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Batch-based traceability for pork: A mobile solution with 2D barcode technology

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Abstract

As an animal-derived food, pork provides Chinese consumers with important nutritional value. The frequent safety incidents related to pork-made food have led the government and public advocate that a traceability system is as an effective means of controlling food quality and safety. This paper thus introduces a mobile pork quality and safety tracing system based on 2D (two-dimensional) barcode (also known as QR code) technology. First, literature search and field observations are used to evaluate the business processes in pork supply chain and key traceability information in the system. Then, a mobile solution based on 2D barcode technology for information collection, transformation, and delivery is designed. Finally, a pilot implementation in Jilin Province's Meat and Meat Products Safety Traceability and Regulatory Digitization Project is reported. The traceability system was integrated with the government supervision system to achieve the supervision and traceability of pork from source to table. Implementation results reveal that the system can realize batch-based traceability of pork, which greatly decreases traceability system cost. Additionally, the information verification mechanism between upstream and downstream players, as well as the full participation of consumers, enterprises, and the government, significantly improve the credibility of the traced information.

Keywords: food safety; batch-based traceability; 2D barcode technology; mobile solution; pork supply chain

1. Introduction

Food safety and quality have been gained more and more attention over past few decades (Dbbene, Gay and Tortia, 2014). Different from Western countries, pork is the most commonly consumed meat in China. Pork production and consumption in China account for a high proportion in the world. According to the National Bureau of Statistics of China (NBSC, 2017), China's total pork production in 2016 was 52.99 million tons, accounting for 62.07% of all meat products (85.38 million tons)，81.84% of pork, lamb, and beef products（64.75 million tons）—an increase of 67.8% over 1996 (31.58 million tons). Because of its heavy consumption, pork quality and safety has a major impact on the country's overall food safety (Ortega, et al., 2011). The Chinese government has recently put food safety as a major priority of people's livelihood and has proposed many policies, particularly related to devising a traceability system, to promote residents' health and satisfaction. For example, in three consecutive years 2015, 2016, and 2017, a comprehensive service platform for traceability and supervision is all emphasized in the No. 1 Central document. In addition, Article 42 of the Food Safety Law of the People's Republic of China indicates that the State is establishing a traceability system for food safety. This is also addressed by the General Secretary Xi Jinping requesting that a national unified information traceability platform for agricultural products and food safety should be constructed as soon as possible.

Provincial governments have started to respond actively to the central policies that encourage investment in food safety traceability system. For example, at the end of 2016, the General Office of Jilin Province promulgated "Implementation Opinions on Accelerating the Construction of Traceability System for Important Products". In March 2017, Jilin Food and Drug Administration invested in the food safety traceability and supervision informatization project for meat and meat products, on which this paper is based.

Traceability refers to "the ability to trace and follow a food, feed, food producing animal or ingredients, through all stages of production and distribution" (European Commission, 2000). The Codex Alimentarius Commission (CAC) has pointed out that traceability is key to risk management, especially in the monitoring and identification management of unintended effects. To achieve these goals, traceability systems have been used in different areas all over the world. Several EU countries, such as France and UK, proposed applying such systems to the production of animals and animal products due to the massive outbreak of mad cow disease in Europe and the rapid development of genetically modified food products (Souza-Monteiro, & Caswell, 2009; Houghton, et. al., 2008). Considered as a necessary tool to increase consumer confidence in food consumption and transparency in the food supply chain (Wu, Wang, Zhu, Hu, & Wang, 2016; Heyder, Theuvsen, & Hollmann-Hespos, 2012; Zhang, Bai, & Wahl, 2012), traceability systems are currently being developed and used for the tracking and tracing of various foods (Hu, et al., 2013; Schroeder, & Tonsor, 2012; Ruiz-Garcia, Steinberger, & Rothmund, 2010).

The traceability of livestock products has long been a focus among scholars. Many traceability systems have been proposed using different technologies, among which

RFID is the most popular one (Costa et al. 2012). Feng, et al. (2013) developed and tested a beef tracing system based on radio-frequency identification (RFID) technology, which realized data collection and transmission, thereby improving management efficiency and ensuring food safety. Liang, et al. (2015) proposed a traceability model for the cattle/beef supply chain based on RFID technology and Electronic Product Code global network traceability system, enabling effective sharing of information among supply chain subjects and seamless traceability of the cattle/beef supply chain. Although RFID technology can enable stakeholders in the supply chain trace information back to the individual pig, the tags are difficult to stick to meat after cutting (Costa et al. 2012). In addition, so many tags are needed along the food supply chain, which increase the cost of the supply chain partners (Aung & Chang, 2014). Therefore, RFID is mainly used in individual pigs, rarely going beyond the cutting room (Kerry et al., 2006). This is particularly true in China where many players in pork supply chain are small companies or even individual households. The high cost cannot be bored by them. This is also the reason why the development of information-based traceability systems for pork supply chain has not been substantially promoted; instead, traceability relies mainly on paper documents. Furthermore, it is not necessary to trace the information to individual pigs because we just need the information about the farm who raised the pig. Therefore, whenever the whole batch acquired by brokers is traceable is sufficient, which motivated out idea of batch-based traceability.

