Framework for Design of Traceability System on Organic Rice Certification

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Abstract. Nowadays, the preferences of organic products such as organic rice have been increased. It because of the people awareness of the healthy and eco-friendly food product consumption has grown. Therefore, it is very important to ensure organic quality of the product that will be produced. Certification is a series of process that holds to ensure the quality of products meets all criteria of organic standards. Currently, there is a problem that traceability information system for organic rice certification has been not available. The current system still conducts manually caused the loss of information during storage process. This paper aimed at developing a traceability framework on organic rice certification process. First, the main discussed issues are organic certification process. Second, unified modeling language (UML) is used to build the model of user requirement in order to develop traceability system for all actors in the certification process. Furthermore, the information captured model along certification process will be explained in this paper. The model shows the information flow that has to be recorded for each actor. Finally, the challenges in the implementation system will be discussed in this paper.

1. Introduction

Currently, there has been a paradigm shift in consuming food. The existences of chemical use in the process producing of food cause a healthy lifestyle awareness develop in society. A healthy lifestyle that has been grown requires the food must have characteristics to be safe for consumption, to be nutritious, and eco-friendly [1, 2]. Therefore, the production and consumer preferences of organic products continue to increase. According to Ariesusanty [3], there is so many organic products that has been developing in Indonesia, one of them is on organic rice commodity. Furthermore, in 2010 300 ha area in Indonesia was found producing the certified organic rice. The area expanded in 2013. As a result, in 2014 the organic rice products dominated the organic markets in Indonesia.

Along with the development of organic products, then the government tries to assure the quality of organic products by certifying it. The assessment in certifying of organic products not only based on the final product but also the production process which starts from cultivation practices until the final product distribution [4]. This policy is regulated by the National Standard of Indonesia (SNI) which explain that certification is a method that the organic certification organization conduct a series of continuous inspection activities, audit system, and final product inspection in order to make sure the organic product fulfill the organic quality requirements [2]. But actually, there is still an obstacle in certification of organic rice that is there has been no certification information system which is able to
trace various activities in the process producing organic product. The existing system still manually to record the data, so it can cause loss of information during storage process and does not utilize to store information in big data.

The traceability development has got the attention for the last few years. Some factors have raised the interest in developing traceability system in the food sector. The existence of several issues and cases that relate to food safety has raised the consumer insecurities. Besides that, consumer needs qualified, nutritious, and non-GMO (Genetically Modified Organism) food materials, and also the special products like organic products have developed for the last few years [5]. Therefore, the regulation of implementing traceability system in the food producing and processing is being developed in many countries. According to European Union law, traceability system is defined as an ability to trace and follow the raw material of food, feed, and food-producing animal or substance that are used in all production process until distribution. This system enables the stakeholders or authorities to recall if the product is not safe for consumption and not according to the applicable provision.

Implementation of a traceability system is an integral part of food production chain. Primarily, used to respond the food safety cases, record production processes, fulfill the government regulations, and analyze production and logistics cost [6]. However, in its development, the developed traceability system was varied and adjusted to user necessity [7]. One of its application, traceability can be used to monitor process and product based on microbiological analysis in tuna loin production, and also can be used to monitor and prevent food loss and waste along food production [8, 9]. According to the description, the objective of this paper was to develop the basic concept of traceability information system that facilitating the certification process of organic rice. The first step taken is to identify the usage requirement of traceability information system in certification process from all actors. Furthermore, system requirement was modeled using unified modeling language (UML) use case diagram.

2. Organic product certification
Organic certification is one of the implementation systems and products control for organic products. All the stakeholders who play a role in a process of producing organic products including the farmers, the processors, and the organic products companies have to conduct a certification in order to maintain the integrity of organic products. The certification process is conducted by a government certification organization or a private certification organization that is acknowledged by the government. According to Indonesia Ministry of Agriculture [4], the certification process of organic products is generally shown in figure 1.

