspects, namely network density and structural holes in the network [18]. Network density refers to the degree of interconnectedness of organizations in a network, representing the stock of social capital in the network. A higher network density indicates a larger stock of social capital in the network and a higher degree of interconnectedness among the actors in the network [19]. A structural hole is a structural location in a network that is dense with relationships and cannot be replaced. Individuals in a structural hole position connect unconnected individuals in the network and have information and control advantages [20]. By occupying a structural hole in a dense network, the agricultural enterprises can gain a great competitive advantage [21], which is one of the important criteria for the evaluation of high-quality origin suppliers. Based on this, agricultural enterprises should consider other relevant factors such as yield and quality, identify high-quality origin suppliers, develop close ties with them based on long-term cooperation, build up a network, and occupy a structural hole position in the network they have established with each high-quality origin supplier.

5.2.2 Relational embedding path

Suppose structural embedding can solve the problem of establishing the target of embedded relationship for agricultural enterprises. In that case, the dimension of relational embedding can guide how to establish the embedded relationship. Relational embedding refers to embedding a single actor's economic behavior in the network of relationships formed by the interaction of other actors. The strength of relational embedding is evaluated by four sub-dimensions: frequency of interaction, the intensity of feelings, degree of intimacy and reciprocal exchange [18]. At the beginning of cooperation, agricultural enterprises need to take these four sub-dimensions as reference standards to improve the strength of relational embedding with high-quality suppliers of origin as much as possible in order to compensate for their shortcomings in the atomic price trading market mechanism. As for specific measures, this paper provides (but is not limited to) the following ideas: First of all, agricultural products enterprises should be close to the market end, so that they can be informed of the market demand more quickly. Through frequent cooperation, they can communicate with the origin suppliers about the changes of market demand in a timely manner and reduce the risk of the origin suppliers. Secondly, origin suppliers (such as origin fruit and vegetable farmers, livestock farmers, etc.) are poorly educated. They have limited learning ability, with little access to improved cultivation techniques with new technologies, except for those handed down from their ancestors. Given this, agricultural enterprises can bring such knowledge of planting technology to farmers in the production area through special guidance to improve their efficiency. Thirdly, there are few well-known origin brands in the market, such as Chucheng and Chilean Cherries, and most of the origin brands do not enjoy popularity and reputation among consumers. Therefore, agricultural products e-commerce platforms can take a series of sophisticated marketing means to help the origin brands gain popularity and increase sales. Fourthly, financial services should be provided to farmers at origin. Through these "curve" channels, agricultural products enterprises should establish close contact with farmers of origin, so as to make up for the disadvantage of bargaining power due to the demand characteristics of many categories and small quantities, and improve the attractiveness of agricultural products enterprises to farmers of origin, so as to achieve the ultimate goal of mutual benefit.

6.Conclusion

In this paper, it proposes a blockchain technology solution for cold chain logistics industry by combining blockchain technology with embedded technology. It achieves asynchronous call contract by introducing message queue middleware, improving the efficiency of data cochain. Meanwhile, the system will monitor whether the data cochain is successful, and it will be on cochain again if there is no data on cochain due to timeout and other reasons, so as to ensure that the data in the message queue can be completely on cochain, which not only ensures the integrity of data, but also does not cause data loss. It ensures the security of data transaction by designing member management service, that is to say, it can join the blockchain network only if it holds the digital certificate issued by specific certificate authority. At the same time, it achieves data isolation through multi-channel mechanism in order to ensure that data is only shared among the relevant parties in each logistics transportation process. The order data is encrypted in the transmission process through the combination of key exchange protocol and symmetric encryption algorithm in order to ensure the security of logistics order transmission. It ensures that only relevant embedded devices can upload data by associating digital certificate with physical information of embedded devices. In a word, it will surely improve the mutual trust of logistics industry, reduce costs and improve security combines blockchain technology with cold chain logistics by combining blockchain technology with cold chain logistics.

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