STUDY ON FULL SUPPLY CHAIN QUALITY AND SAFETY TRACEABILITY SYSTEMS FOR CEREAL AND OIL PRODUCTS

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Abstract: Global food industry and Governments in many countries are putting increasing emphasis on establishment of food traceability systems. Food traceability has become an effective way in food safety management. Aimed at the major quality problems of cereal and oil products existing in the production, processing, warehousing, distribution and other links in the supply chain, this paper firstly proposes a new traceability framework combines the information flow with critical control points and quality indicators. Then it introduces traceability database design and data access mode to realize the framework. In practice, Code design for tracing goods is a challenge thing, so this paper put forward a code system based on UCC/EAN-128 standard. Middleware and Electronic terminal design are also briefly introduced to accomplish traceability system for cereal and oil products.

Keywords: cereal and oil products; full supply chain; traceability; tracking; electronic terminal; RFID

1. INTRODUCTION

Food traceability system, also called food tracking and tracing system, has become an effective way in food safety management. After several food safety related issues, particularly several food sandals, the global food

industry and governments in many countries have paid increasing attention to systems along the food chain. In order to rebuild the confidence of the consumers and to gain competitive advantages of their brands of agricultural products, governments in many countries compete to pass legislations and regulations to guide developing and implementing of identification systems and traceability systems.

Table1. shows characterized differences between countries all around the world. In June 2002, the Canadian federal government established an ambitious goal that, before 2008, the country would achieve tracing back 80 percent of agricultural products to its source, supporting the "Brand Canada strategy"(Lu Changhua et al., 2007), of which a mandatory identification system for cattle and beef on July 1, 2002 came into operation. In December 2003, the United States developed the statutes of tracking food safety, which required all enterprises involved in food transportation, distribution and import recording their trade information for tracking and tracing back(Cheng Hao. 2007). In addition, the United States also plans to include 70 percent of the cattle in the NAIS (National Animal Identity System) project at the end of 2009 (Xing Wenying. 2006). Traceability system was initially promoted by the EU to control the risks of mad cow disease in 1997. In July 2003, The EU published a White Paper on Food Safety, proposing a new framework for food safety system. Most countries in the EU have implemented mandatory livestock and meat products traceability system (Zhu Haipeng. 2007). The EU also had a plan called TraceFish, the main objective of which is to study the full supply chain traceability of aquatic products (Liu Junrong. 2007). The Japanese Government has passed new legislations on cattle and beef requiring a mandatory traceability system from farm to retail (Wang Lifang et al., 2005). The system allows consumers via the Internet to enter identification numbers of beef on the packaging box getting access to production information of the beef. Australia has plans for general mandatory traceability. NLIS is currently carrying out, which enables trace backward and forward from farm-of-origin to abattoir (Schroeder et al., 2005). At present, most agriculture developed countries are active to implement food.safety traceability systems, but they have different focus.

Table 1. Features in typical traceability systems

Countries or regions	Traceability system	Key technology	Application scope
Canada	Cattle identification	barcode, eartag	beef
US	NAIS	RFID, DDB	beef
EU	TraceFish	barcode, data exchange	aquatic, products
Japan	Food identity	barcode	beef
Austria	Livestock identification	eartag, RFID	beef
Britain	Critter identification	eartag	critter

Table2. shows aspects of traceability systems in china. China has also achieved important progress in food tracing. In April 2004, the State Food and Drug Administration and 7 other departments chose meat industry as a pilot industry, started meat and meat products traceability institution construction and system implementation (General Administration of Quality Supervision. 2002). The main tasks include: developing suitable technical standards and Management norms, publishing guidelines for implementing traceability system including "Meat products tracking and tracing Guide" and "Fresh product tracking and tracing Guide". In June 2004, Administration of national barcode management promoting investigated on vegetable products traceability and started an application project on two vegetable production bases located in Shouguang and Luocheng respectively in Shandong province (Zhou Yingheng et al., 2002). The project was successful i n food quality control in the origin and enforcing standards of market access, product identification and recall. Integrated with electronic auctions and E-commerce, this project established a traceability system for pollution-free vegetables. Shanghai Livestock Bureau legislated to build digital archives for pigs, cattle, sheep and other critters, and the residents can now get access to the egg production information through internet (Shanghai agricultural committee. 2001). In August 2008, Beijing will enforce a food traceability system along the full supply chain for the food supplied for Olympic games to secure food quality and safety (Chang Xiang. 2007).

Table 2. Traceability systems for Agricultural products in china

Project name	Project Implementation Unit	Application scope	Start year	Key technologies
Traceability systems for vegetables supplied to Beijing	Beijing Municipal Bureau of Agriculture, Department of Agriculture of Hebei Province	vegetables	2002	barcode
Traceability institutions and systems for meat and meat products	State Food and Drug Administration	Meat and meat products	2004	eartag, RFID
Egg production information	Shanghai Livestock Bureau	egg	2003	barcode
Traceability systems for vegetables	Administration of national barcode	vegetables	2004	barcode

2. KEY TECHNOLOGIES

Aiming at the major quality problems of cereal and oil products existing in the production (cultivation), inspection, storage, processing, circulation and other links, this paper starts with systematical analysis of the source, channel and the kind of contamination, which forms the traceability system framework.