![Figure 1. Organic certification process](image-url)
The certification process diagram of organic product system can be explained below:

(a) The organic farm producers submit a certification proposal to the organization of organic product certification.
(b) The certification organization appoints an audit team.
(c) The audit team conducts auditing process of document adequacy.
(d) The audit team delivers the audit result to the certification organization.
(e) The certification organization delivers the audit results to the certification committee for being discussed in an internal meeting in order that some recommendations can be given.
(f) The certification committee delivers the recommendations to the certification organization.
(g) The certification organization delivers the assessment results, whether the applicant deserves the certification or not.
(h) The organization of organic product certification periodically conduct a surveillance.

3. Methodology

The basic requirement to develop an effective traceability system is to determine the information that needs to be tracked. Therefore, the information about organic rice production process was needed. The analysis was conducted in a whole of involved stakeholder. This section provides the information about the methodology of data collection on preliminary research.

• Field survey

Organic rice is one of the commodities that mostly developed in Indonesia. The field survey was conducted in January and August 2017 in Cisayong Sub District, Tasikmalaya District, the center of organic rice production in West Java. Field survey was aimed to (1) understand the structure of the production chain of organic rice, identify the involved actors and the interactions in it and to (2) map the needed information at each stage of production.

• Interview and document analysis

To collect the data was also conducted by a semi-structured interview with ICS (internal control system), the chairman of farmer group association (GAPOKTAN), and distributor of organic rice. Interviews were conducted to obtain detailed information about the production process and the other data about certification purposes. In addition, documents regarding the relevant information should be recorded.

4. Usage requirements of traceability organic certification

In the development traceability information system as a certification process, the main thing required is the ability of the system to save and communicate several important documents such as cultivation, processing, quality of the product, and the others. Therefore, it is important to define the terms of usage requirements for all actors that involved in the certification process. A system approach was used to develop a certification information system. The requirement of system usage was developed using UML (unified modeling language) use case diagram. According to Urva and Siregar [10], the designing of use case diagram able to give the description of involved actors, functions, and also interactions. In the use case diagram, there are 4 elements that can be identified. The explanation of each element described as follow:

• Use case: A use case describing the action shown by system that generates the measurable result for actors, mostly symbolize in ellipse form.
• Actor: Describing the person who has interaction with the system. Actor can be individual or organization and symbolize as stick figures.
• Associations: Associations describe the interaction between actors and use case, and symbolize as a solid line.
• System boundary: System boundary shows the scope of the system. In this study, a rectangular form is used as symbol for boundary system.

According to Lee and Xue [11], the designing of use case has advantages to help the complexity management since focusing on one specific usage at a time. Figure 2 shows the diagram of a use case
for traceability information system in organic rice certification process. The following use case examples are defined and different actors are associated with each use case:

- **Record of cultivation**: Farmers recorded all activities during paddy cultivation. The data such as varieties used, irrigation system, plantation, fertilization process, pest and disease of plant, and etc were recorded in the system.
- **Record of handling**: Material handling practices such as drying, storage and etc that conducted by stakeholder, start from farmers, processor and distributor should be well recorded.
- **Record of processing**: Processor must record all of the processing. Several recorded parameters in processing practices are processed varieties, quantity, and quality of product.
- **Authenticate claim**: All actors who play a role in organic rice production able to take the data and claim their activities that conducted has been appropriate with the determined organic standard based on storage system.
- **Document study**: Based on the demand, the certification system should give an information holistically about the certification actors who has the role in organic rice production.

### 5. Information capture model

The traceability system was developed to solve the abnormal situation, create the transparency in production process and give the information to consumer and a whole of involved stakeholder including food certification institution [12]. Therefore, for developing and implementing this system, a whole information about raw material origin, production and processing, product quality, packaging material and etc is required. The developed traceability system for organic rice certification process begins from cultivation practices until whole process based on three phases shown in figure 3.