Another recent technology for traceability is Blockchain which "is a type of distributed ledger technology (DLT), meaning it is a data ledger that is shared by multiple entities operating on a distributed network" (Leong, Viskin and Stewart, 2018). Due to the characteristics, like decentralized, distributed, trusted, unchangeable retroactively, Blockchain is seen as a curer of supply chain traceability and some big companies like Walmart has started piloting Blockchain project in its food supply chain (Yiannas, 2018). Although Blockchain is a promising technology in traceability, its development is still in early stage, and there is a long way to go for mass adoption.

The above analysis shows that many current new technologies, although very promising in theory, may not be feasible economically, especially in the context of China where most companies in pork supply chain are very small and have very poor affordability. This problem combined with the recent surge of adoption of smart phones in China triggered our current research. In 2010, China's mobile Internet industry was started and has since developed rapidly. Around 2014, the mobile apps WeChat and Alipay proliferated throughout the country overnight. With the popularity of these two applications, 2D barcodes have become common among the Chinese. Aung and Chang (2014) posited that mobile phones and the Internet would set up the foundation of the development of traceability systems, which the high cost problem could be solved (Badia-Melis, Mishra, & Ruiz-García, 2015).

Based on this, this paper developed a pork traceability system based on mobile Internet and 2D barcode technology. The system can provide information regarding all aspects of the pork supply chain, from breeding to consumers, and can integrate with the government supervision system to achieve supervision and traceability of the entire life cycle of pork from source to table. This system was widely used in Jilin Province

in 2018 and produced promising pilot results. This paper contributes to the literature in the following aspects: First, a mobile solution based on 2D barcode technology has been developed, which greatly reduce the users' costs; second, a two-way verification mechanism is embedded in the system to avoid false information; third, a 2D barcode traceability scale is designed in the retail stage to make the cut meat labelled and linked to the upstream supply chain.

The remaining paper is organized as follows: Section 2 conducts an analysis of pork supply chain; Section 3 describes the developed traceability system and related equipment. The application result of the systems is presented in Section 4. Section 5 concludes the paper.

2. Business analysis

Through a literature search, field observations, and interviews, routine processes in pork production and distribution were investigated and analyzed. These processes include feeding, immunization, disinfection, inspection and quarantine, acquisition and transportation, slaughtering and processing, distribution of carcass, pork segmentation retail, and food production and management. According to relevant quality and safety standards in the pork production process, the Hazard Analysis and Critical Control Points (HACCP) was used to identify key traceability information and traceability businesses. Farms and slaughtering enterprises surveyed in this study were mainly distributed in counties and cities of Jilin Province. Interviewees included enterprise managers, workers, consumers, and government supervisors.

2.1 Business flow analysis of the pork supply chain

Figure 1 illustrates the business process of the pork supply chain. Key players in this chain include: farms (households), brokers, slaughtering enterprises, dealers, market stall owners, and food producers (mainly food processing plants and catering service units). It consists the following activities:

Breeding: farms (households) feed, immunize, quarantine, and otherwise care for pigs until they are sold.

Acquisition: brokers collect pigs from farms (households) and transport them to the slaughtering enterprise.

Slaughtering: After entering the slaughtering enterprise, pigs are placed as one batch for food suspension and rest. After a series of activities, such as electrical stunning, stabbing, bloodletting, evisceration, and head and hoof removal, pigs in different batches are separated by hooks and finally enter the circulation and sales link in the form of carcass.

Wholesale and distribution: meat from the slaughtering enterprise flows to dealers, who sell meat products to downstream dealers, market stall owners, and food producers via wholesale.

Segmentation and retail: dealers and market stall owners cut meat into pieces and then sell them to either the next level of sales units or to food producers and consumers directly.

Food processing: food producers purchase meat products and process them into

165 food or dishes for public consumption.

166 **2.2 Key tracing information**

167 The purpose of tracing is to transform the logistics of the physical flow into
168 information flow and obtain a product's production history and process information
169 according to reverse information flow (Moe, 1998). Tracing information collection is
170 crucial to achieve traceability. China's pork supply chain involves breeding, acquisition
171 and transportation, slaughtering and processing, distribution and retail, catering, and
172 other activities; each link includes many information. However, in practice, not all
173 information is related to quality or safety and can influence consumers' perceptions of
174 security. To help ensure the traceability of quality and safety information, the work
175 related to information acquisition, processing, and presentation should be reduced as
176 much as possible, and the key traceability information should be identified.
177 The HACCP method was chosen as a basic analytical tool, as it provides scientific,
178 reasonable, and systematic critical-point identification, potential hazard assessment,
179 and hazard control (Chen, Hartarska, Wilson, 2018; Allata, Valero, & Benhadja, 2017;
180 Minor & Parrett, 2017; Soman & Raman, 2016). According to HACCP and food-safety-
181 related standards, along with regulations and policies in China, three types of
182 information at each stage of the pork supply chain are collected: business entity
183 information, quality and safety information, and transaction record information (Table
184 1).

