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The Research of the Tracking and Traceability System for Vegetable Quality Assessment and Assurance

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ABSTRACT
The paper Proposed a tracking and traceability system for vegetable quality assessment and assurance. The system used coding technology to realize the total quality management and "from farm to table" tracking and tracing. Besides, the system provided automatic assessment of the quality of vegetables and intelligent guidance of planting vegetables. The paper firstly Studied the principle and model of the system, and then described the design and implementation of the system. Finally, some key issues of the system are discussed in detail.

Keywords: *HACCP; Quality Assessment; Tracking and Traceability System; Supply Chain*

I. INTRODUCTION

There is a saying in China: Bread is the staff of life. Food security is closely related with the lives of the people, it has become a major global issue.

In recent years, food safety incidents were frequently reported, such as "red-yolk duck egg", "tonyred", "Melamine milk" and so on, these incidents focus more and more people's attention. In December 2010, the Research Center of China's full Well-off and Tsinghua University Media Research Laboratory carried out "Chinese consumer confidence in food safety," Survey across the country, and published "the report of consumer confidence in food safety in 2010-2011" in "Insight China", the report said that a nearly seventy percent (67.9%) respondents to China's food security situation was "insecure." Of which more than half (52.3%) of respondents state of mind is "more disturbing", while 15.6% of people said "Particularly insecure".

To enhance the food safety, the government has issued a series of laws, regulations and standards to enhance food safety. For example, on December 31, 2005, General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China (AQSIQ) and Standardization Administration of the People's Republic of China(SAC) jointly issued the national standards GB/T 20014.1-2005 "Good Agricultural Practice"(GAP) . The food industry has also taken a number of technical measures to enhance food safety. The Total Quality Management (TQM) and Hazard Analysis Critical Control Point (HACCP) program has developed early in last century [1]. Various of new Information Technology such as Wireless Sensor Network(WSN) [2], RFID [3][4], Petri Net [5] has been used and all kinds of information systems were developed over the last decade.

The food supply chain management especially the vegetable supply chain was another focus issue in food safety management [3][6]. The tracking and traceability system was a useful and efficient example. Traceability system for safe agriculture product realizes whole process tracking of vegetable products from production base stations, processing and packaging, storage and transportation, to wholesale markets as well as retail markets. It help consumers to obtain more reliable quality information.

The tracking and traceability system has become an essential method for food quality assurance, but as you know, there were difficulties and barriers. They were discussed in detail in the following sections.

The paper proposed a tracking and traceability system for vegetable quality assessment and assurance. The system followed the HACCP program, developed a software to implement the GAP management specification, used ANCC(Article Numbering Center of China) coding technology to realize the total quality management and "from farm to table" tracking and tracing. Besides, the system provided automatic assessment of the quality of vegetables and intelligent guidance of planting vegetables. [7]

The paper described the principle and design of the system. In Section II, the model and procedure of the supply chain has been presented. Design and implementation of the system has been detailed described in section III. Some key issues of the system were discussed in section IV. the trend and future development of the system were proposed in the last section.

II. MODEL AND PROCEDURE

A. Model of the Supply Chain

As shown in figure 1, the vegetable supply chain has five main components (contained some partners) and data flows. It used an information platform and database system to record the information about vegetable's producing and marketing procedure as planting, processing and packaging, storage and transporting, marketing. After the consumers bought, they could retrieve the information to perform tracking and tracing.

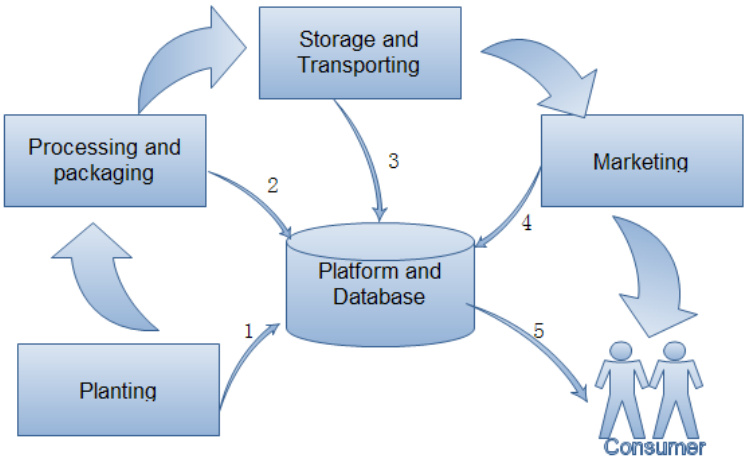

Figure 1 Model of the Supply Chain

B. Roles and Components

There were several roles in the whole system, they were Farmers, College-Graduate "Village Officials"(CVO), Vegetable Production Base Stations (VBS), Distributors, Transporters, Markets and Sellers, Agricultural Materials Company, Agricultural Experts and Government Supervisors.

