DEVELOPMENT OF THE PROTOTYPE OF CLOUD-BASED FOOD SAFETY TRACEABILITY SYSTEM

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ABSTRACT

Currently, concern about food safety is increasing dramatically. So food safety traceability system provides transparency and safety in consumer trust. This study aimed to develop a traceability system prototype which enables users to trace the food products from the manufacturer's production process back to raw materials from suppliers. Developing a prototype of the cloud-based food safety traceability system for food production management for chilled and frozen food and vegetable products is divided into two stages. Design a model of the cloud-based food safety traceability system for food production management. Besides, assessment of a prototype of the cloud-based food safety traceability system for food production management. Results of the evaluation of the system prototype by three experts, overall performance has the highest efficiency. Meanwhile, the users are satisfied with using the system prototype.

KEYWORDS

Cloud-Based, Food Safety, Food Production Management, Prototype, Traceability System

1. INTRODUCTION

Currently, the concern about food safety is increasing dramatically. So food safety traceability system provides transparency and safety in consumer trust. The traceability system lets final users verify feedstock quality in the food chain, from final users to production processes in the food industry (Foreign Agricultural Advisory Office for the European Union, 2022). Besides, traceability from the food industry to the supply chain.

Food traceability is essential in the industry, where consumers can trace each manufacturing process step. In addition, specialists can trace back when defects or problems occur in the production process. It is possible to ascertain the source of food quickly. Reduce the costs and quantity of recalled items because they can identify only the lot in question. They are increasing food safety requirements, besides complying with consumer demands that consumers want to know the origin of food. In addition, it prevents unsafe foods from reaching consumers (Foreign Agricultural Advisory Office for the European Union, 2022; Giuseppe T. et al., 2019).

In the study of Zheng M. et al. (2021), rice was used as an example and proposed food safety traceability systems using two-dimensional RFID code and big data technology with the Internet of Things. The article applies RFID technology to the system by analysing system requirements and designing tables and database systems. The process of information for food production is traceable through the design of dynamic query platforms and portable devices. In the study, a food-safety traceability system based on big data and the Internet of Things will guarantee traceable information's integrity, reliability and security. It is an effective solution that improves the reliability of traceable information. It ensures the integrity of information and has a high-performance data storage structure.

The main components in the application with RFID are (1) RFID Tag or Smart Label or Electronic Label. Microchips and antennas use for attaching electronic objects used to store information. There are several variations in their usage, (2) RFID readers or interrogators, devices used for the use and recording of data into the electronic label, which send radio signals to electronic devices for returning information and converting the received signals into digital formats for further processing. This device is both fixed and portable that can use as appropriate. RFID uses radio waves to read and record data, reducing barrier restrictions. It is possible to hide electronic labels in objects and read multiple tags simultaneously (Maimun, P., 2016; Kuawtaweekun, T., 2016).

Manufacturing is facing challenges in improving productivity. Modern factories will send several machines to the production line/assembly line. Each engine on the assembly line generates a large amount of detection and production data. The article aims to develop a distributed traceability system with Blockchain technology on IoT devices to improve the stability of factory production lines. To reduce the defect rate and raise the performance to a new level without relying on centralised data storage. It's a distributed and robust system. It can withstand node failures with better scalability and data interaction. The distributed network enables secure data collection and the potential of public traceability system protocols. In addition, it allows many factories to participate and build a shared traceability ecosystem (Shih, C.S. and Yang, K.W., 2019).

Improving services for pilgrims is one of the priorities of the Saudi Arabia government. Food supply is considered one of the primary services for pilgrims. In the current situation, meals are prepared under non-specific standards or regulations. Besides, the quality assurance process needs to work with multiple providers. The article proposed solutions for solving the problems by introducing the automation of all food supply services by establishing several centralised and specialised food factories operating under a single authority, widely distributed to cover a large area of the pilgrims. The factory will be responsible for food service to the performers on time without compromising the quality. The proposed system uses blockchain technology for quality control in the supply chain to record every transaction, verify the origin of every material used in food production, and track any problems at the source. Food will be cooked under specific standards and requirements, digitising the quality assurance process and making it more centralised (Radain, D. T. et al., 2021).

Tian, F. (2017) developed a food supply chain traceability system for real-time food tracking based on HACCP (Hazard Analysis and Critical Control Points), blockchain and the Internet of Things. Which can provide an information platform for all supply chain members with openness, transparency, impartiality, reliability and security. In addition, it introduced a new concept, BigchainDB, to fill the gaps in decentralised systems by scale. It concludes with a description of the use case and discusses the challenges of implementing blockchain technology in the future traceability system of the food supply chain.

