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Traceability implementation based on RFID at agro-industry: A review

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Abstract: Information system technology in the agroindustries sector has been developed. One of these is system of traceability based on Radio Frequency Identification (RFID). Before RFID developed identification information of agro-products using a barcode system. Currently RFID implementation in the agro-industry sector to identify product information safety quality tracking and control of the environment is still very limited. In fact RFID implementation petrified decision makers to make a quick decision to directly monitor the movement of agro products through the data or interface with a computer program. This review discusses the development of RFID system in agro-industry. The implementation of RFID for product safety and quality. To implement RFID technology for tracking. The ability of RFID sensor to control the environment around the product. Testing the accuracy of RFID system in the agro-industry. Output application of RFID in the agro-industry is the identification data and a better selection of products to meet the standards and minimize elimination and return of products in global trade.

1. Introduction

The lack of uses of technology and information presented by some food products causes doubt in choosing products [1]. So far the information is only in the form of product information and barcode labels [2] and it can provide incomplete information to consumers [3]. To create the system requires a high accuracy for validation and cost and with a high error probability [4]. Traceability system motivated by increasing consumer and government attention to food security food hygiene and the authenticity of food products [6, 7]. The product tracking ability means that the flow of materials and information from the company through the agro-industry supply chain can be monitored. The benefits of traceability are for scheduling planning and optimize production [8, 9]. Traceability has an important role in competitive strategy [10] and to improve coordination of companies in the supply chain [11]. In previous studies process data and product information in a company or supply chain can be lost [12, 13]

The traceability system allows the elimination of bad food products lack of security requirements and regulate the surrounding environmental conditions [14]. As one of the criteria for a food safety assurance system the traceability system is able to provide guarantees for consumers to verify the safety standards of food products [15]. The problems that occur in the food crisis cheating concerns about the selection of food products doubts in determining the quality of products can encourage traceability systems [16].

The information technology based traceability system can be applied in tracking the food industry with Radio Frequency Identification (RFID) [17]. RFID can implement information tracking activities in each supply chain at the same time [18] as facility to accelerate operational mobility and visibility in each supply chain and improve inventory management efficiency [19]. In Indonesia the food industry of raw materials with the application of traceability using RFID technology has not been widely applied only limited use in the food manufacturing and process operations have not been integrated with standards already set [20]. RFID systems can find commodities food products or materials and identify the origin of products in the supply chain from some information sources such as consumers retail and others [21].

RFID technology provides benefits to easily identify product information applicatively. Information about food safety and food security guarantee systems is needed and can be accessed easily with RFID tracking technology. RFID technology in this agro-industry is important to make it easier for agro-industry actors decision makers and consumers to access information. With a review approach the traceability implementation based on RFID at agro-industry aims to help decision makers in providing complete product information product requirements and standards product safety product conditions and reducing product returns.

2. Materials and Methods

The main methodology was analyzed from various literature with a systematic review applied in this review. A structured review system and a search of relevant international journals to determine the theories and topics that will be discussed in the review [22].

2.1 Data collection

Data collection is carried out by exploration of international journals from various sources. Provisions relating to concepts about the application of RFID in agro-industry are used in models and system simulations with system dynamics to make relevant references.

The main topic is analyzing the literature review or international articles on the journal's RFID system's ability to track the existence of agro-industry products and their history. The arrangement is determined the topic and title abstract keywords of the research journal articles in the database of academics research and library archives from the internet or international journals such as WSEAS International Conference Emerald Insight and ScienceDirect.

2.2 Data Analysis

By searching for the total results of international journal research articles on traceability implementation based on RFID system in agro-industry supply chain and logistics are the main topic in this review. After the sampling process a systematic study was carried out in the literature selected to analyze the traceability system of the agro-industry supply chain. The systematic review process is depicted in Figure 1.
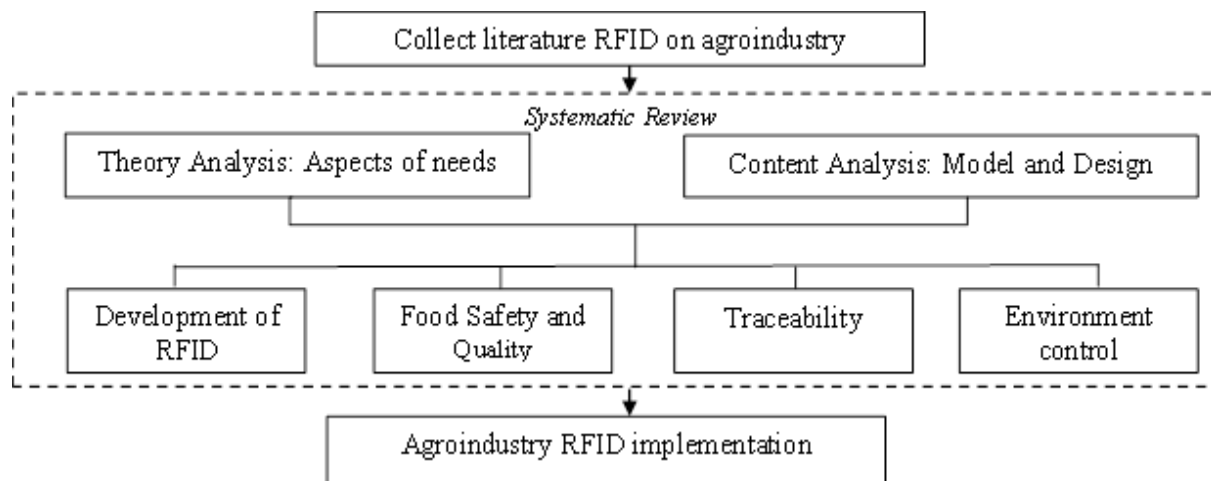
Figure 1. Figure of systematic review process.

