

TRACEABILITY SYSTEM IN AGRI-FOOD SUPPLY CHAIN: AN EXPLORATORY STUDY IN AGRI-FOOD EXPORTER COMPANY

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ABSTRACT

Tracing back the product information of fruits or vegetables that were sold in the grocery store is important in parliamentary procedure to ensure the quality and safety of the product for consumers. Nonetheless, tracing back the product information was not easy if there are inadequate data about the product which are gathered and shared across supply chain echelons. An exploratory study was conducted to clarify how an Agri-food exporter company did a traceability system across their supply chain echelons. The study found that the company has minimum traceability data and the products from various plantations are mixed in their packaging operation. And so, a traceability system was proposed to treat the troubles. The traceability system refers to a mechanism in Global Standard One (GSI) system. Utilization of Radio frequency identification (RFID) technology was also recommended to improve the ease of data collecting and sharing from farmers or collectors to the company. Finally, the company should develop an information system and utilize data warehouse for managing the traceability system.

Keywords: *Agri-food, global standard one, supply chain, traceability system.*

1.0 INTRODUCTION

Global trade, has led to greater risks in food safety issues due to dangerous food can be quickly and widely spread among countries and a lot of people who could be affected [1]. Therefore, the government has given attention to the problem of food safety through forbidding import of the fruit indicated unsafe, as in the case of apples contaminated *Listeria monocytogenes* [2]. Related to that, the government has been also issued regulations regarding food safety control, especially for fruits and vegetables [3-5].

Safety control regulation for fruits and vegetables, in the government regulation [5], is focused at the point of production or at the point of entry / exit (import / export) product. The regulation is inadequate to carried out tracking and tracing of Agri-food product back to the grower.

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Especially, while one of export commodity is banned from importer country, maybe the commodity is contaminated by hazardous materials or bacteria (like the case of apples from California [2]), then the same commodities from various agricultural regions will also be banned. Based on detail observation on a Agri-food exporter company, the condition can be occurred because there is no representative data for the origin of products or the commodities from various harvest regions in the company information system.

Thus, it needs a mechanism, the traceability system, which ensures information quality and food safety can be traced across all of the supplier's configurations, from producers (farmers) to consumers [6, 7]. Charlebois et al. [1] mentioned at least three goals traceability: guarantees product quality and safety are acceptable to consumers, manages the potential risks found in food products, and helps improving the product quality and production process by means noncompliance identification. Moreover, the traceability system gives an opportunity for the supply chain stakeholders, i.e. distributor, retailer, consumer, and others, i.e. governments to retrieve information about Agri-food products in the market.

Several studies have addressed the model traceability of agricultural products [8-11]. The use of RFID technology for traceability of fruit are also discussed in several studies [12-16]. GS1, a nonprofit organization, which is engaged in the development of traceability standards, have also been recommended for fruit traceability mechanism [17, 18]. However, characteristics of the fruit supply chain in Indonesia led to the GS1 guidelines can't be applied directly. Necessary adjustments, especially when associated with tracking and tracing needs of the fruit from the farm to the final consumer. However, in principle, the application of traceability should have three main components namely the identification, capturing, and information exchange [14, 15, 17-19].

This paper presents an exploratory study about traceability in an Agri-food exporter company and proposed a traceability system for Agri-food supply chain by means Global Standard One (GS1) and radio frequency identification (RFID) technology. The system proposed is focused on assisting the distributor (exporter company) for managing data of the Agri-food across the supply chain echelons. The use of RFID technology is intended to improve the ease of tracking and tracing information of the Agri-food products in the whole process of distribution from producer to consumers [16]. With the proposed of the traceability system, the Agri-food exporter company can build an information system application in order to support tracking and tracing of fruit and vegetables that they exported.

This paper is presented in several sections. A preview of methodology is shown in the first section. After that, we present the result of an exploratory study about structure of supply chain for Agri-food exporter company and their existing traceability process. In the last section, we proposed a business process traceability for the company and functional requirements for an information system application for supporting the business process traceability.

2.0 METHODOLOGY

A brief overview of our research site, exploratory study and data collection method are presented.