Except the consumer, there were four components in the system, as shown in figure 1, each rectangle represents a component. They were also four work procedures or areas.

Farmers perform the planting operations such as seeding, applying fertilizer and pesticides, weeding and gaining. As most of farmers couldn't operate computer, CVO acted as an special role to help them. One CVO would help a group of farmers. CVOs and farmers would work in planting area; A VBS managed a group of CVOs and farmers, the station were responsible for the vegetable processing and packaging; the Distributors and Transporters in charge of the storage and transportation.

As the characteristics and innovations of this system, the system introduced several special role, they were CVO, Agricultural Materials Company, Agricultural Experts and Government Supervisors.

- The Agricultural Materials Company will provide the safe and certificated seeds, fertilizers and pesticides etc. The safe and certificated agricultural material was a critical control points (CCP) for the vegetable's quality assurance.
- The Agricultural Experts provided the technical support through this platform and the knowledge and information would bring the intelligent guidance of planting vegetables.
- The Government Supervisors would supervised the whole procedures from original to consumer and enhance the quality safety of vegetables.

C. Data Flow

Information communion is crucial to collaboration between supply chain partners. Information exchanges were shown in figure 1, the short curved arrow represented the vegetable's flow and the five numbered long curved arrow represented the data flow. The five data flows were explained in detail below:

- Data Flow 1: The CVOs helped the farmers to record the planting operation information, the seeds, fertilizers, pesticides and the operating time would all be recorded.
- Data Flow 2: the VBS recorded the processing operation information such as processing condition like temperature, water quality, process time and packaging material, etc.
- Data Flow 3: the Distributors and Transporters would input the information like storage conditions and transportation times into the database.
- Data Flow 4: the Markets and Sellers would record the time of receiving the vegetable and the time of sales.
- Data Flow 5: the Consumers would get a trace code when they.bought the vegetable, they could tracking the whole life-cycle information about the vegetable through the trace code and the platform.

D. Collaborative Workflow

The design of the collaborative workflow is the key to system success. [6] The material flow, the data flow and the cash flow should be considered carefully.

The figure 2 illustrated the collaborative workflow of our system, the thick arrow represented the material flow (vegetable flow) and the thin one represented the data flow(information flow).

When the farmer gained the vegetables, he will package them by himself or transport them to CVO or VBS directly. The markets or sellers will order or purchase them through the information system, when purchased, the vegetables will be transported to the target and the consumer will buy them.

In the Data flow, the Farmers will report their planting operations to CVO; the CVO may input the CCP information into the tracking information system. The Farmer or CVO or VBS will published the vegetable supply information through the information system. The markets or sellers will explore information and order the vegetables they want. As VBS received the order, they will send the transportation demand to the transporter. The transporter will input the logistics information to the system. The market or sellers will confirm the order when they received the vegetables. Besides, the Agriculture Materials Company will publish the materials information and the Agriculture Experts will publish the planting technical information.

The Government Supervisors will take a quality sampling from VBS or markets randomly and casually, and publish the quality reports in the system.

Finally, the consumer can use the vegetables' trace code to tracking the whole lifecycle information of the vegetables.

As a business secret, the cash flow are not presented in the paper.

