

Research on Tracing Strategies of Catering Food Safety Based on Internet of Things Technology

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Abstract: Food safety traceability is a technical tool that can effectively prevent and improve food safety problems. This paper makes an analysis of the current traceability methods and reviews the progress of catering food traceability. This paper introduced the Internet of Things, RFID electronic tags, two-dimensional code tags and other technologies, elaborated on the establishment of the food safety traceability system in conjunction with related technologies. Taking the traceability of catering and food safety as an example, The paper performs system management of catering food in the production of raw meat products, production of raw vegetable materials, procurement of raw materials, and supplementary cooking materials as well as the cooking process. It pioneers the use of single product management to achieve accurate traceability, which has realized the monitoring and management of food warehousing and logistics through sensor equipment. Accurate traceability of the sales of goods can be achieved on mobile phone app. It analyzed and designed the various links in the traceability system of catering and food safety. Then, the implementation methods and tasks undertaken in each link were given, which verified the significance of using this system.

Keywords: Traceability, Internet of Things Technology, Two-Dimensional Code, Food Safety

1. Introduction

Contaminated meat, illegal cooking oil, fake beef, drug residues in agricultural products and other food safety incidents happened frequently, which seriously threatened the health of consumers, caused strong dissatisfaction and widespread concern among consumers and affected the continuous and stable development of the food industry. In addition to self-discipline and accountability of food manufacturers for food safety, social supervision is also a strategy for addressing food safety.

Food safety concerns the national economy and people's livelihood. According to a survey, the average rate of eating out for three meals a day in developed coastal regions of China is as high as 60%. Taking food and beverage as an example, simple monitoring of raw materials for agricultural products does not play a particularly effective role in most food and beverage foods. We need to combine the traceability of raw materials to produce and circulate food products. It is the supervision of raw materials production, procurement, processing, storage, logistics, and sales,

providing consumers with a complete information traceability system, that is an ideal means of food safety.

The traceability of food safety is usually the collection, conversion and analysis of food information, including food production, storage, transportation, and sales, so as to achieve effective management of food safety traceability information. Generally speaking, there are two types of traceability. One is from the source of production to the end consumer, also known as "forward traceability"; the other is from the consumer to the source of production, also known as "backward traceability". The food quality safety traceability system built on the application of Internet of Things technology can effectively grasp the nutrition information, production process information, and production area information of food, and has played an important supporting role in the development of a safe food industry chain and the establishment of a safety traceability system covering a comprehensive industrial chain. The methods are inseparable from the support of the Internet of Things technology. The ever-changing RFID technology, two-dimensional code technology, cloud computing technology and the rapidly

developing communications network provide good conditions for the promotion and application of food traceability systems. Wen Xijun, et al. combined with the comprehensive animal husbandry information service platform in Xinjiang to further study the application of Internet of Things technology in animal slaughter processing management system. Chen Xiwen et al. researched and developed an information code conversion database and software system for agricultural and livestock products based on the Internet of Things system. According to the characteristics of vegetable cultivation and processing, Sun Shujin designed a vegetable-food safety traceability system based on RFID technology. Lu Lei et al. conducted in-depth research on the design of RFID middleware in traceability systems and implemented a vegetable traceability system based on the Internet of Things technology. Wang Chengrui et al. proposed a process of communication between browsers and servers to improve food traceability and realized the function of Web server in the embedded network.

2. Related Technologies

2.1. Internet of Things

What is the Internet of Things? The concept of the Internet of Things was proposed in 1999. It is a sensor network that connects everything to the Internet through various sensing devices. In essence, the Internet of Things is based on the computer Internet and uses electronic tag technology, sensor identification technology, wireless communication technology, and computer network technology to construct a comprehensive network that connects everything in the world. Through this network, intercommunication between articles may be achieved by various communication technologies, and this communication is automatic and does not require manual intervention. The Internet of Things is an extension of communication network applications and an extension of Internet service objects and content. It uses a tag, a sensor, and a controller to connect any item to a sensor network and the Internet. The items communicate and exchange information with each other to achieve intelligent and automatic identification, positioning, and tracking of items, monitoring and management, aiming to realize precise management and scientific decision-making.