In Taiwan, small-scale farming is common; most farmers grow crops based on their experiences. Therefore, excessive spraying of insecticides and fertilising often occur. In addition, raising livestock with management strategies in the enterprise can sometimes lead to antibiotics or other harmful chemical residues. The Taiwanese government has established a product traceability system with traceable markers. All agricultural products' information can be inquired through farmers' records on production and sales through Taiwan's agricultural product safety inspection information network. Qualified organisations will visit the production site to confirm whether the production record meets the requirements. By sampling the product, every batch inspected is recorded and traceable. Taiwan currently promotes a system of traceability of agricultural products and hopes that farmers will use it voluntarily. The traceability system can cause inconveniences that all farmers do not accept. Therefore, the study developed a traceability system of farm productivity using the Internet of Things technology, allowing the system to generate real-time production records (Jiang, J. A. et al., 2017)

The study of Tanthidolanet, N. and Boon Ying, S. (2020) has developed a model for the traceability of safe food crops in communities with RFID technology. The results showed that the community-based safety food crop traceability model with RFID technology consists of three modules: Module 1 for administrators, Module 2 for farmers, and Module 3 for customers.

Green Food operates a business related to processing agricultural products, vegetables and fruits by processing them into streaming, chilled and frozen products. The company uses raw materials ordered from various suppliers. In addition, there is a large number of documents related to the processes. Previously, Green Food implemented a manual archiving system that created problems in case of wanting to trace back which raw materials were received. When raw materials and processed goods are stored, such information is difficult to find and takes a long time. Sometimes a document is faulty, mismatched information cannot verify the correct information, or the document cannot be searched. The information is not up-to-date. At the same time, most studies of Thailand's agricultural food product traceability systems are aimed at traceback from manufacturers to raw material suppliers. This study contributes to developing a prototype of a cloud-based food safety traceability system, which enables final users and auditors to trace the food products from each production process of the manufacturer (Green Food) back to raw materials received from various suppliers.

Then conduct an implementation of a traceability system, a case study of Green Food as a pilot. The proposed system can manage the frozen fruit and vegetable production process semi-automatic, with RFID technology to meet the needs of Green Food.

2. METHODOLOGY

The research was conducted to develop a cloud-based food safety traceability system model. The study aimed at a food safety traceability system for the stream, chilled and frozen food and vegetable products industry, namely Green Food, as a pilot.

2.1 Data Collection and Analysis

The data collection using an assessment form for a prototype of the cloud-based food safety traceability system for food production management. The population in the study consisted of experts who have experience in the area of information and communication technologies. The sample group comprised of three experts who either held a doctoral degree or had at least five years' experience in information and communication technologies for evaluation and suggestions. A purposive selection method was selected. Jamil (as cited in Hamzah, F. et al., 2019) stated that a minimum of five years of working experience would ensure expertise in their respective fields. Analyse the results of the evaluation of the appropriateness of a system prototype using mean and standard deviation.

2.2 Research Processes

The research is divided into two stages.
Stage 1: Design a model of the cloud-based food safety traceability system for food production management.

1.1 Relevant articles and research papers were analysed and synthesised in the following topics: Cloud technology, traceability system, Internet of Things, information and communication technologies, food safety and food production.

1.2. Use the obtained information to synthesise and summarise as a model of the cloud-based food safety traceability system for food production management.

1.3 Research instrument was designed as an evaluation form. Five criteria for evaluation were considered using the 5-levels Likert scale anchored with the terms Strongly Agree, Agree, Undecided, Disagree, and Strongly Disagree (Samsudin, S. et al., 2019; Brown, S., 2010).

Stage 2: Assessment of a prototype of the cloud-based food safety traceability system for food production management.

2.1. A system prototype was proposed for evaluation by the three identified experts. There are five aspects of black box testing, such as (1) functional requirement test, (2) Functional Test, (3) Usability Test, (4) Performance Test, and (5) Security Test.

2.2 Analyse the system prototype's evaluation results using mean ($\bar{X}$) and standard deviation (S.D.).

2.3 Results of the Study

Stage 1: The model of the cloud-based food safety traceability system for food production management was designed as illustrated in figure 1.