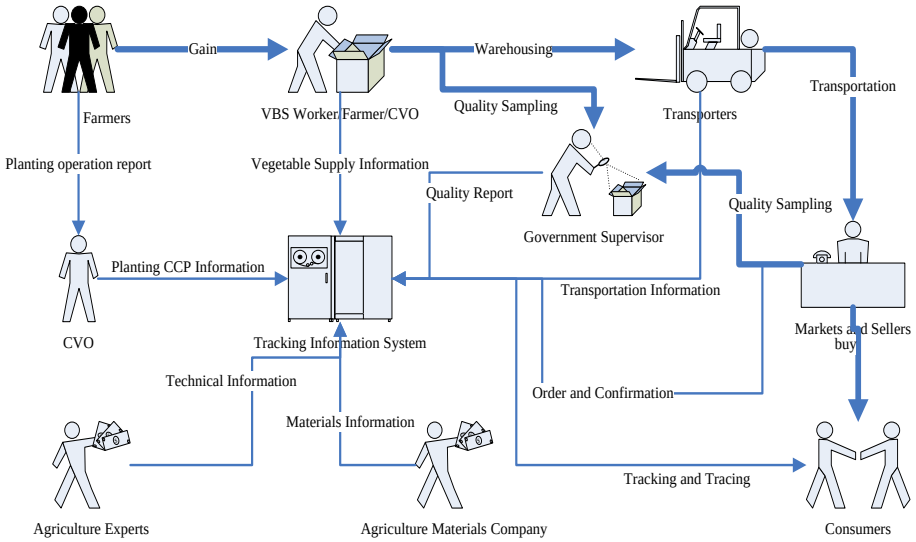

Figure 2 the Collaborative Workflow of the System

III. DESIGN AND IMPLEMENTATION OF THE SYSTEM

This section will show you the architecture and modules of the tracking and traceability system.

A. Modules of the System

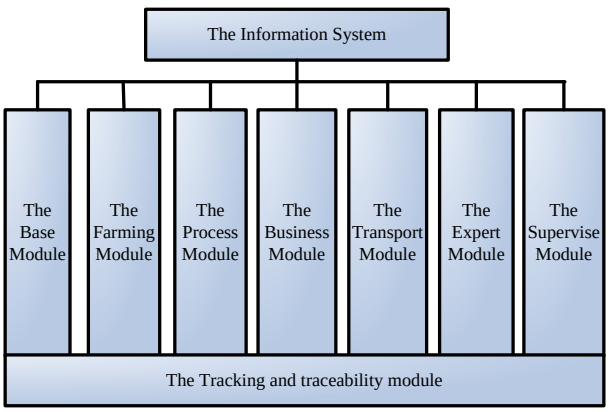

Figure 3 The Collaborative Workflow of the System

There were eight modules in the system; they are shown in figure 3. According to the user's requirement, most of the modules are developed and deployed in C/S model. The Tracking module is in B/S model, some of them are both in C/S and B/S model.

- The function of Base Module include: system administration, user and privilege Management, agriculture materials management, the land information management, information review management, etc.
- The Farming Module was used to record the farmer's operation, such as seeding, apply fertilizer and pesticides, gaining and so on.
- The Process Module was used to record the critical information about process and packaging.
- The Business Module was used to publish, manage and confirm the vegetable orders.
- The Transport Module was used to publish, manage and retrieve the logistics information.
- The Expert Module was used to publish the planting technical information and to provide the online technical support for farmers.
- The Supervise Module provided an interface for Government Supervisors to review and inspect the whole system and to publish the quality report.
- The Tracking and Traceability Module performed as a Web page, the consumers can explore the page and input the trace code of the vegetable they bought, and then they will acquired all information about the vegetable.

There are some features and innovations in the system, as described above, the system realized the total quality management and "from farm to table" tracking and tracing function, the system provided automatic assessment of the quality of vegetables and intelligent guidance of planting vegetables.

B. Deployment of the system

The information system is a distributed system, it developed in C/S and B/S model. The C/S model is safer while the B/S model is easy to access. The architecture of the system is shown as following figure 4.

The system development uses multi-layer structure, the database server is the bottom layer and all clients are the top layer. The Clients and servers are connected to the internet, so the system can be used anywhere. The client can access the Application Server or Web Server only, as the encryption of the Application Server or Web Server, the client cannot view the database inner structure. The Application Server and Web Server do not connect to the Database Server directly, it's must use the service of the Access Server.

The multi-layer structure allows the all components of the system be deployed separately, it's safer and efficient. From a developer's view, the multi-layer structure allows the components of the system are changed and updated separately, it's easier.