185 **2.3 Traceable business design**

186 Based on the analysis of pork supply chain processes and selected key traceability
187 information, the traceable business can be determined as shown in Figure 2. Tracing
188 subjects include farms (households), brokers, slaughtering enterprises, dealers, market
189 stall owners, and food producers. The information will be verified by both upstream
190 and downstream players to avoid false information.
191 Breeding: farmers (households) use the traceability system daily to overall record
192 pigs' breeding information (don't record breeding information of one specific pig) and
193 to register outbound information when pigs are sold. Here we don't trace the breeding
194 information at the individual pig level because it is very difficult and not important.
195 Acquisition: brokers use the traceability system to identify and confirm farmer's
196 identity information, and mark each batch of pigs by blood stab codes which consist of
197 brokers' code and farmer's code such as #1(farmer's code is assigned dynamically
198 following the sequence of the acquisition, such as 1,2,3). Then, use the traceability
199 system to record the relationship between blood stab code and farmer and the license
200 plate number of the vehicle that used for the acquisition.
201 Slaughtering: the broker transports pigs to the slaughtering enterprise. According
202 to the vehicle license plate number or the broker' name, workers in the slaughtering
203 enterprise confirm and upload relevant information about this acquisition to the
204 traceability system, including the inspection and quarantine information, pigsty
205 information assigned to these pigs. The enterprise staff prints 2D traceable labels(2D-
206 TL) during the slaughtering process, attaches a label to each carcass, identifies the blood
207 stab code, and uses the traceability system to match each 2D-TL to a carcass.

Wholesale and distribution: each dealer stores, transports, and wholesales the pork products. When pork products must be cut, the dealer uses the 2D barcode traceability scale (2D-BTS) to identify the corresponding traceable 2D barcode and prints the 2D-TL, which is affixed to the pork that was segmented or to the product packaging. Relevant information is uploaded to the traceability system using the 2D-BTS.

Segmentation and retail: when market stall owner segment and retail meat products, the 2D-BTS is used to identify a traceable 2D barcode corresponding to the pork products sold, including a printed and 2D traceable transaction receipt(2D-TTR) after weighing. Relevant information is uploaded to the traceability system using the 2D-BTS.

Food processing and production: food producers use the traceability system to scan the traceable 2D barcode on the 2D-TTR and register purchase information. Consumers can use a mobile phone to scan the traceable 2D barcode on the 2D-TTR and view traceability information directly.

3. Traceability system and traceability equipment

3.1 System development environment and system architecture

Based on mobile internet, the traceability system adopts a Browser/Server (combined Client/Server) architecture to develop a corresponding PC terminal and mobile device software according to different user requirements and usage scenarios. The Client/Server (C/S) architecture comprises client program running on the user's computer and server program running on the central server. The client needs to implement business logic, so the client bears great pressure. Browser/Server(B/S) architecture is consisted of web browser and server program, user need not any other special installation except a web browser, the web browser deals with a handful of business logic in the front, while the main business logic is done in the server. Figure 3 illustrates the overall system architecture.

3.2 2D barcode application

As an interdisciplinary, cross-field, and cross-industry information application tool, the 2D barcode is closely related to people's daily lives and economic operations; these codes have become an important supporting technology in the digital economy. They are widely used in fields that involve item traceability, mobile payment, logistics and transportation, electronic ticketing, industrial manufacturing, and asset tracking. With regard to item traceability, 2D barcode identification technology can facilitate product identification and automatic data collection while meeting users' unique traceability requirements.

The 2D barcode used in this study has two purposes. First, the code can be used to obtain identifying information of each link subject. After the real name of each subject is registered in the traceability system, the traceability system generates a unique-identity 2D barcode for each subject. This code carries a traceability system network link address and key parameters of the subject's identity. The structure of content information is the network link address + subject role code + identity code, such as

http://192.168.183.33:8099/xmTraceServer?roleid=40283d4&userid=40283d. Mobile phone apps (e.g., WeChat and Alipay) can be used to scan this 2D barcode; then, the app can parse the network link address, enter the specific function module of the traceability system, read key parameters of the identity of the corresponding subject, and retrieve database data to display subject-related information. Figure 4a shows a farmer's identifying code.

Second, the code is actually a traceable 2D barcode for each piece of meat. In the slaughtering link, slaughtering enterprises use the traceability system and coding equipment to print traceable transaction labels (Fig. 4b), which contain a traceable 2D barcode corresponding to white strip meat. This traceable 2D barcode also carries a traceability system network link address and key parameters of the identity of white strip meat. The structure of information content is the network link address + serial number code of the white strip meat, such as http://192.168.183.33:8099/xmTrace Server? mid=40283d495d64ed1d015d72c95f64027d. Through the traceability system, white strip meat is matched with its 2D-TL. Specifically, information about the breeding subject, acquisition and transportation subject, slaughtering subject, and quality and safety information (e.g., immunization, inspection, and quarantine) is matched with the serial number of white strip meat. Mobile apps such as WeChat and Alipay can be used to scan the 2D barcode, after which the app parses the network link address, enters the specific function module of the traceability system, reads the key parameters of the 2D barcode corresponding to the meat, and retrieves database data to display subject- and quality-safety-related information associated with the meat.

