Information Traceability Management of Food Cold Chain Based on Blockchain Technology

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Abstract: With the development of China's economy and society, people's quality of life, food security problems continue to appear, people's awareness of food security gradually improved, in order to make people at ease to buy food, food cold chain information traceability management has become a concern. The purpose of this paper is to study the information traceability management of food cold chain based on blockchain technology. According to the combination of blockchain technology and food traceability system, pork is selected as the specific tracking object and application prospect, and a specific scheme of meat food cold chain information traceability management system is designed. The system was deployed using RFID sensors and other technologies, and the effectiveness of the traceability system based on data block chain was verified through black box testing and performance testing.

Keywords: Blockchain Technology, Food Cold Chain, Information Traceability, Traceability Management

1 Introduction

Economic globalization is changing people's way of life and exerting a profound impact on global economic development. Continuous food safety accidents and food recalls in the global market have increasingly drawn people's attention to food quality. However, the rapid development of the whole society has also aroused people's desire, and many food production and processing enterprises completely ignore the word honesty. Food production and processing do not pay attention to quality, but only to sales (Ayushi Srivastava, 2022, and Nishant Kumar, 2022). Food quality concerns the safety and personal interests of every consumer. Both producers and consumers want to know the raw materials and sources of their food or final consumer products to ensure the reliability, safety and quality of food (Fran Casino, 2021, and S. Balamurugan, 2021).

Amitangshu Pal pointed out how effective food security work depends on traceability. The economic importance of combining private stock incentives with social benefits is reviewed (Amitangshu Pal, 2019). The Internet of Things (IoT) in food traceability provides new ideas for solving intelligent production problems and for meat product safety and quality market formation. Based on data from 264 pig households in Shaanxi, Renato Ferrero used the Unified Technical Acceptance Theory (UTAUT) to explore the factors influencing the

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adoption of technology by pig breeders. The results show that farmers' willingness to adopt is influenced by farmers' performance expectation, effort expectation, social influence, individual innovation and risk perception. Individual innovation plays a mediating role in the effort of expectation and adoption intention, while risk perception plays a moderating role in the effort of expectation and adoption intention (Renato Ferrero, 2022).

The innovation of this paper: This paper creatively uses the principles, characteristics and applications of blockchain technology to analyze the feasibility of combining blockchain with food cold chain information traceability management system, and discusses how to combine blockchain technology with food cold chain information traceability management system to solve the problems in the system.

2 Technical Requirements for Cold Chain Food Traceability

Because cold chain foods require higher temperatures and shorter life cycles, the technical requirements for their production, processing, transportation and marketing are higher than for ordinary foods during the traceability process. Here are some of the current technical requirements and issues:

(1) Requirements for temperature management

The traditional temperature management is to install a thermometer in a truck or warehouse. The temperature management must meet the following requirements.

Easy to manage. In many cases, food is managed by one or more distributors. Temperature management usually requires the collaboration of multiple companies, which makes it difficult to effectively implement the management system in the system (Iresha D, 2021, and Rebekka Wohlrab, 2020).

Easy to collect data. Thermometers installed in warehouses and trucks are used for management purposes and require regular real-time temperature checks. In some management systems, temperature recorders are also used to change the process of actually connecting each record to the computer and collecting data for manual manipulation (Othmane Rahmaoui, 2019, and Leticia Morales-Trujillo, 2019).

(2) RFID sensor labels

RFID sensor tags combined with temperature, humidity and other factors are used, which usually record sensor data into memory on a regular basis. The readable label store provides access to labels whose state meets the requirements of temperature management (Aniruddha Bhattacharjya, 2022). RFID sensor tags with integrated storage measure and record the current temperature.

(3) Early warning system

With regard to the temperature requirements for cold chain foods, the temperature should be kept at a constant low temperature during the traceability of special foods. In order to avoid the failure of the temperature management system and avoid unnecessary losses, an early warning system should be installed in the food warehouse or truck container to monitor and

report the temperature in real time through the connection with the food traceability system terminal.

3 Food Cold Chain Information Traceability Management System Based on Blockchain Technology

3.1 System Environment Deployment

The food cold chain information traceability management system developed in this paper runs in the Windows environment. The front-end page is developed as HTML, CSS and JavaScript, and the back-end is developed as Python. The database uses SQLite to complete the functional business module of the system through the end-to-end combination.

3.2 Deployment of Pork Cold Chain Temperature Sensor Nodes

Sensors must be deployed on multiple nodes. The positioning of the sensor can be realized normally. The rule implementation involves dividing the monitoring area into a network and placing sensors at the center or node of the network to ensure that the temperature data being monitored is representative. Therefore, the design of this paper is to install six sensors on both sides of the cold chain car in Figure 1, and each sensor runs every 15 seconds.

