

# Study of Visual Traceability System based on Blockchain

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**Abstract.** Food and drug safety issues are becoming prominent. However, the common traceability systems are mostly for fresh foods such as vegetable and meats, but not cover the wide range of products. In addition, in the current traceability system, the problem of information storage has not been taken seriously. But through the blockchain, the information can be fully transparent and cannot be falsified. In this paper, the traceability system for general products is designed by using the characteristics of blockchain technology.

**Keywords:** product traceability; blockchain; visualization; traceability system.

## 1. Introduction

With the advancement of economy and technology, the safety issue has become increasingly prominent. The problem of food and drug safety has emerged in an endless stream. The news of fake milk powder, fake vaccines, and fake Chinese herbal medicines appears from time to time. In early 2018, E. coli (*Escherichia coli*) outbreaks to 36 states in the United States, killing five people. Farmers and suppliers threw away millions of lettuces. Finally, people found this epidemic from a mango farm in 7 days later. In the 1970s, BSE (bovine spongiform encephalopathy) broke out, [1] and developed countries began to establish food safety traceability systems for livestock products such as beef.

Blockchain technology has entered the public's vision these years. Its decentralized and trustless features are well known but the real applications are rare. Especially in the product traceability combined with the IoT. IBM built a food trust solution on the blockchain platform for Wal-Mart's vegetable issues. Shanghai also establishes a vegetable traceability system for 6 vegetable bases to guarantee the supply safe. Most of the traceability systems are for agricultural products that do not require processing. However, the most products have more processes like manufacture, storage and transportation. These traceability processes are complex and must involve large amount of data. If we still rely on the central database which most of traditional traceability systems are using, it will be error-prone because of human factors or some machine reasons.

This paper will use the blockchain technology to store the data including processing, storage, transportation and even the stores, so that we can ensure that transaction information is not falsified. Decentralization can avoid threats caused by excessive central rights. We will also build a consumer-oriented system for product traceability. This system will show the information on the blockchain in a visual interface to consumer and help them understand the process of their products traceability.

## 2. Product Traceability System Requirements Analysis

What we want in this system is that consumers can check the authenticity of the product and know the source of the products by inputting the tracing code on the product packaging. It also makes it easy for the manufacturer of the product to find the problem product in time and know which part of the problem is going to be recalled and evaded in the future. The blockchain-based visual traceability system can store the raw material information, processing flow information, storage environment information, and transportation information of each product in the form of transactions, and it can ensure data security at the same time. The system includes three modules: user interface layer, intermediate function layer and blockchain data layer, which show in Fig. 1.

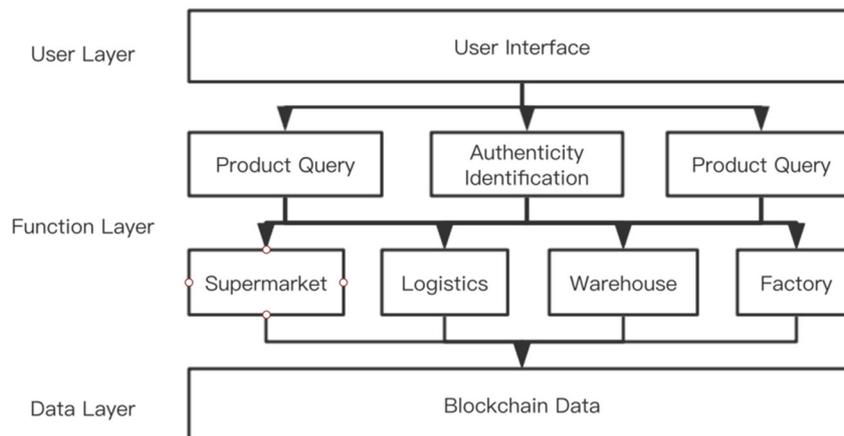


Figure 1. The construction of blockchain-based visual traceability system

The interface is designed for users to query the product source by inputting the tracing code of the product, and then present results to the users in a visual form. In recent years, the purchasing activities of various categories have flourished. Some unscrupulous merchants sell fake products by using brand packaging and pretend these products bought from overseas. Through this design, users can know the true source of the products and know whether the purchasing is true or not. While honest merchants can further enhance their user stickiness.