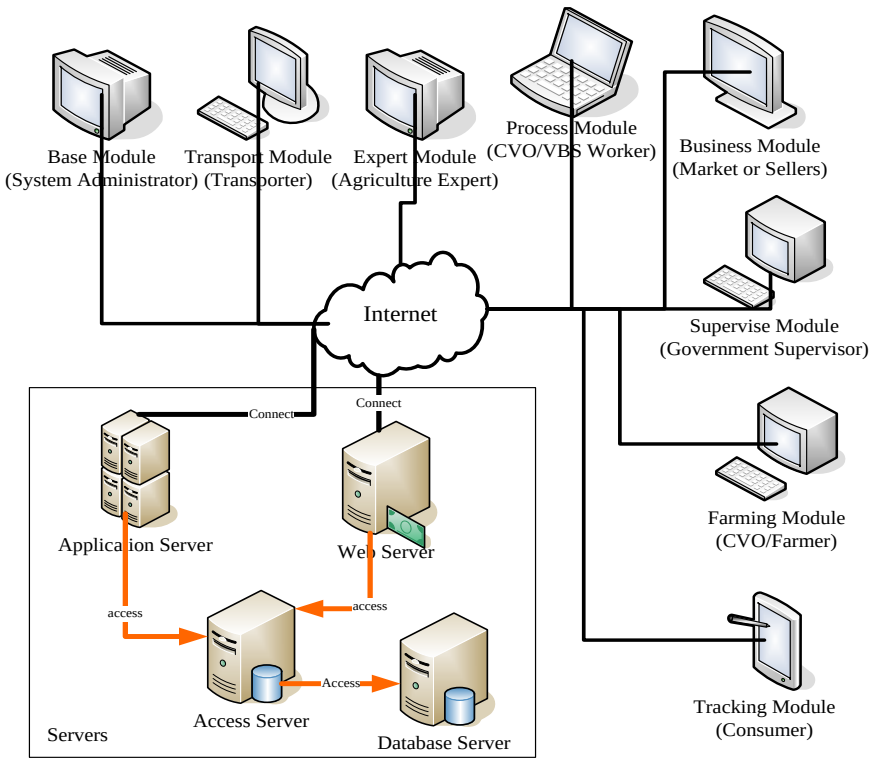

Figure 4.The Deployment of the System

IV. DISCUSSION OF SOME KEY ISSUES

There are some key issues or difficulties in implementing the system. We'll discuss them in detail as follow.

A. Information Acquisition

Information acquisition is the basis of the tracking and traceability system, RFID is the most popular technology for information acquisition. In recent years, RFID technology has been adopted by some agricultural enterprises and retailers all over the world. There are some cases of RFID adoption in vegetable supply chain in China. For example, In order to guarantee the food safety for the 2008 Olympic Games, Beijing has formally begun on constructing a food safety tracking system using RFID technology. Despite the promising applications of RFID in vegetable supply chain, a number of challenges have hampered the adoption of RFID. The major issues can be broken down into standard challenges, cost challenges, return on investment (ROI) challenges and etc.[3]. So the information of our system will be inputed manually by the workers or operators in each module.

The information system contained not only the information in traditional supply chains but also the planting operation information for HACCP control. But the farmers have no basic knowledge to operate the system, so the CVO (College-Graduate "Village Officials") is critical to the system success. Fortunately, the Chinese government vigorously promotes the "Village Officials" project. The application of the tracking system resolves the problem that the CVO has no practical jobs to do. The CVO will be involved in the system, and they can help farmers to operate the information system. The system also can help the CVO's own business.

B. Quality Assessment

There are four levels of vegetable quality in china. They are organic vegetables, A grade green vegetables, AA grade green vegetables and "green" vegetables. The Origin of the environment, production processes and product quality of each level vegetable must meet the requirements of relevant national standards and norms.

One of the most important features of this system is the ability to automatically assess the level of vegetable. It's very difficult to implement the function; they must follow a series of operation rules and specifications. We have design a complex algorithm to accomplish it. Firstly, the agriculture materials must be certificated before be inputted into the system. Secondly, the operation rules and specifications has been separated into a series of control points(CPs) and the CPs will be inputted into the database as a assess item. Then the farmers' operation information has been entered into the system. So finally, when the farmer gained the vegetable (CVO perform the operation in the information system), the system will compare operations and the assess items and automatically assess the level of vegetable.

C. Intelligent Planting guidance

The system contains a mini expert system for intelligent planting guidance, the farmer can search the planting information and access the technical services, if there are no needed information in it, they can seek the agricultural experts' assistance online.

V. CONCLUSION

The system has been put into practical application in Wenzhou, China and has received a lot of benefits. For some practical reason, the technology of the system is not the most advanced one, but it can work well.

In the future, the application of Internet of Things (or CPS) will be better for the tracking and traceability system, and other new techniques will be applied in it.

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