From Figure above a review system to determine the discussion and supporting factors for traceability systems in agro-industry taken from the journal literature on RFID in agro-industry. Select the section that becomes the critical point in food traceability then the topics discussed and summarized in detail and systematically in the review [23]. Review approach of the literature and findings to be described systematically structured and analyzed from the theory of analysis and content analysis. from the analysis refers to the development of RFID food safety and quality traceability and environmental control both in individual studies opinion surveys and experimental research to integrate a study [24].

2.3 Classification of RFID Discussion
In this review is discussed several developments in RFID and object analysis in RFID system data recording. Some classification of RFID indicator sensors tags in the agro-industry from several articles. The important things from traceability document traceability learned in the field and that this is a complex topic. Some scientific articles identify the accuracy of RFID systems both small and large scale. Examples of agroindustries such as shipping materials marketing mixes cold chains and supply chains [25]. So in this review we can find out the accuracy of RFID technology in agro-industry and the gradual tracking of agro-industry activities.

3. Results and discussion
RFID technology has grown in recent years and is currently being pursued product identification and tracking process for the food sector food safety and food quality [26]. Currently RFID is a facility for traceability because it can determine the existence of products environmental control and food safety control [27].

3.1 Principles of Traceability
Many studies that discuss traceability principles in agroindustries especially food and other industries have been found [5, 7-9, 16, 17, 25]. All distribution in agro-industry and logistics must be fully identified both information and product history recording. In the supply chain identification of tracking units connected to the transformation system can track internal products. The principle of traceability refers to overall product identification. the identification process is carried out by determining the volume and weight type of product length of processing distribution and warehouse [28].

Traceability is the ability to track activities historically applications or locations and a series of records about identification. Identification made by Codex Alimentarius is a traceability in writing or

using hardware [29]. Traceability can identify inaccuracies and errors in data recording so that this can obtain important information in recording activities in the supply chain. In risk management traceability is a method used to minimize risks to the process and distribution of agro-industrial products. assist decision makers in product identification processes solve problems with non-standard products in food safety and food security.

3.2 Development of RFID Systems in Agro-industry

RFID standards have emerged since 2000 due to the importance of ensuring the security and operation of tags and RFID readers throughout the country. in general RFID tags have a standard in the system. Electronic Product Code (EPC) protocol language and program format is one of the standard aspects of RFID. Large organizations such as EPC Global (network computers used to share product data between trading partners) and the International Organization for Standardization (ISO) formulate standards on RFID in the use of general RFID systems [30, 31].

RFID is considered as a viable successor for barcodes with an estimated development in the agro-industry large companies and cold chains. RFID on cold chains is often used for environmental control such as temperature control humidity control and product tracking [32]. So far the information presented is only in the form of material/product information labels and barcodes for information validation by producers or suppliers of food products. Barcodes have the ability to control inventory reset and checkout with additional information such as nutritional information product codes net weight and expiration dates. Bardode has weaknesses data stored in database information is limited and lacking. Therefore an innovation was developed to be able to store a lot of data control the environment and disguise information with a computerized system [21]. The development of traceability in agro-industries ranging from manual labeling barcoding to RFID can be seen in Figure 2.
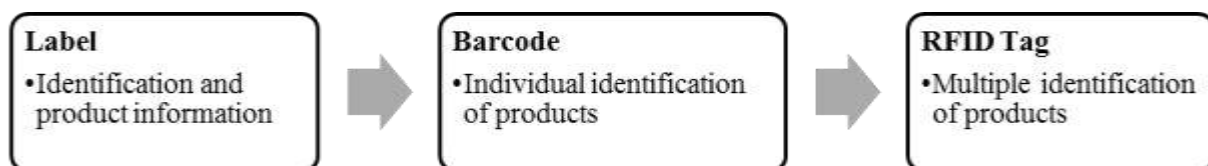

Figure 2. Representation of the evolution of labels barcodes RFID [26].