The middle functional layer mainly implements three functions: product query, product authenticity identification and problem product recall. Product query is for all products. Authenticity identification is for hot cosmetics and products of mega brands that are prone to fakes, and also for those products which have the huge impact, such as milk powder, medicines, luxury goods, etc. Product recall is mainly for products that are in the state of counterfeit after identification. Users can report the specific manufacturer according to the source information of the product. All these functions above need to link to the data from retailers, logistics, warehouses and factories.

The underlying blockchain data is equivalent to a database, but data is stored in the blockchain. The implementation of the above functions requires calling the database on the blockchain for presentation. The advantage of using a blockchain is that it can guarantee the authenticity of the data. Product information is not easily tampered with and is monitored by all nodes after being stored.

### 3. System Design

#### 3.1 Blockchain Network Design

In this system, we use blockchain to upload and store the data. All parts in the supply chain are the nodes of blockchain such as producers, transportation companies, and retailers.

##### 3.1.1 Consensus Mechanism

In this paper, we choose PoW and DPoS to be our consensus mechanism. PoW is used at the beginning of the blockchain to create the genesis block. When the number of nodes in blockchain is enough and the blockchain runs stable, the system changes the consensus mechanism to DPoS.

PoW's advantage is high security, [2,3] but it consumes a large amount of energy during its operation and the process of calculating random Numbers results in a slow speed. On the other hand, DPoS relies on the stakes owned by the nodes and only a part of nodes joins the consensus calculating. Thus, it solves the problem of low speed, but it sacrifices some decentralization features because it limits the bookkeeping right to a small number of nodes each time.

Combining these two consensus mechanisms, the creation block was generated by PoW and change to DPoS when the blockchain is stable. In this way, we can ensure the stable operation of the system and reliable data at the initial stage. After the volume of transaction data increases, DPoS mechanism is adopted to meet the business demand.

**3.1.2 Workflow of Blockchain**

In the blockchain, once the transaction data is received by the block, all participating nodes will store a copy of the transaction. This traceability system contains several main transaction roles: producer, logistics company, retailer and costumer. Any one of these nodes can prove the transaction. If someone attempts to tamper with the transaction record, other honest nodes can prove its illegal behaviour according to their own records of the transaction, and this dishonest node will be kicked out of the chain.

Producer is responsible for the production of the goods, and then delivers the goods to logistics company. The producer defines its own transaction information, and publishes the initial transaction number, producer information, production data, batch, data of manufacture, quantity of goods and etc. on the network to create a transaction.

Retailer sells goods directly to the consumer, which is the final stage of commodity circulation. It connects the producer and consumer. Its transaction information includes the previous transaction number, current transaction number, retailer information, batch, quantity of goods and time of listing.

Costumer is an individual or organization that purchases products from a retailer. Logistics company delivers goods from producer to retailer and its transaction information contains previous transaction number, current transaction number, logistics company information, transportation information, transportation route and consignee.

The basic flow of trading between trading roles in this article is shown in the Fig.2.

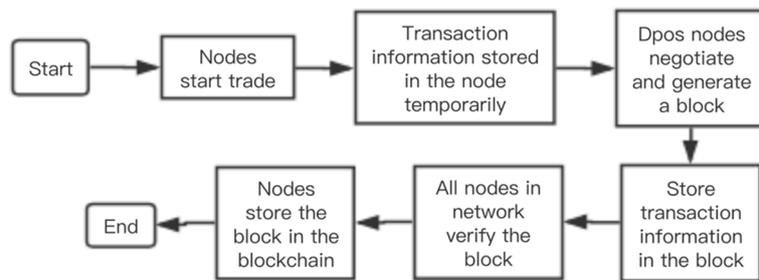


Figure 2. System transaction.

