

PRELIMINARY STUDY OF BENEFITS AND BARRIERS-COSTS RFID TECHNOLOGY IMPLEMENTATION ON TRACEABILITY SYSTEM OF BANANA IN INDONESIA

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ABSTRACT

This paper presents a preliminary study that discusses the benefits and barriers-costs, implementation of RFID technology in traceability systems of agricultural products fruit in Indonesia. Benefits and barriers–cost factors are examined from perspective of supply chain entities which are categorized based on the technology component. From this study found that required a follow-up study to identify more about the benefits and barrier implementation of RFID technology in traceability systems of agricultural products fruit in Indonesia.

Keywords: *RFID, component technology, traceability system, supply chain, agricultural*

1.0 INTRODUCTION

RFID technology has been implemented widely in various fields such as manufacturing, supply chain management, agriculture, health, clothing, chemical, environmental, sports, finance, transportation, and military government [1-5]. RFID technology has also been used for various purposes such as human identification, traceability, public transportation entry, government identity cards, parking entry, goods distribution, ticketing and building entry [6, 7]. These implementations of RFID technology in the area of traceability deserve further discuss. Traceability is one of the most important factors for market growth [6]. Traceability can improve supply chain efficiency, reduce theft and fraud as well as realize significant cost savings.

Traceability is defined as the ability to trace an item or group of items from one point to another in a supply chain/distribution, either backwards or forwards [8, 9]. Traceability of products has an important role in a supply chain because consumers can easily find out more information about a specific product in terms of both product quality and product safety [8, 10]. Traceability is also a risk management tool which allows respond to potential risks and provide an opportunity for the authority to isolate the problem by pulling back the food products and then prevent contaminated products from consumer's reach [11, 12].

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RFID technology for traceability is widely applied to several products, one of which are agricultural products, especially horticultural fruit products [13]. The importance of supply chain traceability systems of fruit products is driven by increased consumer awareness in consuming agricultural products which are safe and good quality [10]. Agricultural products to be presented in this paper are horticultural fruit products export-oriented in Indonesia. The focus of this study is banana, banana is one of Indonesian export commodities. In 2013 banana exports to Singapore was as much as 7 tons, in addition to the government's plans to penetrate the Turkish market [14, 15].

In the last few years, several countries have implemented RFID traceability system for agricultural products such as Malaysia, Thailand, Singapore, Australia, Japan, Netherlands, China, South Korea, and others. In Indonesia, the implementation of RFID technology in the traceability of agricultural products, especially fruits still very uncommon. Thus, this study aims to determine how the role of RFID technology for traceability existing in various states in the course of research and try to analyze what is the cost restraints in the execution of these technologies in Indonesia. Agents benefits and barriers-cost will be measured based on the perspective of supply chain entities will be categorized based on component technology.

2.0 METHODOLOGY

The first step in this preliminary study of the benefits and barrier-cost RFID implementation on traceability system of agricultural products fruit in Indonesia are literature study and fact-finding. Literature study is done by reading and taking the essence of a number of literature related to the study. The main topics of this paper regarding to RFID, traceability, food product value chain, supply chain entities, and four kinds of technology components. Literature used in this paper are from 2005-2015. Fact-finding carried out by benchmarking's method against some countries that have implemented RFID in its agricultural product traceability system. Countries which used for benchmarking are Malaysia, Thailand, Australia and Singapore.

The second step is to adjust the results of literature study and discovery of the facts with the core study are discussed. The core of this study begins with identifying the correlation between the food product value chain with the supply chain entities. The food product value chain consists of a plantation, cutting, processing, packaging, loading, delivery, warehousing, retail, and consumer [16]. Supply chain entities consist of a farmer, collector, village (local) wholesale, agents in the central market (non-local), wholesale market (non-local), fruit vendor/small market/small restaurant, and end consumers [10]. Supply chain entities in Indonesia is unique because it has different characteristics for every region even for each product. Correlations were identified to demonstrate the role and relationship of each entity to the value chain. The next stage of this study is to identify the benefits and barriers-cost experienced by supply chain entities in terms of technology components. Component technologies will be analyzed based on the understanding of the United Nations Economic And Social Commission For Asia And Pacific (UNESCAP), which consists of technoware, humanware, infoware and orgaware [17]. Research methodology is shown in fig.1.