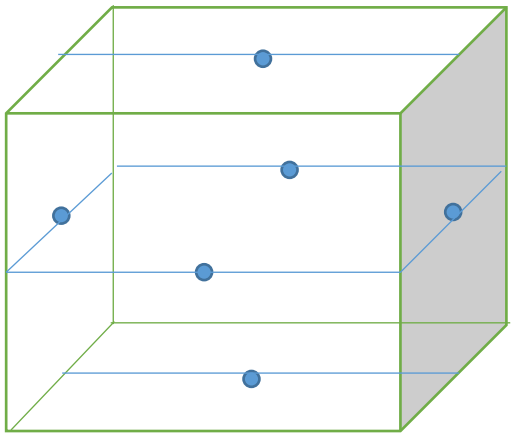

Figure 1. Distribution position of car sensor

3.3 Temperature Data Feature Fusion Model

The judgment of outliers can be determined according to Chauvigne criterion. We implement sensors every 15 seconds to collect data, which is more suitable for 5-minute data collection intervals. For a single sensor, 20 sets of temperature data were measured within 5 minutes, and the resulting temperature data were defined as t1, t2... According to formula (1) and formula (2), the mean value and standard deviation σ are calculated respectively:

$$\bar{t} = \frac{1}{n}\sum_{i=1}^{20} t_i \tag{1}$$

$$\sigma = \sqrt{\frac{1}{20}\sum_{i=1}^{N}(x_i - \bar{x})^2} \tag{2}$$

According to Chauvigne criterion, the outliers are calculated and eliminated, and the outliers tmin and tmax are calculated according to formula (3).

$$\begin{cases} t_{\min} = t_i - ks \\ t_{\max} = t_i + ks \end{cases} \tag{3}$$

where ks is the confidence limit.

3.4 System Functions

The functional structure of the system is shown in Figure 2:

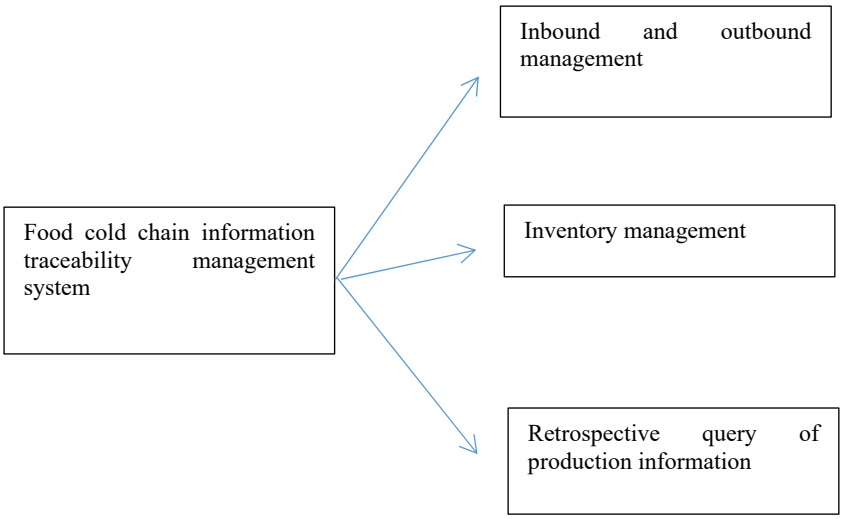

Figure 2. System function structure diagram

(1) Import and export management

The 915 card reader is installed at the door of the warehouse. When the power supply with the unique RFID tag passes through the port, the card reader will check all the tags and display the storage management interface on the display, including all the food information to be stored. The output information can be transmitted to the background database server through the

network.

(2) inventory management

The glass cabinets are numbered, RFID identifying the cabinet number is marked, and the food is classified into different cabinet numbers by type. During the inventory, the staff took away the RFID marking machine and scanned the cabinet number first, then the food inside. The RFID dialer displays the label information read this time. When the device is confirmed, the inventory data is transmitted to the background database through the network. The staff take stock of each cabinet in turn. After taking inventory of all cabinets, the device can query and print a table of differences between the actual inventory quantity on the computer terminal and the amount recorded by the computer. If there is a loss or profit, the equipment can be manually recovered or adjusted inventory quantity.

During an inventory task for a single project, the inventory information obtained from the computer is transmitted wirelessly to the server. Figure 3 shows the process of transferring information from the warehouse to the inventory machine.