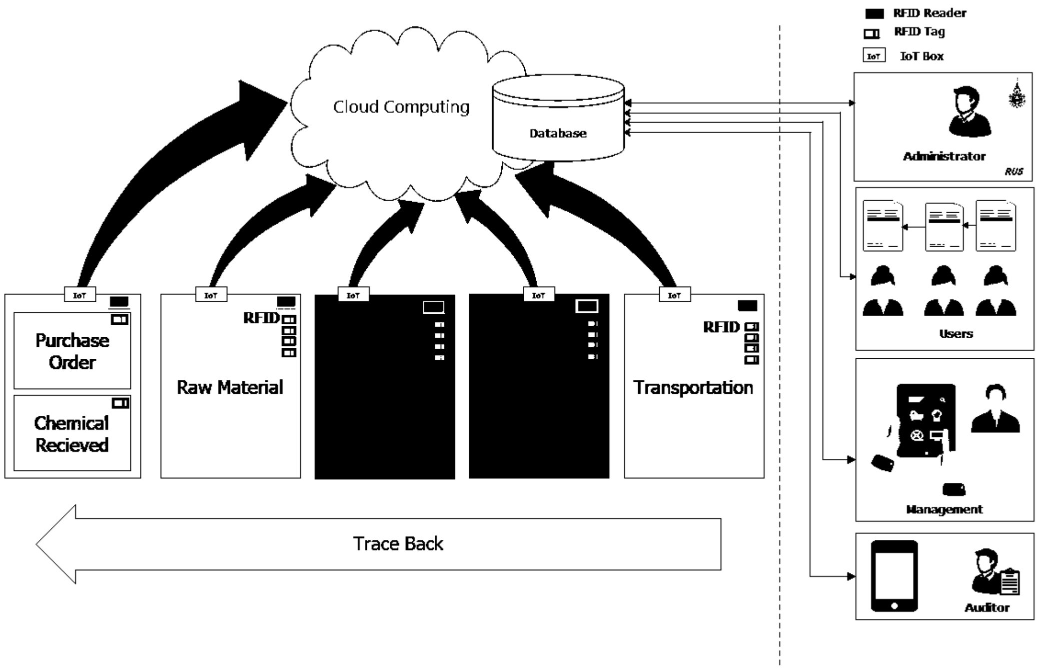

Figure 1. Model of the cloud-based food safety traceability system for food production management

Figure 1 shows a model of the cloud-based food safety traceability system for food production management consists of three parts as follows:

1. The online document recording includes (1) Purchase order, chemical received, (2) Raw material, (3) Production, (4) Packaging, and (5) Transportation.
2. The application which manages the daily documents.
3. RFID package for monitoring and tracking work processes.

Stage 2: Assessment of a prototype of the cloud-based food safety traceability system for food production management.

1. Conduct experiments using the system prototype to manage the production processes for the stream, chilled and frozen food and vegetable products industry, Green Food.
2. The system’s users were divided into two groups: administrators and users, supervisor and operator.
3. Results of the assessment to determine the effectiveness of the system prototype by three experts, using five aspects of black box testing. The system's overall performance has the highest efficiency level, with an average of 4.57 and a standard deviation of 0.57. when considering each aspect, it found that the system's speed of operation has the highest efficiency, with an average of 4.73 and a standard deviation of 0.46.

The results of the system prototype evaluation in each aspect are as follows. (1) Functional Requirement Test has the highest efficiency, with an average of 4.67 and a standard deviation of 0.48. (2) Functional test has the highest efficiency with an average of 4.46 and a standard deviation of 0.59. (3) Usability Test has the highest efficiency, with an average of 4.54 and a standard deviation of 0.66. (4) Performance Test has the highest efficiency with an average of 4.73, and the standard deviation is 0.46. (5) Security Test has the highest efficiency, with an average of 4.42 and a standard deviation of 0.67.

4. It found that users are satisfied with using the system prototype. Whereas it is easy to use, reduces document processes and human errors, and enables to monitor of raw materials and finished products. Besides, enable to trace back sources of raw materials. So it increases overall productivity in the production processes.

3. CONCLUSION

The prototype of the cloud-based food safety traceability system for food production management for stream, chilled and frozen food and vegetable products of Green Food can work properly.

The systems model consists of three parts as (1) The online document recording, (2) The application which manages the daily documents, and (3) RFID package for monitoring and tracking work processes. It is easy to use and efficiently identifies raw materials' sources without human errors. Results of the assessment of the system prototype by three experts, overall performance has the highest efficiency level. Meanwhile, the users are satisfied with using the system prototype.

Presently the system prototype is under development with chilled and frozen fruits and vegetable products industry, Green Food. It can monitor and record various stages in managing production processes in chilled and frozen fruits and vegetables. There are a lot of audit documents to ensure the system works efficiently. In terms of changing the trajectory of employees from a manual inspection system to an automatic system using RFID technology. At the initial stage, it should be done as a parallel system. Both manual inspection and automated inspection systems with RFID technology.

Researchers will develop a system for streaming fruits and vegetable products for further study. Then should broaden the usage temperature range of RFID from -30 to 120 Celsius. In addition, comparisons are made to summarise the performance periodically by planning the work in a sequence of steps according to the document process flow system.

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