![Figure 2. Traceability system in certification use case diagram](image-url)
The development of traceability system currently varies and it is adjusted to its application purpose. In this case, traceability is used to track the internal information about the organic rice production process. The ability to trace internally can be defined as the ability to track the production information internally to ensure that the production process conforms to the organic requirement from upstream to downstream. There are three categories of information that should be recorded by each stakeholder in the organic rice production chain, those are process information, product information, and quality information. The method to capture information for each stakeholder can be different. Figure 4 shows the information model that should be captured in the organic rice processing based on three phases.

**Figure 3. Organic rice traceability timeline**

**Figure 4. Information captured in process producing of organic rice**

The input and output of each process are shown by the model presented above. Information captured at each stage is numbered. These numbers represent the general information that should be
captured in the organic rice production chain. The general points of information captured were identified through the preliminary study based on descriptive and qualitative analysis in a whole of stakeholders that involved in the process of producing organic rice in Tasikmalaya District. This information can be the basis for certification institution to guarantee the organic requirement of the products. Furthermore, table 1 shows the specific information that should be recorded in each point.

| Information capture point | Key Point                  | Information                                      |
|---------------------------|----------------------------|--------------------------------------------------|
| 1                         | Land information           | Block number, area, water source, water treatment, |
|                           |                            | land status                                      |
| 2                         | Seed                       | Variety, seed source, seed treatment, seed status, |
|                           |                            | seeding date, quantity, quality, transplanting date |
| 3                         | Fertilizer                 | Name, source, composition, method, dose,          |
|                           |                            | application date                                 |
| 4                         | Pest and disease control   | Pest and disease species, treatment type, total   |
|                           |                            | amount, rate of application application date      |
| 5                         | Postharvest handling       | Harvest date, handling status, worker, wet       |
|                           |                            | production, dry production                       |
| 6                         | Storage                    | location, storage date                           |
| 7                         | Outbond                    | Consumer ID, date of sale, quantity              |
| 8                         | Inbound                    | Supplier ID, quantity, lot number, storage location, |
|                           |                            | date entry                                       |
| 9                         | Inspection                 | Moisture content, foreign materials, damaged     |
|                           |                            | materials, empty grain, called grain              |
| 10                        | Polishing                  | Milling ID, milling date, quantity, degree of    |
|                           |                            | polishing                                        |
| 11                        | Blending                   | Mixing ID, composition                           |
| 12                        | Weight adjustment          | Product weight                                   |
| 13                        | Packing                    | Packing material, packing supplier                |
|                           |                            | Moisture content, whole kernels, medium grains,  |
|                           |                            | small grains, foreign material, chalked grains,  |
|                           |                            | paddy grains, chemical residues, nutritional     |
|                           |                            | content                                          |
| 14                        | Inspection                 | Consumer ID, date of sale, quantity              |
| 15                        | Outbond                    | Distribution ID, Vehicle ID, Customer ID,         |
|                           |                            | Quantity                                         |

Currently the implemented traceability system in the certification process is still conducted manually by a government certification organization or a private certification organization. During the on-farm production and off-farm stage, the required information was recorded in an activity logbook. This is time-consuming and inefficient. Further, manual recording was vulnerable to loss of data during storage. In the development of this traceability system, relational databases are used to implement the system. In the system, there is only one database for the entire production phase. Users can enter all relevant data from on-farm until distribution process. The database system then connects to data entry, performed activities and other parts that recorded. Furthermore, this data can be accessed by the certification institution to ensure that all processes performed appropriately with organic requirements.

6. Challenges
Currently, the implementation of traceability system in food production is one of the basic requirements that must be applied almost throughout the country. It is because the traceability system can be a tool for risk management that allows stakeholders and policy makers to withdraw the unsafe
food products. Furthermore, the traceability system is also important because it serves as a tool to document the chain and production processes, as regulatory requirements, as transparency processes for consumers, and as a tool to analyze logistics and production costs. The absence of a traceability system will lead the un-transparent of production process and cause the absence of a stakeholder’s ability to identify and isolate the errors of production and the source of contamination in case of product withdrawal from the market [13]. However, in the implementation of a traceability system, several problems will be faced, such as:

(a) Human resource
The availability of qualified human resources is the success key in system implementation. Complexity of traceability system requires expert human resource to develop, to implement and to manage the system. Several stakeholders who has different goals will make the traceability become more complex. Stakeholder who plays a role may have insufficient human resource and skills to implement and manage the traceability system effectively [14, 15].