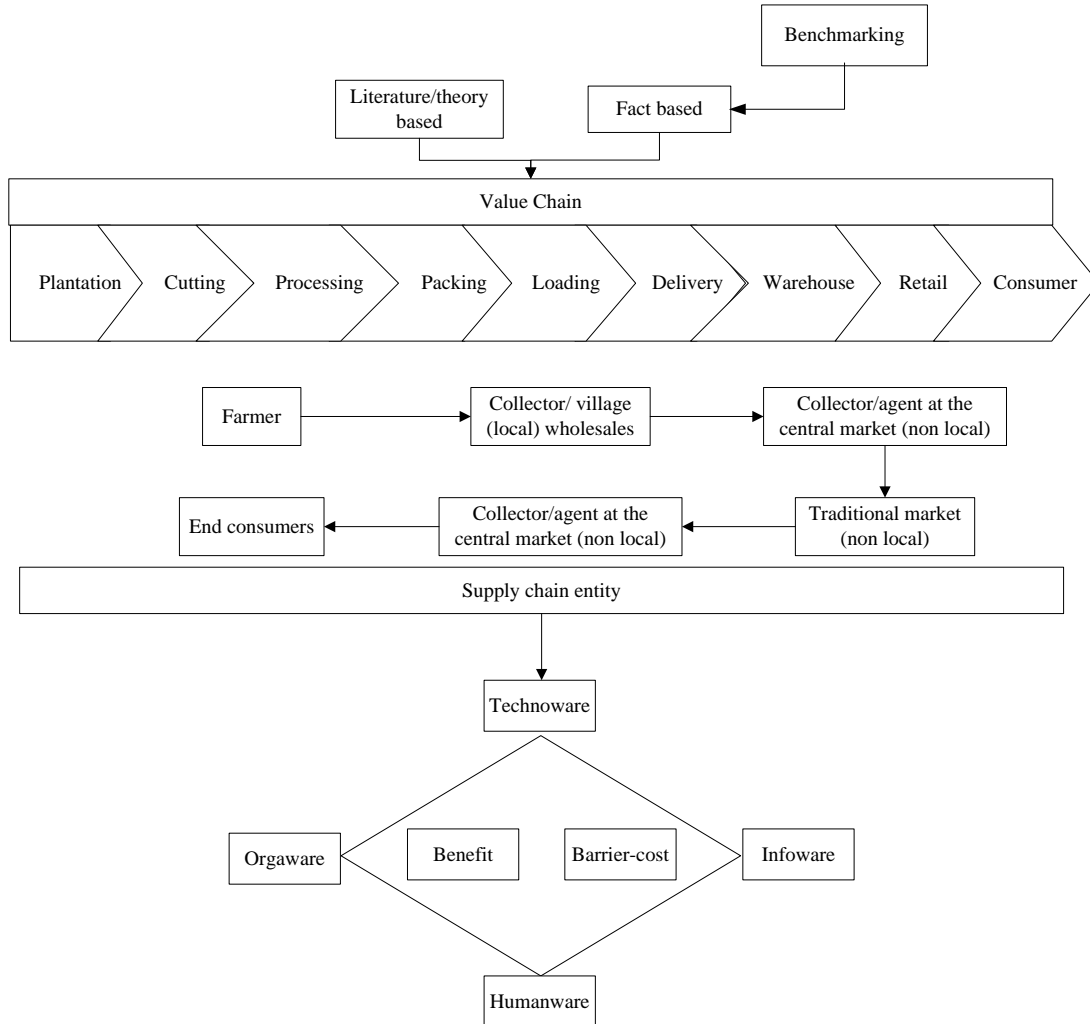


Figure 1: Research methodology

3.0 RESULTS AND DISCUSSION

3.1. Correlation Supply Chain Entities with Food Product Value-Chain

The correlation between supply chain entities and the food product value chain is based on the same literature that discusses about banana supply chain, the difference is the area where the research studies conducted. Research [10] discusses bananas distribution chain in Tawangmangu, Central Java. A second study was conducted by [18], which covered three areas in West Java, Lebak, Cianjur, and Sukabumi. The results from both studies show that farmers entities play a role in planting and cutting the trees. Farmers sell bananas to the village wholesales. Village wholesales have a similar function to the collector who buys bananas from the farmers. Purchase method consists of two methods; weight based and tree based. Weight based means collector will give you the standard price as the price given to another buyer with the agreement from the farmer. If a collector wants to buy a tree, it means that collector has to be active in looking for a good tree with young bananas or trees with ripe fruit. Besides selling to the collectors, the farmers can also sell them directly to the village (local) wholesalers.

Supply chain then heads to the agent at the central market, [18] did not elaborate on the role of this agent in the banana value chain in Indonesia. In Australia, this agent obtains supplies of

bananas from some regions or cities. This agent is non-local agent or the one who has the same role as the collectors market entities (non-local) on research [10]. Furthermore, agent distributes bananas to the wholesale market and then towards the small market/small restaurant/fruit vendor and ends with the consumer.

3.2. Benefits and Barriers-cost

Benefits and barriers traced based on four component of the technology. According to [17] explained four components technology are technoware, infoware, humanware and orgaware.

1. Technoware

Technoware refers to the physical capital utilized for various workpackages (in both principal and supporting activities) undertaken by all kinds of organizations (in the private as well as public sectors).

2. Humanware