Barcodes are still found in the market because of the low price than RFID. RFID has many advantages over labels and barcodes in the product management sector control and security aspects tracking production transportation storage and shipping [18, 31]. RFID can track in realtime and supply chain environmental monitoring [30].

3.3 RFID sensors in the agro-industry environment

The system used by RFID refers to standards like ISO15693 RFID protocol in the sensor flow interface can accommodate some information flexibly and can be monitored in temporal data [33]. Smart frequency cards are sensors in RFID systems. The card is used for tracking design identification of product presence and temperature and humidity control in the agro-industry chain. The system used is the Smart The Cold Chain System (SCCS) is a semi-passive tag commonly used in cold agro-industry chains. The system is programmed to detect conditions (temperature humidity and pressure) using various sensors [34]. SCCS can store sensing type data store conditions and handle overflows and detect values in user memory from tags. It can be integrated into the Internet of Things (IoT) [14, 34] the sensor will capture data and information in the product and the surrounding environment and be transferred through the information system and displayed by the reader [34].

The second sensor is Biosensor. It can identify components to change physical quantity [35]. RFID biosensors can capture product temperature sensors product conditions microbes in food and

packaging products such as fungi molds and yeast. In addition RFID biosensors can also record the basic identification of RFID tag functions. It can monitor the quality of certain foods because of them can detect degradation molecules and may be adjusted accordingly with the type of product that is packaged [34].

3.4 Temperature Sensors

Temperature sensors in traceability systems have been used in agro-industries especially supply chains. The instrument used is called a mechanical thermometer using indicators of alcohol roll and vapor pressure. The second uses an electric thermometer using thermocouples temperature measuring circuits resistance variable sensors and semiconductor probes [35]. Label placement on packaging and food containers used to track and monitor cold chains. Measuring and recording temperature historical food products will be recorded in the database.

Thus the temperature sensor provides information about the estimated time on the product that has exceeded the temperature threshold or not. Temperature sensors are also considered an indirect indicator of the quality of food. In RFID systems in agro-industry temperature and humidity sensors are not related to tracking the existence of products product quality is displayed visually based on the data obtained. The data obtained by applying RFID in a temperature sensor determined the time during the distribution of either constant or delay time. And management or decision makers can find out the results of data from the supply chain and have the responsibility to determine product prices [36].

3.5 Humidity Sensor

The moisture sensor can determine the amount of water vapor in the atmosphere [34] on several sectors such agricultural food sector the medical sector and the environmental sector. Relative humidity and transmission of moisture records for users the humidity sensor has developed and connected with RFID tags. Moisture RFID tags are likely to collaborate for reading temperature and humidity without opening the box that maintains the integrity of the packaging. Some applications used RFID humidity and temperature sensors in Table 1.

Table 1. Applications used RFID temperature and humidity sensor.

Factory	Tag	Type of tag	Functionality description	Country
Savi	Sensor Tag	Active RFID sensor tag	Temperature and humidity monitoring of metalcontainers.	USA
Axcess International	Active sensor family	Active RFID tags	Monitoring temperature humidity and database	USA
Evigia	EV524	-	Temperature humidity and vibration monitoring.	USA
G2 microsystems	G2C501	Active UHF tag	Presence the condition of route temperature and humidity	USA
Ela Innovation Active	COIN T RH	433 MHz	Temperature relative humidity sensor	France

Source: Fabien et al. [26]

3.6 Testing the accuracy of RFID systems

RFID is designed to optimize control and tracking in this case minimizing product returns by considering the accuracy of information. The results obtained from the testing of RFID systems in agro-industry have been compared of information accuracy process optimization from use before and after RFID testing. The tests carried out were pre-test and post-test [37].

In pre-test testing is done to test the readiness of RFID as a whole both software and hardware. Pre-test is divided into 2 parts hardware which consists of the power supply and RFID circuit and software designed to build using programming languages. RFID implementation and data were collected to be compared with after RFID implementation. Post-test is done to test the accuracy of the information.

This is done by comparing the accuracy of information before and after using RFID technology. In detail of data collected and processed includes transportation time scanning waiting time the speed of responding to the system [38].

4. Conclusion

Implementation of traceability based on Radio Frequency Identification (RFID) has been applied in tracking agro-industries. RFID technology provides the advantage of easily identifying product information applicable to food safety and quality. The relationship between RFID systems and sensors can facilitate decision makers to track the existence of products monitor environmental conditions at the time of distribution (temperature and humidity) reject products that are out of standard. Various types of sensors have been developed including sensor tracking temperature sensors and humidity sensors. Testing the accuracy of RFID systems with pre-test and post-test. This traceability system is important to be implemented in the agro-industry because it can provide complete information about product requirements product safety demand and reduce product returns.

Acknowledgments

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