2.2. RFID Wireless Electronic Tags

RFID, an abbreviation for Radio Frequency Identification, is the abbreviation of Radio Frequency Identification. It is an interactive electronic tag that communicates through radio frequency technology. Sometimes it is called radio frequency card which has been most widely used in the Internet of Things. The working principle of RFID is that a base station transmits a radio frequency signal. After the electronic tag enters a radio frequency field, it obtains energy through a coil inside the tag, drives an IC chip in the electronic tag, and then establishes communication with the base station. RFID radio frequency card is a non-contact wireless

communication technology, and it can identify objects that are moving at high speed and multiple labels can be identified at the same time. The operation is quick and easy. It is an identity that is associated with objects as well as the best electronic tag of the Internet of Things.

2.3. Two-Dimensional QR Code

With the widespread use of smart phone terminals, two-dimensional bar codes are gradually being recognized by the public. This technology was born in the 1940s. The relevant researches began in the 1980s in western countries, including PDF417, QR Code, Code 49, Code 16K, and Code One, etc. There are two kinds of two-dimensional barcodes: stacked two-dimensional barcodes and matrix ones. The matrix two-dimensional barcodes are formed in the form of a matrix, which is the common two-dimensional barcode. Its experimental principle is that 1 and 0 are used to represent the points on the position of each element appearing or disappearing on a matrix graph, which makes use of a matrix graphic to encode the binary code stream.

The matrix two-dimensional code is an encoding mechanism that is based on the computer image and combines the encoding principle to automatically identify the graphic symbols. The working principle is: input the two-dimensional code image information into the computer through the image input device (such as the camera on the phone), and then identify and decode the two-dimensional code of the computer image technology to decompose the corresponding text information. In addition, the The two-dimensional code information also has a verification mechanism which can identify the wrong two-dimensional code, and perform error correction and restoration on the two-dimensional code of the image information that lacks part of the image (for example, errors of those which have been damaged and contaminated can be corrected automatically) to achieve correct identification.

The characteristics of two-dimensional code: 1. High-density coding, 2. Wide range of coding, 3. Fault tolerance, 4. High reliability, 5. low cost.

3. The Construction of the Traceability Systems

As a Chinese proverb goes "People regard food as their prime want". Food safety is related to the national economy and people's livelihood. However, at present, some greedy businesses produce unsafe food in order to cut cost and obtain large profits, which has seriously affected the health of the people

There are many ways of food regulation conducted by government supervisors. However, due to various reasons, such as time, location, equipment, and process, our food and beverages are sometimes not properly monitored. This may lead to large-scale food safety incidents. In fact, there is another way to carry out regulation, that is, to allow ordinary people to carry out simple and safe identification, so that

unsafe food or food that is suspected of being unsafe may not be sold or marketed. Naturally, the whole market also has self-discipline. The best way to identify food safety is to trace the source. Once the traceability system has been established, people can buy the healthy food.

This paper mainly discusses how to trace the source of food and beverage. Researchers found that the traceability of food and beverage needs to be designed and managed from the following aspects (as shown Figure 1).