In the developing country, such as Indonesia, quality of human resource in agricultural, especially in farmer level is very low. Most farmers have low levels of formal education or do not complete basic education. Consequently, the ability to absorb the information and to adopt technology is limited. Furthermore, in the case of small and medium industries, the traceability system can lead to more workload due to the limited capacities of employed human resources [14]. Therefore, it is necessary to improve the work competence through training.

(b) Financial resource
Develop and implement the traceability system is costly and it can cause financial problems [16]. Therefore the cost of implementation and maintenance the traceability system is an important aspect to consider due to the complexity of the production process. This complexity because of several requirements, such as: (i) traceability must be capable to handle both internal and external traceability in the information exchange process, (ii) traceability must have the ability to track the food one step forward and one step backward, (iii) the built system must be effective in its use, (iv) the traceability system must be expandable to reach the new relevant information [12].

(c) Lack of awareness
The main purpose of the traceability system is to record and to document all activities in the production process from upstream to downstream. Consequently, the stakeholders assume it as an additional burden in production. Lack of knowledge and information about the benefits of traceability and the absence of compatibility with the stakeholders who play a role are the problem in the development and implementation of the system [17].

(d) Limited information
Traceability in food production processes is closely related to the uncertainty so that difficult to obtain certain information completely, accurately, timely, and easily accessible. Whereas according to European legislation on food traceability, EC 178 (2002), that the traceability system should be able to track in all stages of production from cultivation, processing to distribution. In fact, however, the obtained information sometimes incomplete, for example, the available information only focused on the origin of the material, not on the food quality and food security [18].

(e) Limited standard
Lack of adequate standards and tools in data exchange is a problem that must be faced in system implementation. The complexity of traceability occurs due to variations in data retrieval, inconsistencies of captured data types, data variations, and lack of standardization in data transmission among stakeholders [19]. Furthermore, the variations and lack of standardization of traceability
techniques in food production processes such as numerical codes, barcodes, and RFID also contributed to the complexity [20].

(f) Managing change
Maintaining the traceability information through the changes in the system is a challenge that must be faced. The study shows that changes can occur throughout the life cycle software. This change resulted in the system to update the traceability data. Therefore, stakeholders in the system need to update the data regularly. In fact, however, strong discipline to maintain the accuracy and completeness of traceability data is seldom conducted so that in practice, many organizations ignore it. Furthermore, discipline can be nurtured through the training in understanding the importance of traceability [21].

Lately, the development of a traceability system is required because various cases of food safety often occur and the transparency process needs to be realized. In the development and implementation process, some problem may be found. Several points that can reduce these problems are (i) developing the standardization, regulation, and strength law in the development and implementation of traceability system, (ii) participation and support of government as policymakers, (iii) increasing the knowledge and awareness of the community, (iv) support of all stakeholders who involved in food production, and (v) good coordination among the stakeholders and policymakers [22].

7. Conclusions
Developing a data management system is required to facilitate the traceability process. In Indonesia, these current system is still limited, where consumers can only access general information about the product. Traceability system is also needed to realize the transparency process. To achieve the traceability, all production processes must be properly recorded. Determining the term of use of the traceability system are the first step in system implementation. Moreover, to enable the effective information exchange is necessary to collect the data models. This study provided a model for information that must be captured by institution certification of organic product in three main phases i.e production, processing, and distribution. The points of information captured are identified in each phase. Furthermore, developing and implementing the traceability system for all stakeholders is quite difficult. Therefore, the strategy of system implementation is needed, one of which is by developing standardization, regulation, and force of law regarding the development and implementation of the traceability system.

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