Tracing information for subsequent sales transactions is also linked to key parameters of meat in the meat circulation process. In terms of meat segmentation, a 2D-TTR (Fig. 4c) is generated using a 2D-BTS, which contains a traceable 2D barcode that retains the key parameters of the original 2D barcode of the meat; at the same time, key parameter information of the subject of the sale and transaction information is loaded. The structure of the content information is the network link address + serial number code of the white strip meat + the code of the 2D-BTS + the code of trading activity, such as http://192.168.183.33:8099/xmTraceServer? mid=40283d495d64ed 1d015d72c95f64027d&wpid=000001&tid=0000011712160001&tc=0. A mobile app such as WeChat or Alipay can scan the code and then parse the network link address, enter the specific function module of the traceability system, read key parameters of the code corresponding to the meat, retrieve database data to display identity information about the upstream link and quality-safety information about the meat, write the transaction subject information and other transaction information into the database, and display corresponding information (see Section 3.3 for details).

3.3 2D barcode traceability scale

Figure 5 displays the 2D-BTS, which was developed on the basis of the original electronic scale according to the actual needs of the traceability business. The traceability scale possesses the following characteristics: (1) it can be connected to the 2D barcode recognition device for code recognition; (2) it can print a transaction receipt with text, graphics, and the 2D barcode; (3) it provides network interface to support

data uploads; and (4) the 2D barcode contains URL address information. With this information, the code traceability scale can store URL information, intercept and store key parameter values of the address, and add the following information to key parameter values: the device's unique identifying information (i.e., the traceability system maintains correspondence between the 2D-BTS and the sale subject); sales date; flow number information; weight information; and price information. Then, the scale can create a new parameter value that contains new URL address information that is assigned when printing the 2D barcode. Table 2 shows the configuration parameters of the 2D -BTS.

The 2D-BTS is mainly used for the segmentation and sale of meat. It can record sale subject information and transaction information from dealers and market stall owners when meat is segmented and sold. Figure 6a shows the business scenario of a sale, and Figure 6b shows the principle of the 2D-BTS. In Figure 6b, "mip" means serial number code of the white strip meat. "wpid" means the code of the 2D-BTS. "tid" means the code of trading activity. "tc" means the tree structure code to identity the hierarchical relationship of market stall owners.

3.4 Traceability system

Business functions of the tracing system were developed according to users' needs, mainly by adopting the B/S architecture. The tracing system is deployed in a cloud computing center. A user can use a PC or mobile device to log in to the system for related businesses. Some businesses must use mobile phones to operate at the business site, but mobile Internet conditions may not be good. Therefore, some functions were developed using the C/S architecture. Farmers, brokers, dealers, retailers, and food producers can use mobile devices to log in and visit, whereas registrants of the slaughter enterprises and out-of-stock slaughter enterprises can use PCs to log in. Each user needs to register using the real name of the traceability system, and the business can only be accessed after verification and confirmation. The login system must confirm the account identity to ensure account security each time a user logs in.

When farmers log in to the system via an app, the function modules include the bar registration, listing file, quotation information, their 2D barcode, personal information, and current prices of pigs. When pigs are sold, the farmer can display his 2D barcode to the broker, fill in relevant information about the pigs in the registration module, and complete registration.

When brokers log in to the system via an app, function modules include pig source information, pig registration, quotation release, quotation information, pig collection file, current demand, and customer management. When the broker visits a farm (household) to collect pigs, he can use the pig registration module and establish contact with farmers through the customer management module.

When slaughtering enterprises' registrants log in to the system via an app, function modules include admission registration, admission file, demand management, and customer management. The demand management module shows pig demand. When a broker transports pigs to the slaughtering enterprise, he fills in relevant information about pig admission in the admission registration module and completes registration.

The registration record can be viewed in the admission file module. Slaughterhouse outbound personnel can log in to the system via PC. Function modules include 2D barcode management, direct sales, outbound files, and statistical analysis. After pigs are slaughtered, carcasses are hung on the assembly line, and the checker prints traceable transaction labels to be attached to each carcass. Slaughterhouse outbound personnel log in to the system via app; their function modules include outbound registration, outbound archives, a personal center, and customer management. In the direct sales module, a dealer is selected; the dealer and outbound personnel complete outbound registration in the outbound registration module, and the outbound record can be viewed in the outbound file.

Dealers log in via app. Their function modules are related to new orders and order inquiries; a dealer and slaughtering enterprise sign a contract, visits the slaughtering enterprise to receive meat, scans the traceable transaction label on each carcass, uploads dealer information, and then transports and wholesales the meat.