The research was conducted in an Agri-food exporter company at Temanggung, Province of Jawa Tengah. The company takes fruit and vegetables from farmers in three provinces, Jawa Tengah, Yogyakarta and Jawa Timur. The three provinces are spread in very width regions. The company exports to some countries for various fruit and vegetables such as melon, mango, french-bean, potato and many others.

Beside we interviewed the company, we also carried out an observation from farmers and collectors or suppliers in some agricultural areas in Karanganyar Regency, Sragen Regency, Magelang Regency, and Ngawi Regency. We also examined documents that were used in the company, such as operational procedure documents, shipping documents, and order documents.

We explore supply chain structure and traceability process of french-bean and melon as a sample. Melon represents a large-sized fruit that can be sold itemize and french-bean represents a vegetable that is sold in small packages. Besides, they have difference in their export freight, while french-bean use air freight and the other use sea freight. Melon and french-bean are also favorite commodities in the company's demand and melon is the highest demand in the company among the other fruit.

We proposed a traceability system for Agri-food supply chain by means GS1 standards and RFID technology. We used some literatures to compose the system [8, 14, 17-20]. We focus on data are should be collected and how to share it.

3.0 EXISTING SYSTEM

We outline supply chain echelon and existing traceability in the Agri-food exporter company.

3.1 Supply Chain Structure

Based on the observation, in general, the fruit and vegetable supply supply chain echelon are pretty similar. The echelons are a farmer or grower, collector, the Agri-food company, importer company, retailer and customer. The last three echelons were abroad because we focus on the export process.

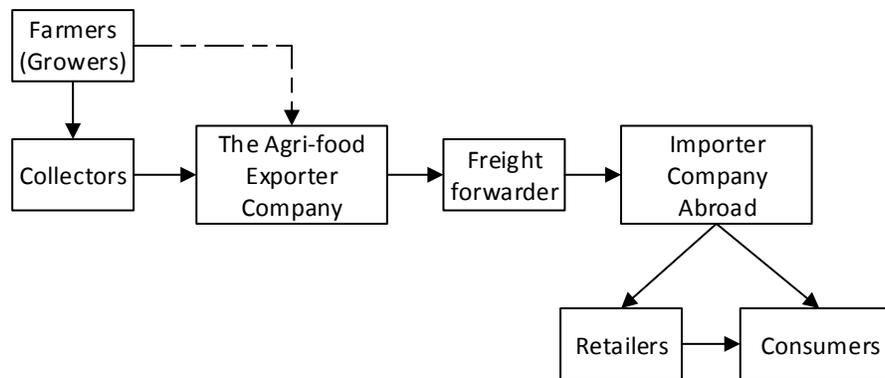


Figure 1: Fruit and vegetable supply chain echelon in Agri-food exporter company

Generally, fruit and vegetable export supply chain is shown in Figure 1. Farmers are parties who plant and harvest fruits and vegetables. Then, the fruits and vegetables that are produced are bought by collectors who supply the products to the Agri-food exporter company. They are two kinds of collectors, an association and personal collector. For example, in the melon's supply chain, there is Asosiasi Agribisnis Melon Indonesia (AAMI), an association for melon farmers, who buy all products from a farmer based on a signed contract. Even though the association buy all the products from the farmer, they only supply qualified products to the company. The product quality is set by the company. Sometime, based on the contract, the association supply seeds and fertilizer to the farmers and the cost of them will be charged after buying process of the products. The personal collector is a such trader in general who buy the products from some farmers and then supply the products to the company. Unlike associations, trader buys only some of the products that are considered qualified.

As shown in Figure 1, sometime farmers sell their product directly to the company. There are two conditions for that, first, while there is a contract between the farmer and the company. Second, the quantity of products that are supplied from the collectors was not enough to fulfill a demand at a time, and it makes the company must directly find and buy products to some farmers.

The received fruits and vegetables from collectors or farmers will be sorted again in the packaging process at the company. The company keeps doing the sorting process to ensure the products meet the quality from an importer. Besides resorting, the company also did weigh, packing, labeling, and quality control processes such as temperature, humidity and so on. Then the products will be delivered using freight forwarder, sea or air forwarder.