2.1 The framework

In this paper, integrated with the information flow analysis, FMECA（Failure Mode Effect and Criticality Analysis）(Kang Ri. 2006) approach is used as a tool to detect the possible critical control points. HACCP (Bao Dayue . 2007)（Hazard Analysis and Critical Control Point）quality system and some related national standards on cereal and oil products are referred to determine the key quality indicators in the supply chain. Then, the traceability framework and an optimal set of quality indicators come into appearance.

2.2 Coding, identification, and digital files management

The information flow along with the food chain can be constructed by the following steps and technologies: first, use electronic tags to track the physical flow and give each batch/item a unique number. Second, design coding standard for materials，semi-products and products in the food chain. Third, Integrating with TQM (Total Quality Management) system, full supply chain digital quality profile management can be realized.

2.3 Middleware for communication

Middleware is a kind of software between the operating system and application software. In traceability system, Middleware is needed to support data exchange between electronic terminals and the traceability platform.

2.4 Integrated Platform

This paper now has briefly introduced principal things including the framework, identification system, coding system, full supply chain digital file management and middleware for communication, to build a traceability system. Integrate all of the technologies introduced above based on the framework, we can successfully construct the traceability platform for agriculture products.

3. RESEARCH ACHIEVEMENTS

3.1 Determine critical control points and key quality indicators

In our research, through HACCP（Hazard Analysis and Critical Control Point）and FMECA（Failure Mode Effect and Criticality Analysis）, we deduced the critical control points and determined the key quality indicators of the full supply chain.The model is shown in Fig.1.Determination of critical control points and quality indicators also provides fundamental data in the traceability system. Coupled with the information flow analysis, this paper proposed an information tracking and tracing back model, which combine the information flow with the critical control points, therefore, endowing the traceability system the function of quality and safety control.

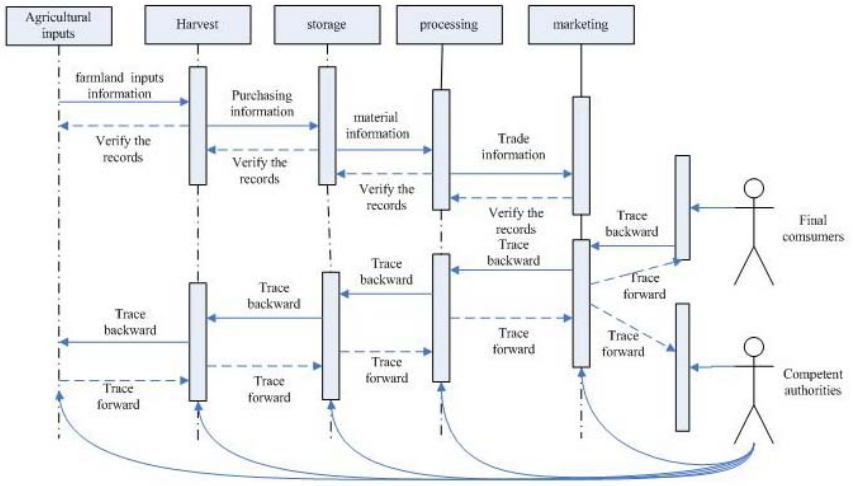

Figure 1：Tracking down and tracing up in the information flow

Now take Peanut oil as an example, after the analysis of production process using the FMECA approach, this paper gives the critical control points, which includes agricultural input, materials test, primary oil-filtering, detection of semi-finished oil, secondary oil-filtering and detection of refined peanut oil.Table3. shows the critical control points and the corresponding key quality indicators.If any of these critical control points missed, it would result in quality information loss and broken of the quality information flow.

Table 3：The critical control points and the key quality indicators of peanut oil production

Critical Control Points	Quality indicators
agricultural input	Seed, pesticide, fertilizer
material test	rate of oil, PH value, percentage of moldy peanuts, impunities in peanuts, humidity
primary oil-filtering	Temperature, additives
detection of semi-finished oil	PH value, color and luster, humidity, volatile
secondary oil-filtering	Temperature, additives
detection of refined peanut oil	color and luster, PH value, humidity, volatile, infusible precipitate, peroxide value, residual menstruum, aflatoxin

3.2 Central traceability database design and data access mode

Based on research above and the peanut oil supply chain, we developed a central traceability database to manage the information flow linked with "retail products code--finished products batch code--semi-finished products batch code--material batch code--source of origin code" ,which were "Primary Keys" of Critical Control Points information. The central traceability database gathered all the necessary quality related information in the supply chain and made the chain transparent.