The 2D-BTS also corresponds to market stall owners in the traceability system. When meat is segmented and sold, the traceability scale is used to identify the traceable transaction label on the product, and the 2D-TTR is printed after weighing. Food producers and traders log in to the traceability system via app, after which they can scan the 2D barcode on the 2D-TTR on the purchased product and register their purchase. Consumers can use WeChat or Alipay's 2D barcode scanning function to scan the traceable 2D barcode attached to any meat product to obtain traceability information.

4. Application of the traceability system

4.1 The achievement of the traceability

After market stalls purchase carcass, 2D-TL carried on the meat will be hung in a prominent position. Anyone including consumers, supervisors and market stall owner can use the software with QR code scanning function such as WeChat or Alipay to scan the 2D code on the 2D-TL to inquire the meat information, including the information of main related entities and quality safety information (excluding market stall information), as shown in Figure 7.

When the meat is sold, the market stall owner use 2D-BTS to print 2D-TTR. Consumers can view the market stall' name, meat weight, meat price, and traceable 2D barcode on the transaction receipt. Consumers can use their mobile phones to scan the 2D barcode on the 2D-TTR. The market stall' information will be added into Figure 7 and displayed at the bottom.

Compared with traditional traceability solution, this solution significantly reduces investment for traceability of each link entities. Farms do not need to invest anything separately. The initial hardware equipment investment of every slaughterhouse is about 20,000RMB, and the daily supplies and human resource costs averaged to each pig are about 2RMB. The initial investment of each sales link entity is around 2,000RMB, and the daily supplies can be ignored. Food producers and consumers use mobile phones to obtain traceability information at zero cost. Low investment costs increase the vitality of the traceability system.

Under the support of the traceability system, it is convenient for government supervisors， meat retailers and consumers to obtain complete, authoritative and credible pork quality information. Based on this, the safety level of pork is improved, and the consumers' perception of overall food safety become better. The good value of the traceability system further guarantees its own vitality.

4.2 Real application

This solution has been approved by the Jilin Provincial Animal Husbandry Administration, who received government funding to build a traceability system along with administrative orders to implement its application. The pilot application has been conducted since March 2017 given relevant approval from the owner, and pilot findings are promising. In the beginning of 2018, the traceability system was promoted and applied throughout Jilin Province. As of mid-December 2018, 54 pig-slaughtering enterprises in the province were included in the system, realizing 100% coverage of designated slaughterhouses at the county level and above. The system also included 2041 farmers, 13 large farms, 805 brokers, and 2410 dealers (sales booths). The system contained 48,897 pieces of entry registration information, 369,416 pieces of outbound information, and 1,059,911 pig transactions. The pig transaction process involved 6,527 people directly.

Application results of this program have been well-recognized by major leaders in the Jilin Provincial Government along with leaders of the Ministry of Agriculture and Rural China. The system construction and application results were published on the front page of *Farmers Daily* on July 16, 2018, leading to country-wide awareness.

5. Conclusion

This paper developed a mobile batch-based pork traceability system based 2D barcode technology. The system design considers relevant business entities and business operations in detail; and integrates the traceability business with pig breeding, purchase, sale, and slaughter services to the greatest extent. In doing so, the system reduces excess workload generated by retroactive business and leverages mobile devices, mobile Internet, and 2D barcode technology. These technologies minimize investment in the development of the traceability system and improve its ease of use and operation. The 2D-BTS solves the key problem of traceability information transmission and helps ensure integrity in the traceability information chain; Through a reasonable design, a verification and information-sharing mechanism between upstream and downstream players in the pork supply chain can be realized without increasing the operation of each link, thus guaranteeing the credibility of traced information. This system also opens a traced information chain between the production and processing links, which provides end consumers a convenient means of obtaining information about the full meat chain using the 2D barcode-scanning method. This extent of information access can enhance consumers' perceptions of the quality and safety of pork products, which may influence their overall perceptions of food safety.

Application of the traceability system serves as the basis for high-quality

development and branding of large-scale farms, slaughterhouses, and dealers. The system can help these entities build brands, identify and minimize fake products, and surmount the highly competitive environment of inferior meat obscuring good meat, thus enabling these entities to focus on high quality and high price. The traceability system also provides strong data-based support for government regulatory agencies at all levels and can play a central role in macro- and micro-quality control. Practical application of the financial investment promotion system in Jilin Province has verified the feasibility, benefits, and value of these results.

Next steps for the traceability system include realizing individual traceability based on the results of batch traceability. In light of achievements in pork traceability, traceability schemes using mobile Internet and 2D barcode technology can be developed and applied to cattle, chicken, and other livestock and poultry production and sales. The research and design of traceability system construction and promotion constitutes another important topic, for which the financial investment mode of Jilin Province provides a potential model. Construction and promotion application based on market forces also warrants further study. Under the support of the new traceability system, the quality and safety management model of livestock and poultry products remains an important research topic.