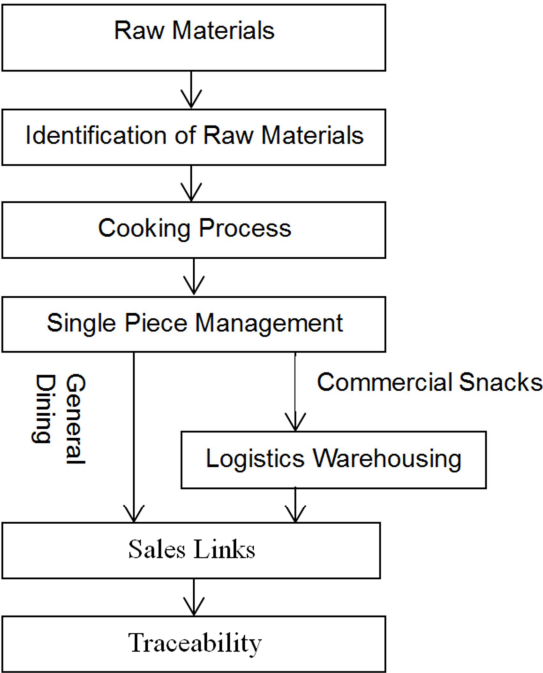


Figure 1. Traceability System Framework.

3.1. Raw Materials

According to the characteristics of catering food, the main source of catering food safety issues should be the production and procurement of raw materials. High-quality raw materials are the key to safe food. How to ensure the safety of raw materials?

1. Vegetarian food

Vegetarian food mainly refers to products produced in the seed industry, which mainly include various cereals, vegetables, and fruits. At present, under the background of new rural construction, large-scale facility agriculture is a trend and a guarantee of product quality. We construct a field-based servo system. Through the seed value system, the names, varieties, grades, origins (including genetically modified genes) of crops are recorded into the system; and then through the servo system, the daily temperature and humidity, pH of the soil, sunshine information such as quantity and rainfall are collected intermittently and continuously. Through the irrigation system, we will make record for the fertilization each time, including the type of fertilization, the amount of fertilization, and the method of fertilization, as well as the toxicity and effectiveness. Through the field management system, the occurrence of

pests and diseases, as well as the prevention and control of the use of pesticides are recorded in detail (as shown in Figure 2).

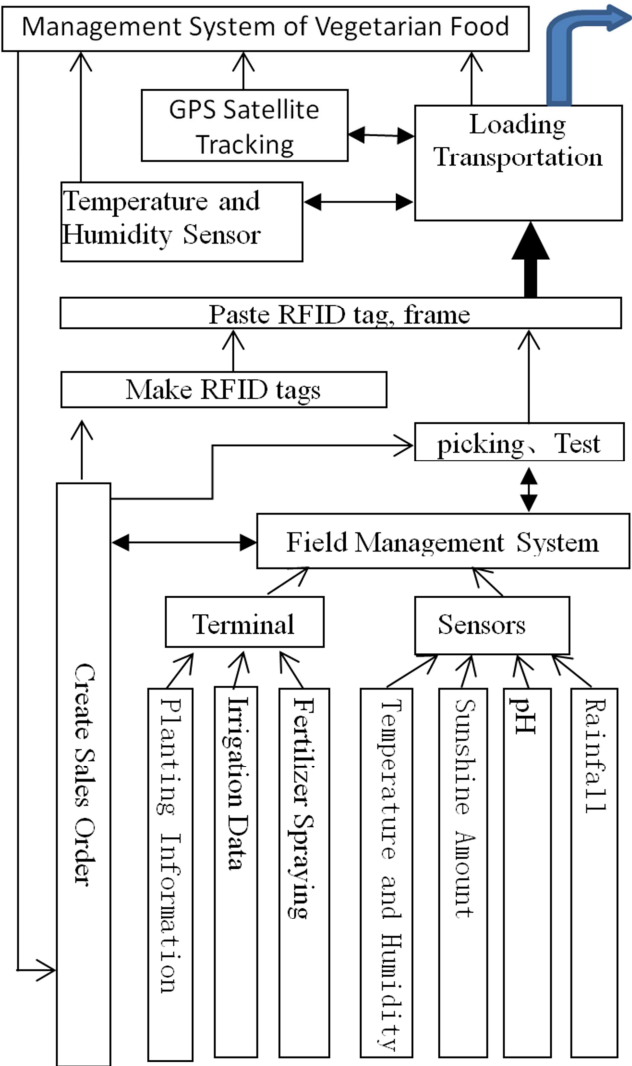


Figure 2. Management System of Vegetarian Food.