**3.2 Functional Module Design**

This section is designed for the three functional modules of product query, authenticity identification and product recall in the middle layer.

**3.2.1 Product Query**

The users enter the tracing code on the product packaging for query. The process shows in Fig.3. First, the system determines whether the tracing code format entered by the user is correct and whether there is such a code. If this code does exist, the system conducts the query and displays the result to the user. The query results will be displayed in reverse order, starting from the information of the store purchased by the user, then going back to the logistics information, storage information and factory processing information. At the same time, the flow direction of products from producing to selling will be presented in the form of map. So as to facilitate users to view the source and flow process of products in an intuitive way.

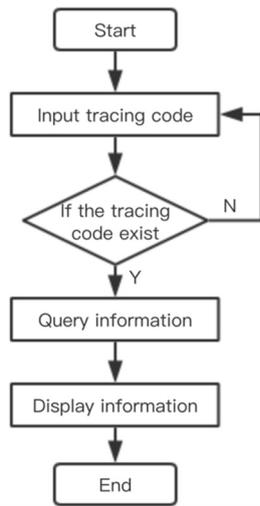


Figure 3. Product query process.

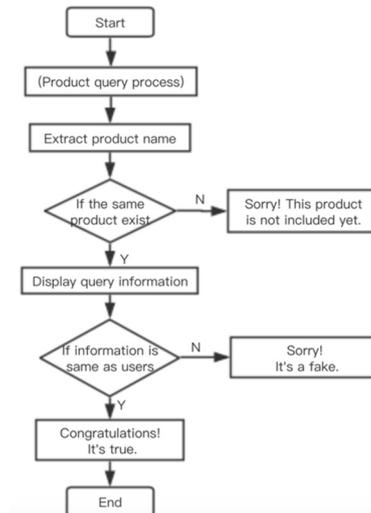


Figure 4. Authenticity identification process.

### 3.2.2 Authenticity Identification

Authenticity query is mainly aimed at advanced cosmetics, imported products and precious traditional Chinese medicine drugs. through the comparison of query results and original records of the product, the system can realize the authenticity identification. The specific process is shown in Fig. 4. After the user makes a query, the system will extract the brand, category and name of the product and search in the existing database. If it does have such product, system will show it to the user. Then the system does the judgement of whether the information is the same as the user's query result, and output true or false conclusion to the user.

### 3.2.3 Product Recall

Product recall is a function for producers. But users can report defective products and trace the flow of recalled products when the manufacturer makes a recall. When the user finds out that the product is fake in the authentication process, he/she can choose the producer by comparing the information of the real product to report it. After the verification, the producer needs to recall the product and release the recall process. The user can query the recall status of the problem product in the product recall interface.

## 3.3 Blockchain Traceability Process

The blockchain is a block that is grouped together in a chain. Each block contains transaction information of the previous block. So, the first block to the current block are connected together to form a long chain. For this paper, the technical principles and processes for customer traceability to goods are as follows:

After the customer and the retailer trade successfully, the product is resourced by inputting the tracing code. Since each block contains the hash of the previous block, the system will backtrack the previous block through the hash contained in the current block, and find the previous transaction of the item corresponding to the transaction number. Finally, the system can query the initial transaction of the good to achieve the purpose of traceability.

The specific process of traceability of the transaction is shown in the Fig.5.