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Figures

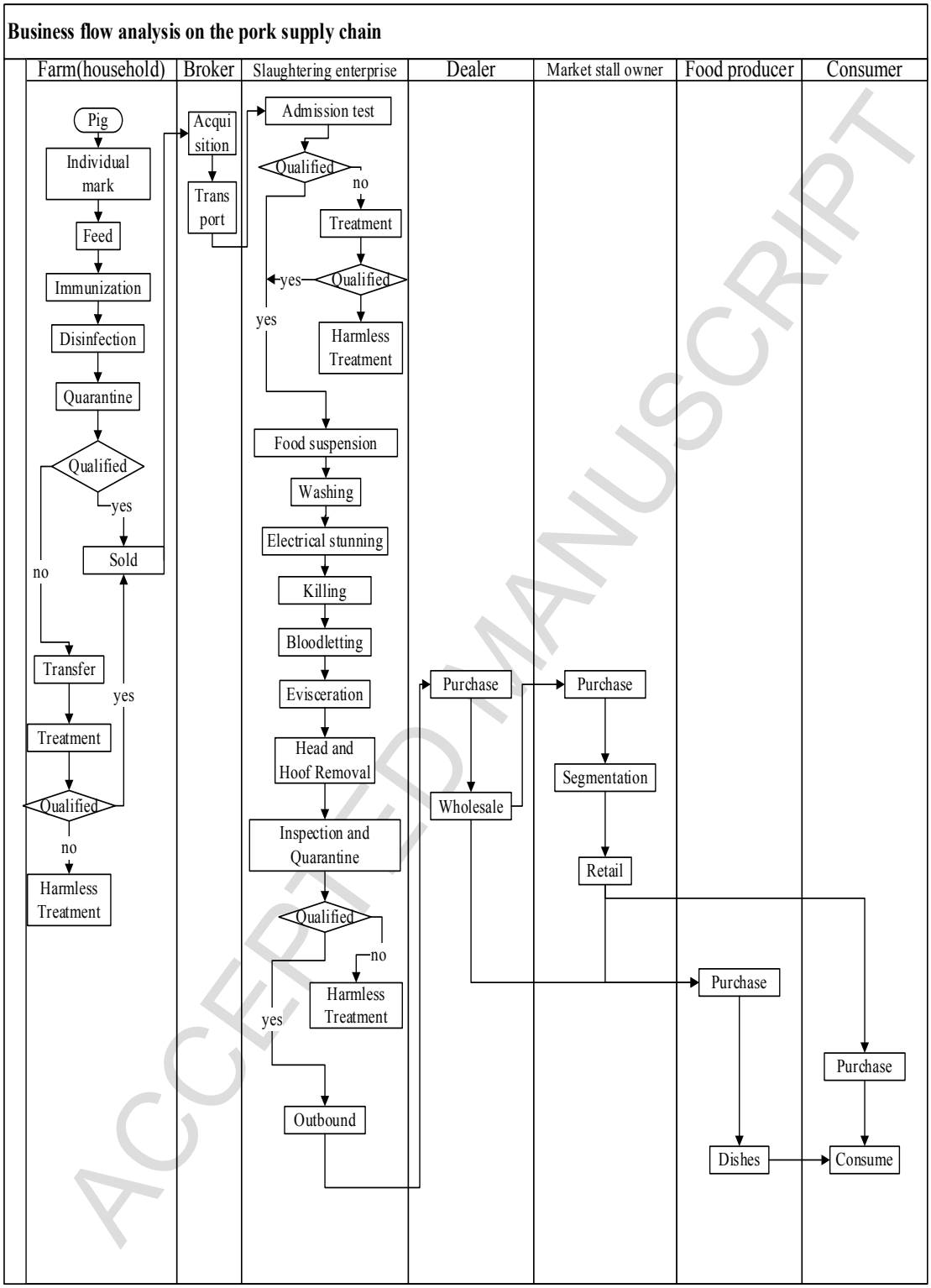

Figure 1. Pork supply chain business flow

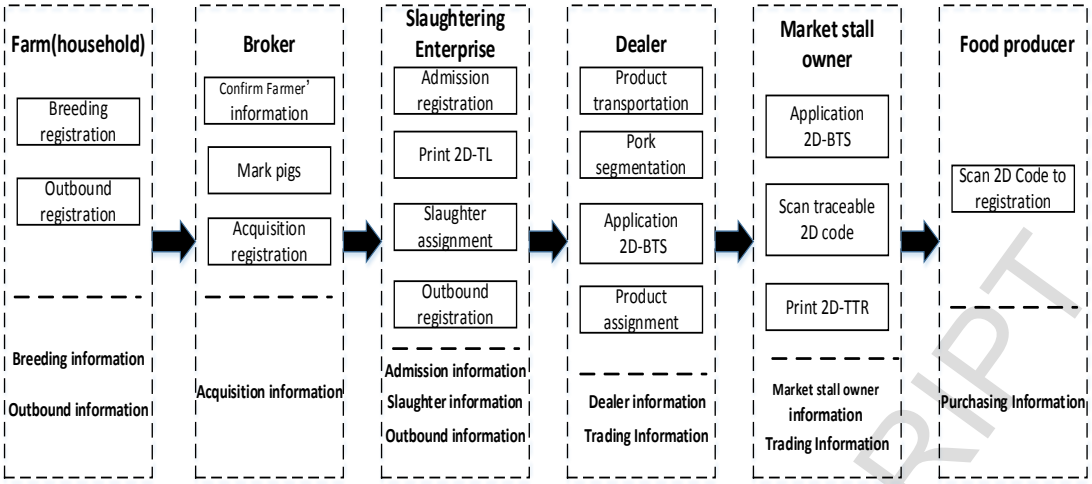

Figure 2. Diagram of business flow for traceability

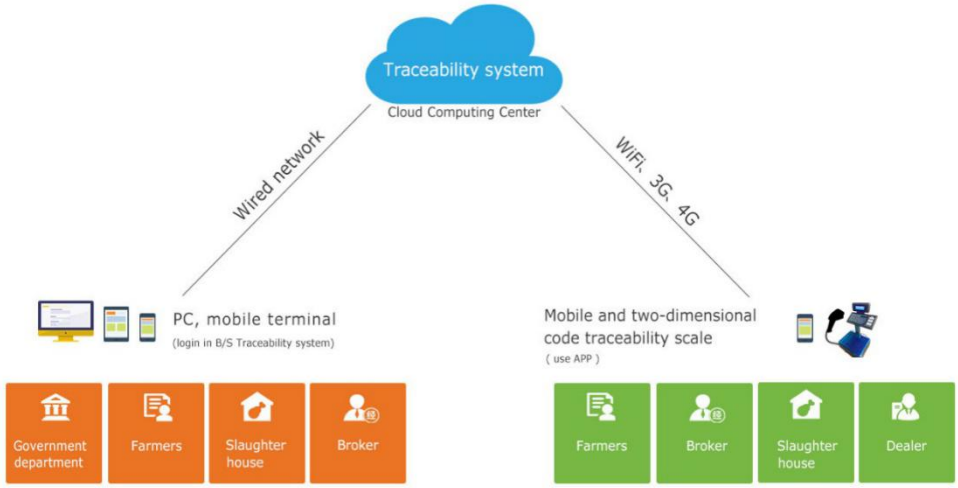

Figure 3. Overall system architecture

Figure 4a. 2D barcode

Figure 4b. Traceable label

Figure 4c. Traceable transaction receipt

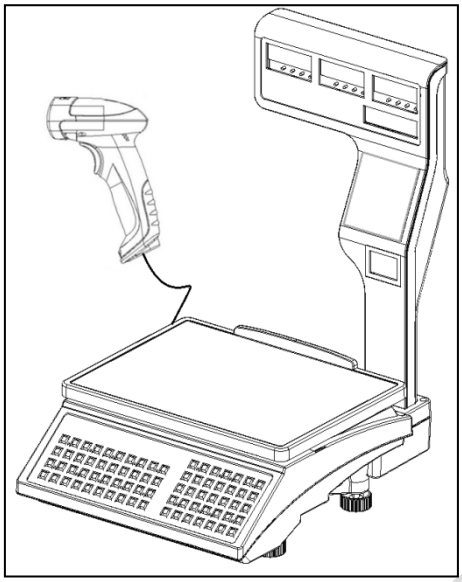

Figure 5. 2D barcode traceability scale

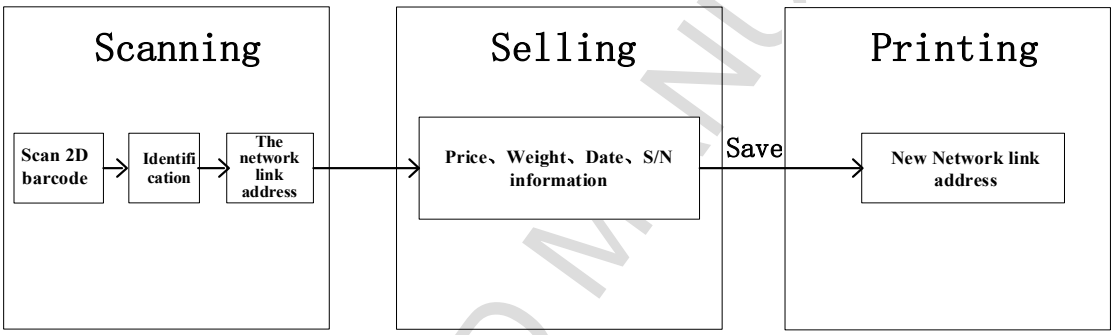

Figure 6a. Meat sales business scenario

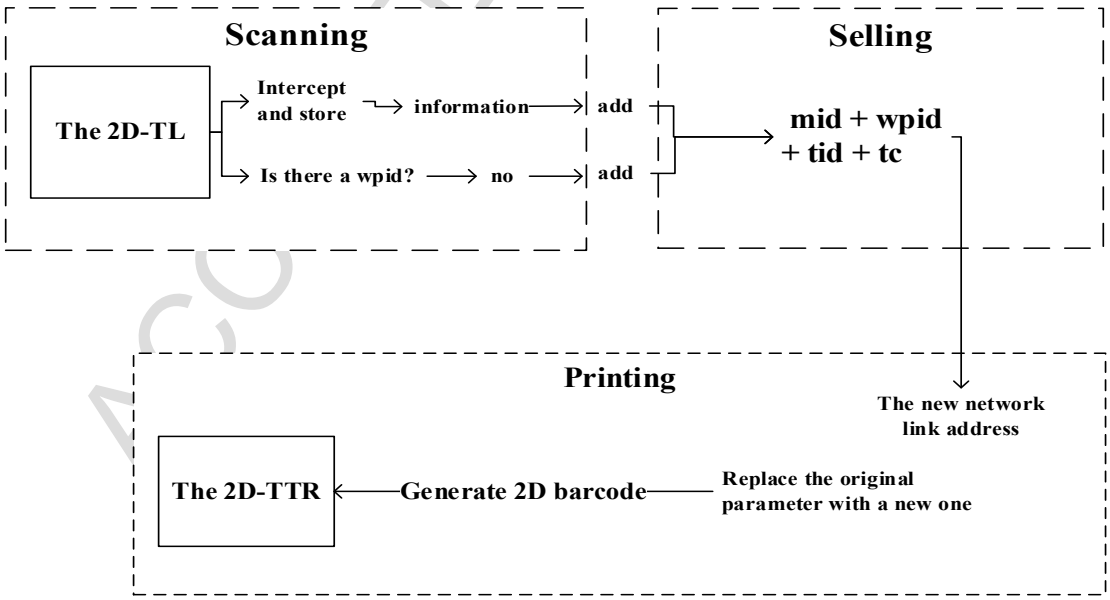

Figure 6b. Principle of 2D-BTS

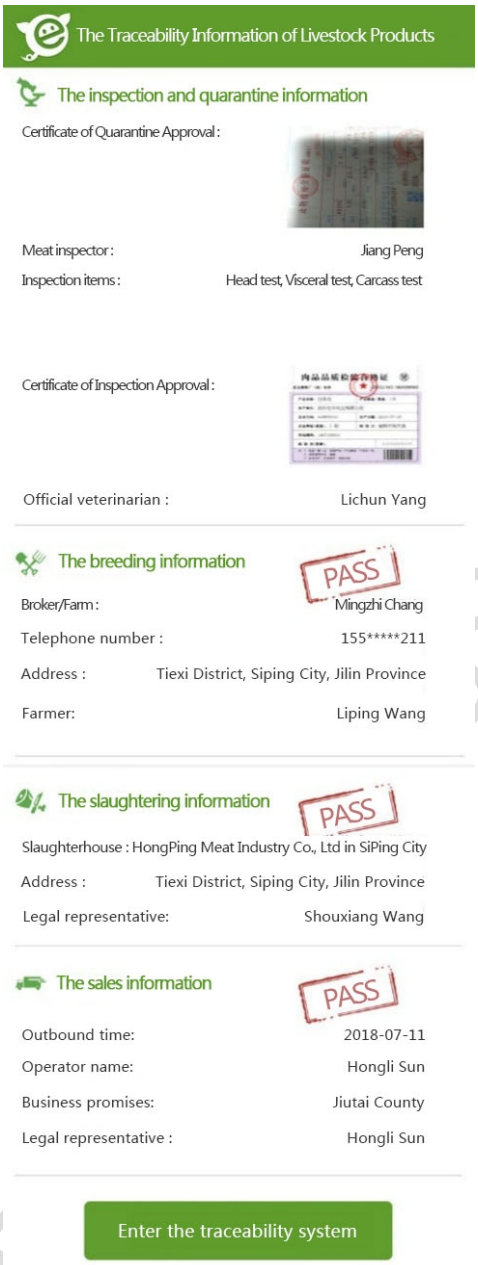

Figure 7. System screenshot

Highlights

- A pork mobile traceability system with 2D barcode technology has been developed.
- The solution can trace all sections of the pork supply chain and coordinate the pork production process.
- The solution is cost effective, easy to use, and credible.
- The solution can support different stakeholders, e.g. companies, government, and consumers.
- The effectiveness of the solution has been proved by a real government project.

Tables

Table 1. Key traceability information

Information type	Description
Business entity information	Name, address, legal person, contact information and license information of farms (households), brokers, slaughtering enterprises, dealers, market stall owners, and food producers
Quality and safety information	Immunization information, self-test report, and inspection and quarantine information
Transaction record information	Transaction time, transaction quantity (weight), transaction information from both sides (seller and customer), etc.

Table 2. Configuration parameters of 2D-BTS

Indicators	Parameter description
Communication interface	RJ45 Ethernet x1, RS232 serial port x2, USBx2, audio output x1, wireless
CPU	Minimum MX6 Cortex-A9 1GHZ single core
Operating system	Linux / Windows
RAM	2G
Built-in printer	Built-in thermosensitive ticket printer
External scanner	Yes
Network	4G full Netcom or WiFi