2. Meat ingredients

Meat ingredients mainly refer to the products produced by the aquaculture industry, mainly including pigs, sheep, cattle, chickens, ducks, poultry, fish and shrimps, seafood, and some wild animals.

For livestock and poultry, we manage it through the breeding system. As pigs and sheep have the large body size, we use RFID ear tags to identify and track them. RFID electronic feet is used to identify and track chicken and duck livestock. Through the farming system, we can manage their species and larvae sources. By installing an access control system on specific road sections, the amount of animal movement and outdoor sports information can be recorded. Through the aquaculture system, each batch of feed is tested and entered into a management system to effectively track the aquaculture process. Strict registration is also required for disease and drug use. (Figure 3).

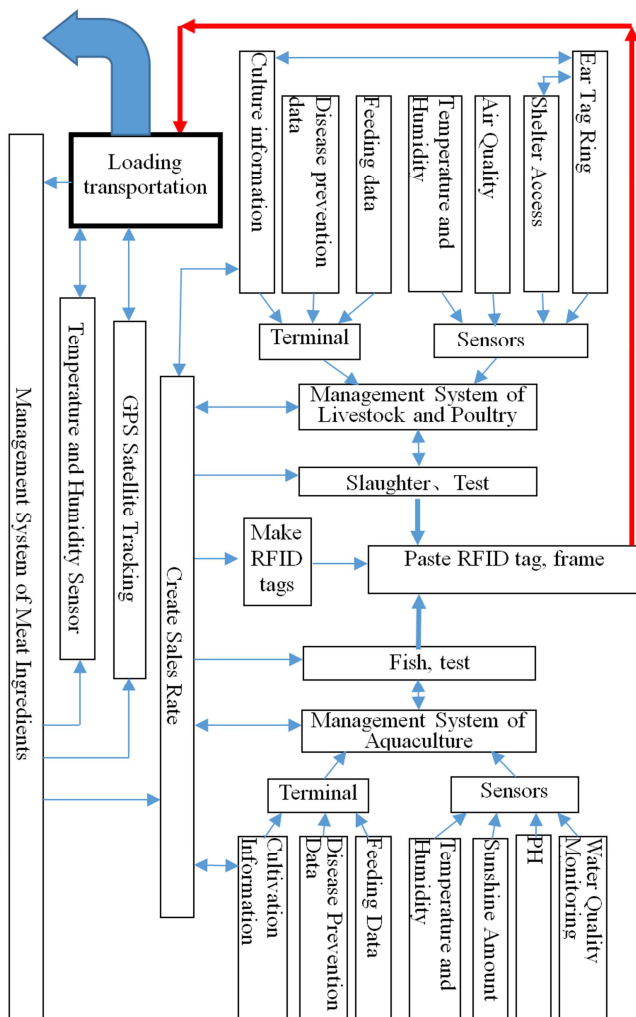


Figure 3. Management System of Meat Ingredients.

For aquaculture, we use a field management system similar to crop management. Through automated aquaculture equipment, related information systems are used to record the farming information, including the management of seedlings, feeding foods, disease prevention, and the management of additives. (Figure 3).

According to the characteristics of seafood products, we recorded the fishing area, preservation methods, storage temperature, and real-time monitoring of bacteria in detail.

For wild animals, we test every legally edible wild animal and carry out individual identification.

3. Cooking accessories

Cooking accessories are also known as condiments. They mainly include: oil, salt, sauce, vinegar, and other spices. They are generally market-purchased. We use strict traceability management systems to strictly import procurement information into management systems, including product names and main ingredients. (materials), quantity, production date, warranty period, processing companies, processing company qualifications, etc. If suppliers have information systems, we interface with them to achieve more effective supervision.