The next step, in abroad, the products that are received by an importer company will be distributed to retailers or consumers directly. Consumers who directly buy the products from the importer company are hospitals, hotels and others. Particularly, personal consumers buy this imported product at a retailer such as supermarkets or traditional markets.

3.2 Traceability Process

If we talk about traceability process, we concern about data that are collected and shared by each echelon across supply chain process [17-19]. Data that are collected or shared by the Agri-food company were shown in Figure 2. The limitation of this observation cannot show data that are collected and shared with importer company and retailers abroad. On the other word, this exploration is focused on internal traceability in the company.

The Agri-food exporter company collect data from farmers or collectors (suppliers) on a document (paper based). The function of the document is only as payment data to supplier and information for production management, for example, in evaluating if the production target has been fulfilled or not. In production/packaging area, the company gives the label (brand) for any product types. The label is attached on a packing or unit product (for some fruit types). Several labels use the standard barcode number, but others are not yet.

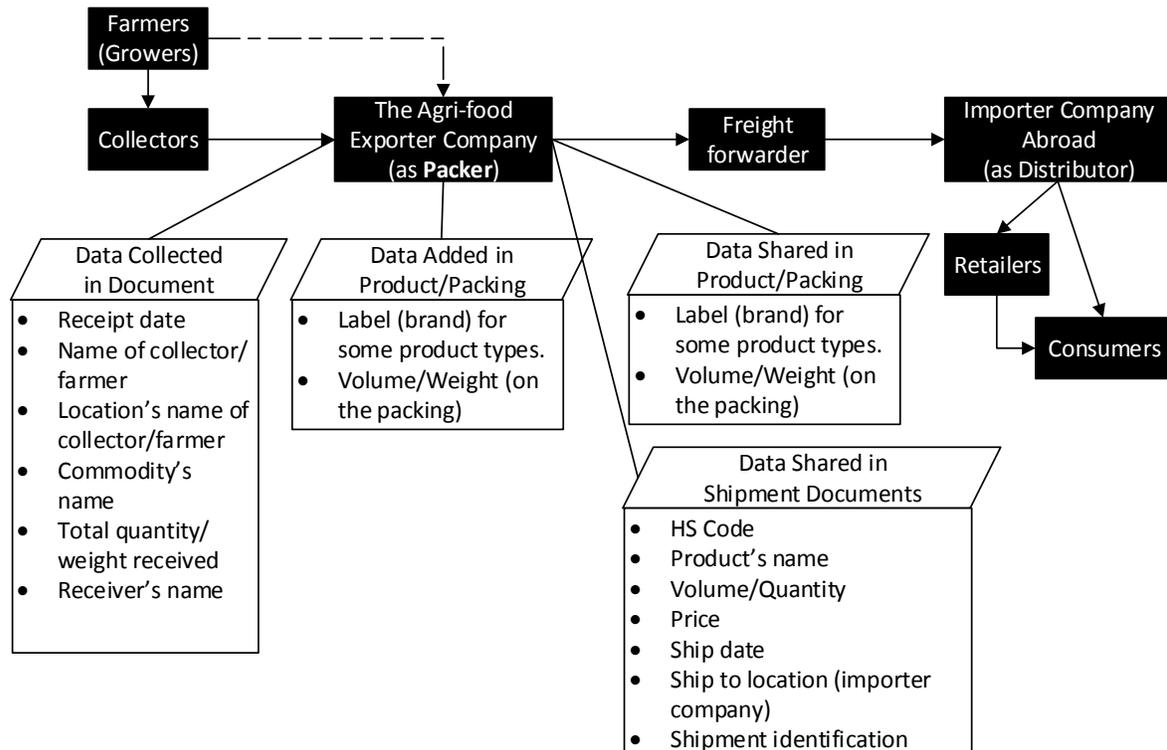


Figure 2: Existing traceability data by the company

The products that are received from suppliers will be processed (sorting, labeling, packaging, and storing in cold room) in one day process. Unfortunately, in their production process, products from many suppliers are mixed without well documented. For example, the company received

melon from three farmers in different region, all of the melons will be packed or stored, and the company cannot trace back the source of the products. This is the problem, while an identified melon has bacteria or chemical problem, then all of the melons from three regions will be banned. The company does not have the ability to trace the source of the product.