Humanware is everything which makes people at work do things and which manifests in what people actually do with available technoware by applying personal qualifications and experiences.

3. Infoware

Infoware is the codified (generally in explicit and recorded form in the print or electronic media) technical knowledge related to specific work-requirements and work-conventions that give the foundations for any technological system utilized in work-packages undertaken by different organizations.

4. Orgaware

Orgaware refers to the coordinated task–tool relationships in the actual practice of work-packages implemented by organizations.

From the literature study and fact-finding, the results for the benefits and challenges of RFID technology implementation on traceability system of agricultural products fruit are as follows:

Benefits

Benefits factor in the implementation of RFID technology on a system of traceability of agricultural products fruits in Indonesia is grouped into four components. They are technoware, infoware, humanware and orgaware.

1. Technoware

RFID technology component of the technoware consists of tags, antennas, readers and host [8]. Tagging is needed to make the product detected by the system by pasting it on the product and carton box directly [16]. Tag also contained some information about who (parties), where (location), when (date or time), what (item / product), and what is happening (process) [9]. Very low frequency passive tags allow it to be applied because the price is relatively cheap compared to high frequency tags [16, 19]. The price range of the low-frequency passive tags is between 7-13 cents per tag.

Reader that is used can be either fixed or mobile handheld RFID reader [16, 20]. Reader duty scans each tag that is attached to a product and then after all the data on the tag is identified, the data will be transmitted to the central database. Fix RFID reader is a reader that is placed where the product will be skipped and cardboard box, fixed reader can reduce the amount of labor in charge of checking. While the mobile handheld RFID reader is an RFID tag reader operated by workers in other words the workers will check the products one by one from an existing or a cardboard box. Then the data that has been identified by the reader will be sent to the center database using Wifi or LAN network.