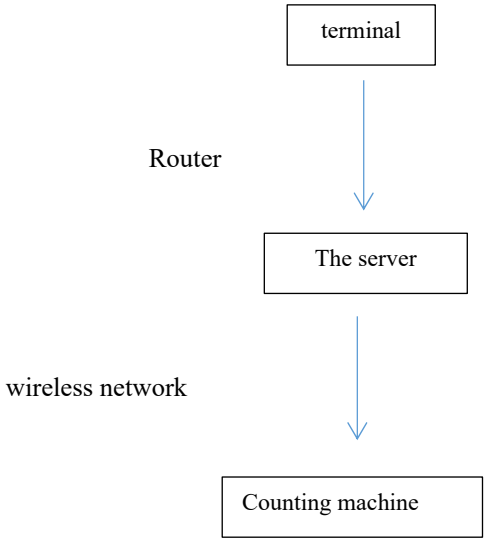

Figure 3. Information transmission diagram of counting machine

(3) Traceability inquiry of production information

The traceability query of production information is the core part of the whole traceability system. The verification of all aspects of food information through information traceability is essential to ensure the safety of food production and to regulate the operational behavior of professionals in the production of high-quality products.

4 System Test

One of the important means to ensure the stability and reliability of the system is the test system. This section tests system functionality designed to ensure system stability and reliability.

(1) Black box test

Black box testing, also known as functional testing, does not care about the internal structure and algorithms of the program. Queries require files to make the test system work with output data obtained using input data. The purpose of the cold chain information traceability management system test is to ensure the normal access and use of other functional modules in the traceability system. This project performs various functional tests on each functional module of the system. List some examples of functional tests, such as Table 1:

Table 1. System test results

Working with Objects	Test function	Expected results	test result
system administrator	Retrieve administrator and add primary or secondary permissions	Return to modified successfully	normal
Breeder	View or modify the basic information of the feeding administrator	Return to modification results	normal
Production and processing administrator	View or modify production processing	Return to modification results	normal

According to the test results, it can be confirmed that the block-based food cold chain information tracking management system can be accessed normally, and the functions of each module can be used normally to ensure the stability and reliability of the system.

(2) Performance test

Test individual modules using the LoadRunner performance test tool to simulate concurrent user operations. Test whether the system runs stably in the multi-user concurrent loading operation, as well as the maximum number of concurrent supports and the required indicators. And provide data support for further system adjustment. The performance test results are shown in Figure 4.

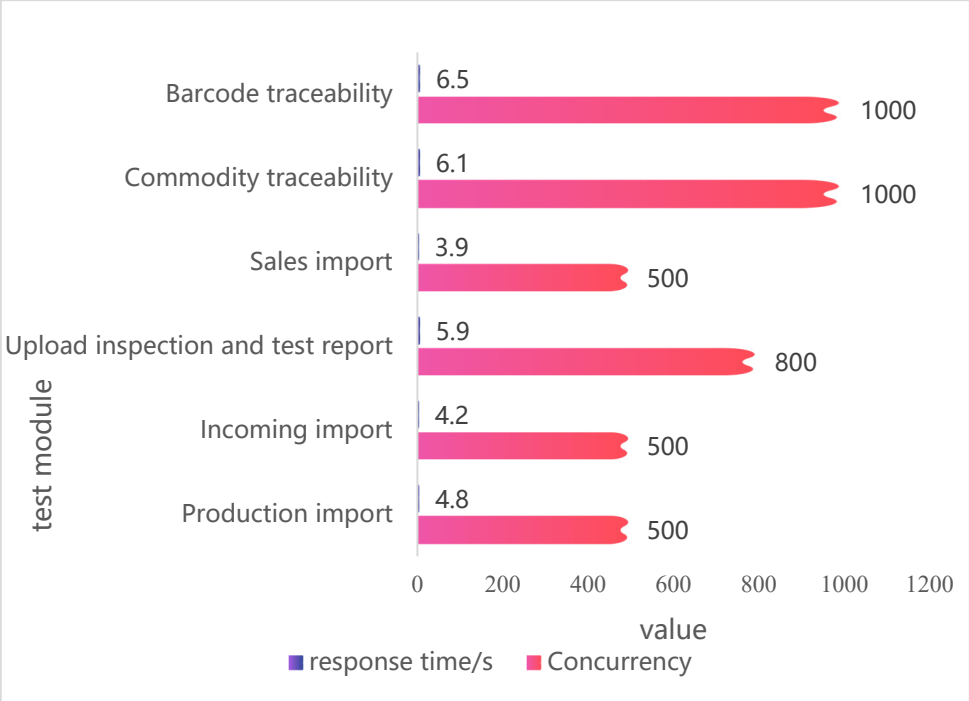

Figure 4. Performance test results

5.Conclusions

In addition to directly harming the health and life safety of consumers, many food safety incidents also have a very negative social impact, leading to a crisis of consumer confidence in the food industry as a whole and affecting its speed of development. Because of the fragmentation and fragility of data, blockchain technology is well suited to traceability. This paper focuses on the combination of block and chain technology and traditional food security monitoring. As there are few related works available for reference, this paper is based on the premise of good research on the principle and mechanism of blockchain technology and method, and detailed analysis of the needs and methods of food security traceability construction, and proposed the method of combining blockchain technology with food tracking.

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