4.0 A PROPOSED TRACEABILIT SYSTEM

In this section, we proposed a traceability system for the company and a preview of functional requirements for an information system for supporting the traceability.

4.1 Traceability System

In order to maintain traceability data that can help the Agri-food exporter company for tracing their export products, there are some roles that must be done by the company and the collectors. The collectors must be involved in collecting the data as shown in Figure 3. The collected data refer to GS1 [17] with some modifications, such as Global Location Number (GLN) is changed to Farmer Identification (FarmID), Commodity/Variety is changed to Commodity Identification (CommID), and Sender ID (GLN) is changed to Collector Identification (CoID). The farmer (grower) does not implement GLN because the farmers generally are not corporate or just a personal farmer who have small areas of the plantation. FarmID, CommID and the other data will be stored in an RFID tag that is attached to a crate / bin. Because of memory limitation of the tag, then the use of ID or code is recommended and detail information about the farmer and the collector must be stored in the company's data warehouse. It means that all of the farmers and the collectors who supply products to the company must be registered in the traceability system application of the company.

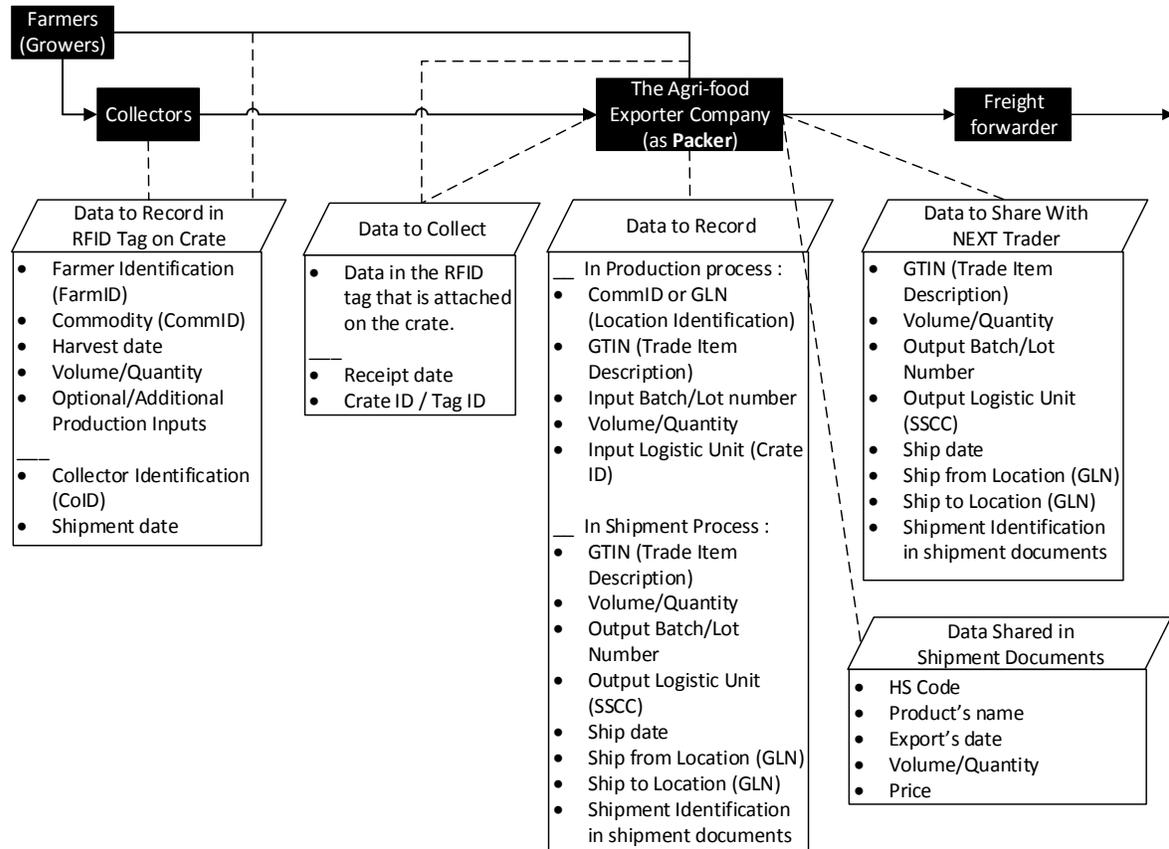


Figure 3: A proposed traceability data which are managed by the company

Use of an RFID tag that is attached on each crate can help collectors in separating products from each farmer. The collectors must obey the rule that each product from farmer must be stored in different crates. It will help the company in identifying the source of the products. There are two options for the company, facilitating crates with an attached RFID tag that will be used by the collectors or only giving RFID tag for the collectors and they attach the tag by themselves.

While crates arrive at the company, each tag on the crate will be scanned and data will be stored in a database of an information system. The attached tag on each crate makes the crate can be individually traceable. The use of RFID tag is recommended for replacing barcode that is attached on crate because RFID tag can store more data.

In the production process, the company must record data of the product information, i.e. commodity name, grade or quality specification and others. The company must also ensure that recorded data can help for tracing. In order the product can be traced over many countries, the product should use Global Trade Identification Number (GTIN), an itemize product identifier, as it was explained in GS1 [17]. As mentioned in GS1 [17], if the product has a brand, and the brand owner is the Agri-food exporter company, then the product will use GTIN that is issued by the company. If the company is not the brand owner, it must use the brand owner's GTIN, i.e. a brand from the importer company abroad. In fact, several products have not brand because both the Agri-food exporter company and the importer company abroad are repacker only, and the brand owner is a retailer. If it happened, the companies should use Global Location Number (GLN) in their product case label. As a recommendation, the Agri-food company should register as a member of GS1 in order to get Company Prefix and GLN. The GLN which is had by the company can also be assigned as a farmer location or FarmID. Detail scenario for cases (1) the Agri-food exporter company is as the brand owner of a product, or (2) the company is not, were explained in GS1 [17].