The system of central traceability database and data access pattern is illustrated in Fig.2.This paper also designed a pattern for data access. Base on RBAC（Role-Based Access Control）,we designed three different roles including consumers, enterprises and quality supervision departments with different rights to use the central database. In the help of the middleware for communication, all users can get access to the central traceability database through three kinds of devices, including fixed terminals in the supermarket, mobile terminals and computers.

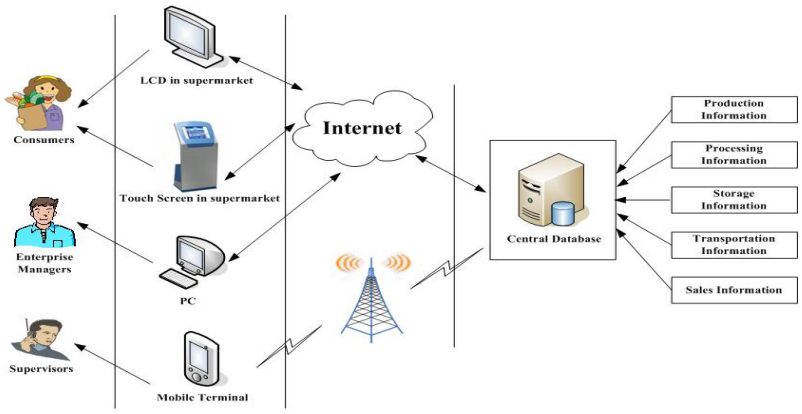

Figure 2：The central traceability database and the pattern for data access

3.3 Traceability code design

Our encoding system follows the UCC/EAN-128 standard (Lin Ling et al., 2004), which is a worldwide standard for exchanging data between different companies. We put forward a unique identification number for encode the data concerning cereal and oil products. The identification number consists of five parts, including enterprise identification number, commodity identification number, batch number and two kinds of verifying number. The first two items in fact form the Global Trade Item Number (short for GTIN). The code structure for cereal and oil products is shown in Fig.3, and an example is shown in Fig.4.

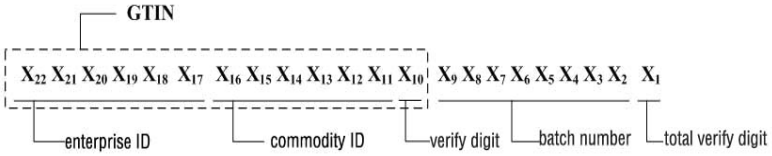

Figure 3: The code structure

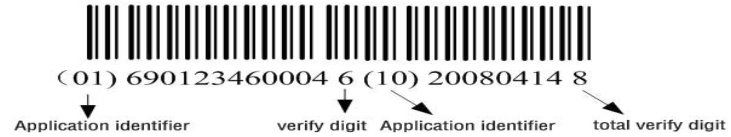

Figure 4: Id number for cereal and oil products

3.4 Electr`onic terminal design based on GPRS network

Since the wireless application widely spread and for the consumers convenience, we developed a kind of mobile electronic terminal based on GPRS data transmission, which was consisted of three important parts: the motherboard, GPRS communication module and a micro Liquid-crystal display (short for LCD). The mobile terminal is shown in Fig.5.The mother board is used for processing information, while the GPRS communication module used for receive the information and send the results back. The micro LCD is simply for displaying the results in a friendly way.

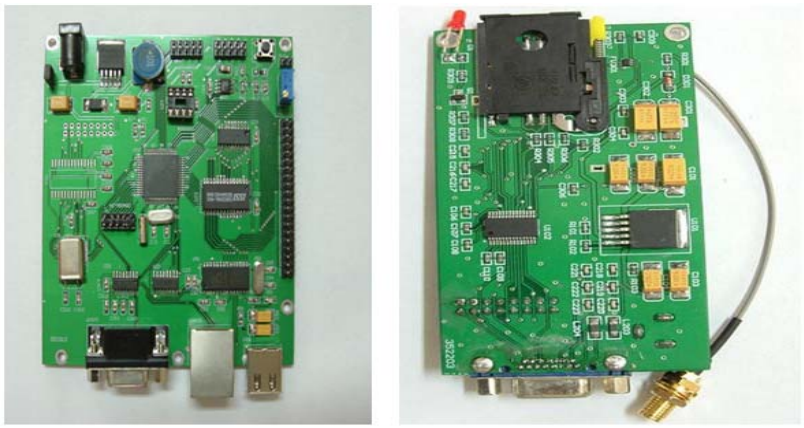

Figure 5：The motherboard and the GPRS communication module of the mobile terminal

4. DISCUSSIONS

1、Cereal and oil products take a large account in agriculture products. Therefore, cereal and oil product quality management has an overall significance in china's food safety, and the research on quality and safety traceability systems for cereal and oil products potentially yields enormous social and economic benefits.

2、The methodology, application system and the pilot project of our traceability systems for cereal and oil products would help the related enterprises to establish traceability systems and rebuild the consumer confidence of Chinese food products, promoting the enforcement of the food safety law of agricultural products in a practical way.

3、All users including consumers, enterprises and the competent authorities can track down and trace up along the information flow easily.

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