3.2. Raw Material Identification

The catering company's purchases are generally purchased in a wholesale manner, generally in bags, bundles, and boxes. Relatively speaking, a single item has a certain value, and some bags and boxes can be reused. Therefore, we use a reliable RFID electronic label as the identification of the item. The current market price of the RFID electronic label is 1 Yuan. It can be fully qualified as an electronic tag at this stage.

After mature crops are harvested, they are packaged into bags, bundles, or frames. Through the traceability system, RFID tags are produced in time, and the crop production growth information is bound to RFID tags (see Figure 2). Livestock and poultry directly read the RFID electronic ear tag and electronic foot ring into the traceability system, and timely import production information, and preferably access to the farm's network; aquatic products and seafood products are generally labeled in a frame manner, which may refer to the label of crops; Wild animals can refer to livestock and poultry. At the same time, the raw materials will be sampled and tested, and the test data will be written into the traceability system. (as shown in Figure 2 and Figure 3).

The use of RFID electronic tags for the identification of raw materials provides the source data for the traceability of food and beverage raw materials, and the material and information basis for the follow-up links. It can not only ensure the safety of food and beverage raw materials at the source, but also supervise the production of raw materials, while achieving scientific production and management.

3.3. Cooking Process

Currently there are five main types of catering companies: commercial fast food (frozen or vacuum-packed fast food), large-scale fast food distribution company (more than 10,000 meals), canteen (school, business), hotel (hotel, star) Level hotel), roadside snack bar (fast food restaurant). However, the basic processing techniques are: raw material roughing -> kitchen processing -> finished product packaging (plating).

In this link, the traceability system is basically in the flow of goods and process supervision. In this section, all materials use RFID tags. The security and stability of the tags themselves should be no problem, but the most critical issue that needs to be addressed is the loss and confusion of RFID tags during cleaning and cooking.

3.4. Single Piece Management

The basic condition for realizing the traceability of goods is to perform single piece management and identification of the goods. After the catering product is finished, we construct the product name in the traceability system, and import the information such as production raw materials and cooking ingredients into the name of the product through the RFID electronic tag, as well as writing the necessary parameters, processor, time, shelf life, storage requirements, package weight and method into the system during the processing. A label is created for the food and beverage product for

identification. According to the characteristics of food and beverage products, one production can produce multiple products. We need to identify each item individually to achieve single-piece management and identification.

Food and beverage products belong to the end-of-consumer products. The value of a single item is relatively low. At the same time, the consumer group is the common people. Therefore, it is very important to select the appropriate single item label. Although the current RFID electronic label has been reduced to "1 Yuan" level, for the product with the original price of a few Yuan, it is undoubtedly a high cost. At the same time, the professionalism of RFID read-write devices cannot provide traceability to end consumers. With its low cost, high-capacity information storage, and convenient reading methods, the two-dimensional QR code is undoubtedly the best end-label system for traceability systems.

In the single-item management link, we use a barcode printer to paste a two-dimensional QR code label with product traceability information into a catering product. Commercial fast foods are affixed to the packaging, and delivery fast foods are affixed to lunch boxes. The hotel dishes are affixed to the bowls, and canteen snacks and snack bar snacks are affixed to the trays (see Figure 4).

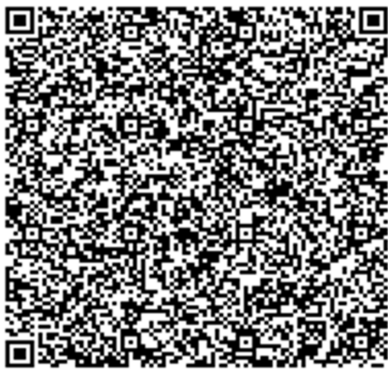


Figure 4. Two-dimensional code.

Relying on the large amount of information of two-dimensional barcodes, serial numbers of individual food products are generated, and two-dimensional barcodes are generated for food types, storage conditions, raw material information, and links to inquiries on websites, which are affixed to individual products to achieve single-item

management. The implementation of single piece management increases the transparency of the production process and also provides a unique code for subsequent traceability. (as shown in Figure 5).