2. Humanware

Humanware will always lead to human resources. There are 237.641.326 population of Indonesian people [21]. The level of fresh fruit consumption in Indonesia is only 34.55 kg/year. The figure is smaller than the level of fresh fruit consumption from FAO and WHO. It says that fruit consumption rate is 73 kg/year. The low levels of fruit consumption in Indonesia due to public concern over the risks caused by products contaminated by harmful bacteria or pesticides. As happened recently in the discovery of contaminated apple by *Liateria Monocytogenes* bacteria, which was harmful to human health [22]. This bacterium was found in apples imported from the United States. This incident wouldn't have occurred if Indonesia had implemented the technology for fruits product traceability system. Before the apple reaches the consumer, the importer or the concerned parties can check on the content and other information related to apple. In addition to importers who can check the product, consumers can also play a role in the process. Before consumers purchase fruit products, they can check with their smartphone to view information about the products they buy [19]. They also can provide comments or suggestions to the concerned parties by adding or giving the existing information. In addition to the benefits derived from the consumer side, the vendor also gets many benefits that vendors can monitor the validity of commodities with the aid of RFID tags, especially for products that are perishable [23].

3. Infoware

There are several infoware in the implementation of RFID technology on product traceability systems fruit in Indonesia, GS1 standards, ISO, IEC and the Regulation of the Minister of Communication and Information. GS1 is a non-governmental organization with purpose dedicated to designing and implementing a global standard and seek solutions aimed at creating efficiency and transparency in the trade chain (supply and demand) and sectors [24]. The GS1 standard contains the rules of doing business and minimal criteria, of which should be followed when designing and implementing a traceability system. Furthermore, GS1 also assists a business in implementing standards, including training, certification, technical support and implementation advice. Products owned by GS1 are GS1 Barcodes, GS1 ECOM, GS1 GDSN, GS1 EPC Global. RFID and EPC Global GS1 also offer solutions that collaborated with its products which Traceability GS1 and GS1 Patient Safety. GS1 can be found in several countries, including Indonesia. Traceability system for fruit products using RFID technology can use the GS1 Traceability for Fresh Fruits and Vegetables, which was the final issue that aroused on May 2nd, 2010 and GS1 EPC Global.

In Indonesia, Regulation of the Minister of Communication and Information Technology Number 34 of 2012 is concerned about the technical requirements of telecommunication equipment close range (short range device). In these regulations, the range of RFID frequencies is between 923-925 MHz. ISO is also a standard used in RFID technology. ISO (International Organization for Standardization) is an independent organization outside the government which is responsible for providing world-class specifications for products, services and systems to ensure the quality, safety and efficiency [25]. ISO has also played a role in facilitating international trade. ISO also plays a role in RFID technology is an ISO for frequency RFID tag. ISO collaborates with IEC in issuing standards on the use of RFID frequencies, ISO. IEC stands for International Electrotechnical Commission. It is a worldwide organization that publishes international standards for all electrical technology, electronics and associated with both. ISO and IEC cooperate to combine all relevant knowledge and experts in related fields to ensure that international standards are suitable to be applied in a particular field [26]. ISO or IEC frequencies used in RFID technology for product traceability system, that is ISO or IEC 18000 [19]. ISO also set about traceability as outlined in ISO 8402 which says that traceability is the ability to search the history, application, or location of a product or activity [27].

4. Orgaware

In implementing RFID not only be met by providing physical facilities, clear standards and human resources, but also filled with doing an arrangement or management of all these components so well organized to achieve a positive [28]. Management or arrangements can be made by an institution both governmental agencies and non-governmental. At the national level, the Ministry of Communications and Information regulates the allowable frequency spectrum for RFID in 2012. This makes it easy for Indonesia in doing export or shipment of products, in tracking or searching more efficiently and also reducing human error factor in the trade lanes. At the farm level, there are also organizations that have the potential to perform management or arrangement in support of the implementation of RFID. According to [10], there are farmer organizations in Tawangmangu which consist of farmers, farmer groups, farmer group village/sub-district and district level farmer groups. In Taiwan, there is also a farmer organization called farmer's association. Farmer's associations help farmers to record their product traceability information [5].