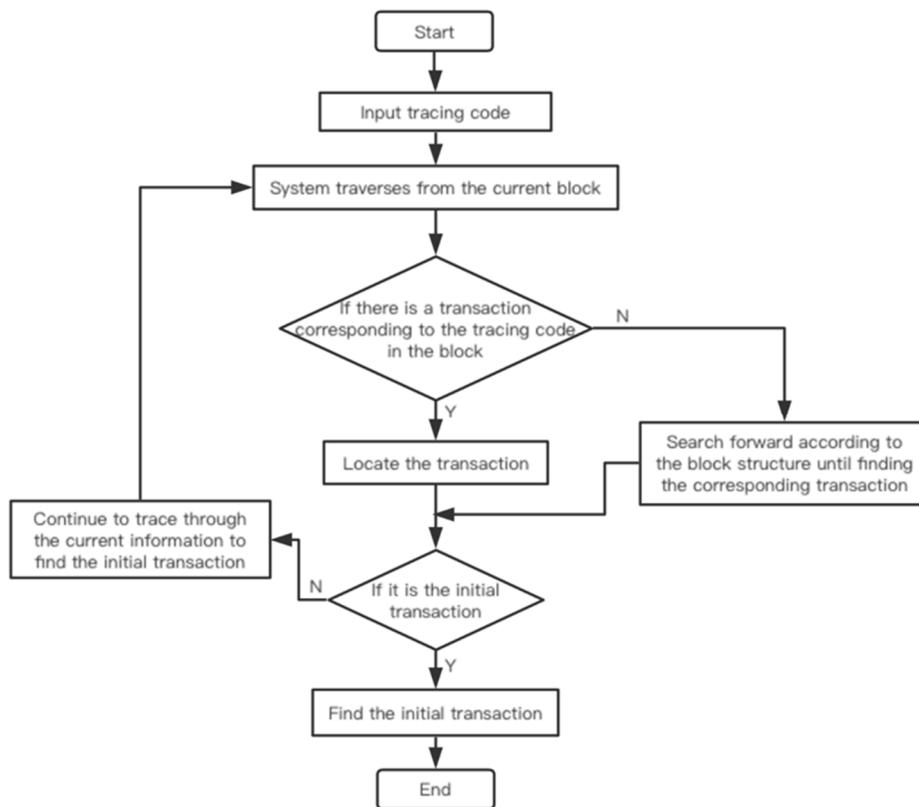


Figure 5. Tracing process of the transaction.

First, the transaction before the tracing is required to be filled in and successfully stored in the block, so that we can trace the transaction information according to the previous transaction number. Second, the user who traces the source can know where the transaction is located by entering the tracing code. The block contains multiple transactions, and the user locates the current transaction position by the transaction number. Choose the shipper’s name, and the system internally queries the previous transaction of the current transaction through the blockchain structure. Then, repeat the second step until the user can trace back to the initial transaction to reach the source.

### 3.4 User Layer Design

A simple and clear interface is designed for consumers. They can use it directly. The webpage connects to the blockchain data and display the product information to consumers. For example, the map indicates the location and flow direction of the production and transportation of the product like Fig6. shows.

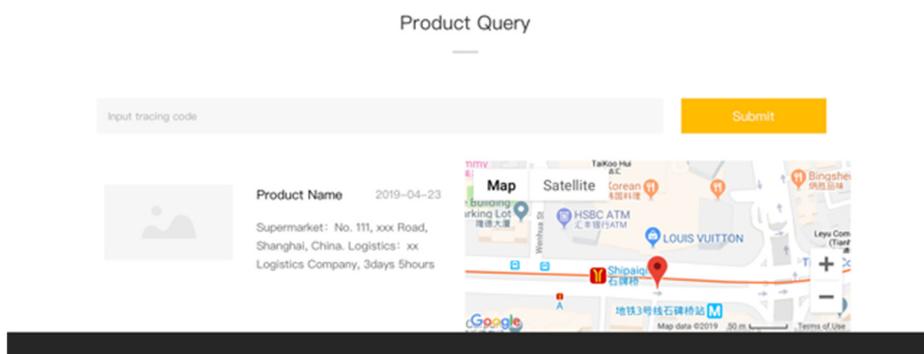


Figure 6. Product search sketch map.

## 4. Conclusion

This paper designs a traceability system based on blockchain technology for general products, and this system uses a visual interface to display information to consumers. The blockchain system in this paper adopts a new combination of consensus mechanism--PoW+DPoS. It can solve the problems like the loss of trust between consumers and producers, the opacity of product information and the mistrust between enterprises. This system also provides a connector for the user layer to read and call information, so that users can query and trace product through the system in this paper, so as to improve the safety of daily life.

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