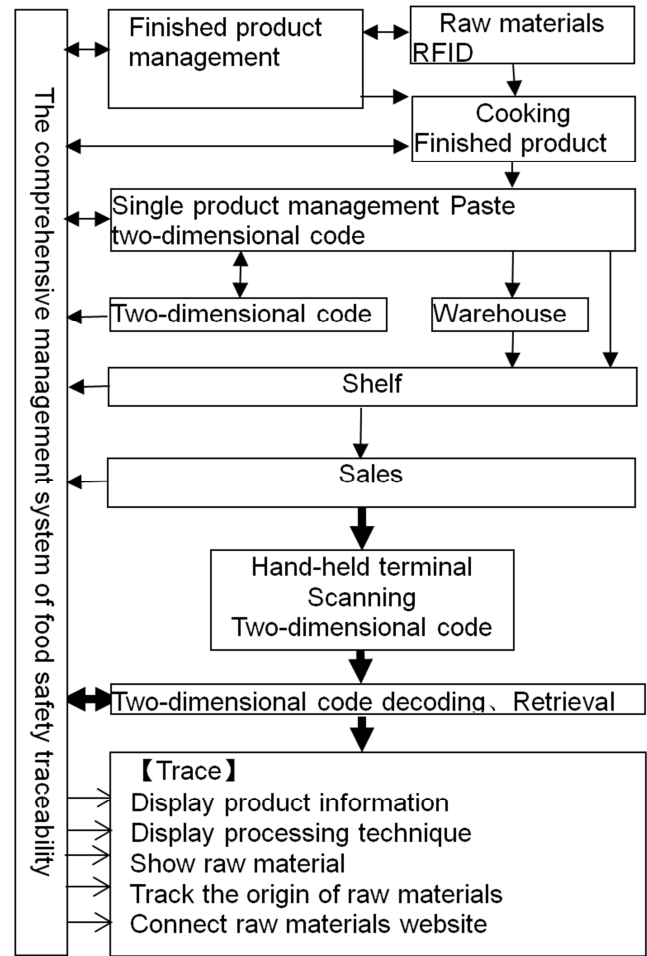


Figure 5. Model of food safety traceability comprehensive system.

3.5. Logistics and Warehousing

Commercialized fast food involves logistics and warehousing. In the logistics and warehousing process of foods, especially commercialized fast foods, the temperature is critical to the quality of the product. Excessive humidity will promote the production of mold. Light and vibration will also have a great influence on the appearance of foods. The collection and recording of food temperature, humidity, vibration, and light data are all the more important, which can both monitor product quality and provide data protection for follow-up consumer traceability. In the logistics and warehousing process, we first read the product label, and then connect the sensor installed in the logistics and storage facility with the product. Through the sensor, information such as temperature, humidity, light intensity, and vibration level that affect the quality of the food is collected and written into the traceability system. If it is more than the pre-set value, the alarm will be promptly made through the management system. (as shown in Figure 5).

3.6. Sales

In this link, food industry is relatively simple. For commercialized fast food, retail enterprises can quickly settle through QR codes. The operation mode is similar to the one-dimensional bar code commonly used in supermarkets. Distribution companies can do counting, pricing, settlement, etc. through scanning QR codes; sales of canteens can be managed by scanning QR codes; hotels can scan QR codes for settlement. (as shown in Figure 5).

In this link, due to the realization of a single piece management, once the food expires or deteriorates, the system will issue a warning and it will be possible to prohibit the sale. Because the use of a single serial number of two-dimensional code management, the original warehouse management system functions can be achieved, which is more precise.