While the company processes a shipment, they also must record data, minimum as shown on Figure 3. Data that are stored in database can be shared to next trader, an importer company, via internet through data as a service (DaaS) mechanism [20, 21]. Retailer or consumers can also access a specific data through DaaS mechanism.

4.2 Information System Requirements for The Traceability

As a consequence of the improvement to the internal traceability in the company, the company should acquire an information organization. In this section, an overview of the information will be explained. Pizzuti [22] recommended that the information system has minimum functions (1) receiving process of lot product from a farmer, (2) receiving process of lot product from a collector, (3) production process (sort, packing, store, and shipment) in the company, (4) data sharing process to next trader, (5) global tracing across supply chain. For the fifth function, if the company and other actors in supply chain use GS1 standard configuration, the external traceability can be carried out. For example the end consumer can also retrieve product information using iGepir, a mobile application [23, 24]

On receiving process, the Agri-food company should develop a mobile application that can read and write data to the RFID tag. The application is used by the collectors for collecting data in the plantation field. The minimum collected data are depicted in Figure 3. The data is stored in an attached tag on a crate. Periodically, the mobile application must synchronize its internal data to the database of the company, i.e. data about registered farmers, commodity, and so on. The other receiving process is happening on receiving area at the company. In this area, the company uses RFID readers to load data on the tag. The data will be utilized in the production process.

In the production process, the information system will be utilized for recording many data as depicted in Figure 3. The information system must guarantee that the internal traceability, both tracking and tracing, can be carried out. Tracking means that the company can follow the path of a traceable item through some production areas (in the company internally) as it moves and define which products are for next shipment [17].

5.0 CONCLUSIONS

A traceability system proposed will improve the data collecting and sharing across supply chain echelons in the Agri-food exporter company. The data can be utilized for tracking forward and tracing back of fruit or vegetable that were exported by the company. However, the company has to develop an information system and data warehouse complied with the traceability system using GS1 standard and RFID technology. Further research will introduce details the information system that must be developed by the company to support the traceability system.

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