Barriers-cost

Barriers-cost factor in the implementation of RFID technology on a system of traceability of agricultural fruit products in Indonesia are grouped into four components. They are technoware, infoware, humanware and orgaware.

1. Technoware

RFID technology components that go into technoware ie tag, antenna, reader and controller [3]. Passive tag frequencies is between 125 to 134.2 kHz because it requires longer antenna and wider read range reader than high frequency tags [19]. It is very dangerous and detrimental both for the consumer or for the entities in the existing supply chain if the entities are not using the reader with a wider read range than the possible occurrence of product. It can make the products pass without any identification. Besides the cost factor of RFID is also a factor that becomes an important issue in recent years [29]. Passive price tags are cheaper compared to active tags. Passive price tags depends on the frequency, amount of memory, antenna design and packaging around the transponder. Passive price tag is 20 cents and the price range active tag of \$10 to \$50 or more. The price range of UHF reader is between \$ 500 to \$ 3,000, depending on the function. This price may not include the price of antennas and cables (cabling) [30].

2. Humanware

Many players in the supply chain of fruits in Indonesia make RFID technology implementation becomes difficult. Diverse background of supply chain entities such as educational level, social status, level of compliance and awareness are still low. It makes the application of RFID technology becoming more complex. The government's policy has not touched the realm of implementation of RFID technology for product traceability system fruits in Indonesia. This is one of the biggest inhibitors. In contrast to Indonesia, other countries such as Japan, South Korea, China, Vietnam and Malaysia have had their own regulations in this regard, so that each entity shall comply with the supply chain and execute it.

3. Infoware

Infoware which is impediments to the implementation of RFID traceability system for agricultural products fruits in Indonesia. It is the same as mentioned in the previous benefits criteria, which consists of the GS1 standard, ISO and IEC. The third obstacle in applying the standard is the global standard uniformity [19]. For example, the use of UHF in some countries is different from one country to another. That is why Indonesia has a difficulty in exporting to the destination country.

4. Orgaware

In Indonesia, there has been no special organization created by government agencies or associated with a product traceability system. In contrast to Japan, the government formed an organization working in food safety field called Food Safety Commission in July 2003 [31]. The organization aims to undertake a scientific risk assessment of food and its effects on human health. Moreover, the Ministry of Agriculture, Forestry and Fisheries (MAFF) in Japan also announced a "regeneration plan food and agriculture" and "security policies and food security". MAFF is implementing some steps, such as a system of support for producers, providing information to consumers, and risk management in food production.

Table 1: Benefits and Barriers RFID Technology Implementation on Traceability System of Fruit Agricultural Products in Indonesia

	Technoware	Infoware	Humanware	Orgaware
Benefit	a. Low frequency passive tags has low price b. Fixed reader can reduce labor in checking goods	Clear regulation (GS1 Standards, Regulation of the Minister of Communication and Information Technology No.34, ISO8402, IEC 18000)	For consumers, they can check the product's detail such as planting information, harvest process, etc	There are some supply chain entities that have the potential to perform management in support of implementation
Barrier	a. Low frequency passive tags require longer antenna and wider read range reader b. Fixed reader price is too expensive	Global standard uniformity (ex : use of UHF in some country)	Diverse background of supply chain entities, government's policy	There has been no special organization created by government agencies or associated with a product traceability system

4.0 CONCLUSIONS

This paper is a preliminary study of the implementation of an RFID traceability system of fruit agricultural products in Indonesia. From the results show that there are many factors that support the implementation of RFID technology in Indonesia. Furthermore, there are many benefits that earned when implementing RFID technology for traceability systems. Besides the supporting factors, there are also barrier factors and cost factors which become challenged in the implementation of RFID in Indonesia. From the results found, it is required a follow-up study to identify more about the benefits and barriers in implementation of RFID technology on traceability system of fruit agricultural products in Indonesia.

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