3.7. Traceability Links

Tracing is a method based on the perspective of the supply chain, which involves the flow of articles from one link to another, and presents relevant information contained in each link. Traceability generally has positive and backward traceability, that is, tracking the trend from the initial state of the commodity, and tracking the commodity circulation process backward from the final state of the commodity. The food traceability mentioned in this article refers to the latter. During the process of tracking the merchandise, it also tracks the production, monitoring, and collection of a series of related data sets in various links.

In this project, we store the information generated in the raw materials, processing, warehousing, and sales of foodstuffs in a cloud database server, and affix RFID tags to the goods in the circulation, or to the QR code on the associated the goods. The database is located in the cloud and can be set up by itself. It can also be achieved by renting Ali and Tencent Cloud. The database system can be implemented using MYSQL.

Traceability terminal software is generally more convenient on mobile phone APP. Currently, smart phones are equipped with a high-definition camera, and the two-dimensional code information captured by the camera can be scanned and recognized by the image processing software. The mobile phone APP software is generally suitable for hybrid development. The current mobile phone mainly has two camps: Android and Apple. The original development technology is highly demanding and the code maintenance cost is high. Hybrid development can actually be achieved through the development of a set of HTML5 code. The three-party platform integration can generate Android and Apple's corresponding mobile phone apps respectively. Currently, the most common types of hybrid development are appCAN, APICloud, and PhoneGap.

The main process of traceability is that the consumer scans the two-dimensional code pasted on the product package through the mobile phone APP, and the APP software parses and retrieves the information of the related product in the

database. If it fails to find it, it can be identified as a non-retrospective system product and it will warn of a possible counterfeit. After the relevant product is retrieved, information related to sales, warehousing, packaging, production, raw material procurement, raw material production, seedlings, and the like of the product is displayed on the screen of the consumer's mobile phone APP. In addition, clicking the links to websites can help consumers query more detailed information of temperature, humidity, light, vibration, etc. stored in the database (see Figure 5). The traceability is often the people's last-ditch effort to the current food crisis, and of course, it is the monitoring mechanism for food production companies.

4. Significance of Safety Tracing Application System

The establishment of a catering food safety traceability application system based on the Internet of Things technology and low-cost two-dimensional codes is of great significance to the catering industry.

4.1. Improvement on Emergency Response Capacity to Food Quality and Safety Emergencies

Under the supervision of traceability system, once food quality and safety problems arise, it is able to quickly take advantage of the two-dimensional code label technology to identify the problem. This can effectively and rapidly manage food safety issues due to product quality and also trace the issue links sequentially, which can timely recall those food items, reducing the problem of food hazards to the health of consumers.

4.2. Promoting the Development of Thriving Businesses and Eliminating Ones with Poor-Quality Products

A large number of high-quality foods produced by great enterprises are often mixed with the poor quality of food products of unscrupulous enterprises. Because of people's mounting concern over food safety, companies suffer from significant decline in sales. The construction of traceability systems can allow these superior enterprises to compete fairly. The use of traceability mechanism prevents the disturbance of unscrupulous traders in food industry, assuring the quality of food products and protecting the health of the people, which contributes to the building of a harmonious society and is of high social value.

4.3. Increasing the Economic Benefit of Enterprises

Through traceability, the added value of goods can be increased. For example, a fast-tracked and fast-food snack is 1-2 Yuan more expensive than a snack without logo, which is acceptable for consumers, for they are very concerned about their identity.

Through the implementation of a traceability management system, the enterprise's informationization can save a lot of

manpower costs, reduce unnecessary waste and production costs.

5. Conclusion

Two-dimensional barcodes are used in the last node of food safety traceability due to its low cost. They are labeled on finished food products and packaging, enabling consumers to quickly trace food sources. With the popularity of smartphone terminals, it became feasible for 2D barcodes to become the last tag of food traceability. Researches also indicate that if unscrupulous companies falsify information in the comprehensive traceability system, it may affect the development of the traceability industry. The supervision of the regulatory authorities on the traceability system of the enterprise can be used to solve this problem.

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