Analysis and design of beef supply chain traceability system based on blockchain technology

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Abstract. The need for beef supply chain traceability system is vital due to increase in counterfeiting and use of excessive preservatives and hazardous chemicals. To overcome these problems, it is needed a system which provides the option for the consumer to verify the origin of all input materials for food product based on one step forward and one step backward in supply chain mechanism. Blockchain technology is used as the solution to this problem. This paper aims to identify the requirement and designing the traceability system that could capture all relevant data. The design of beef supply chain traceability system will be described as a business process flow with BPMN (Business Process Model and Notation), in which BPMN will be described the stakeholders involved with the task and needs of the designed system. Based on requirement analysis, this system composed of 4 stakeholders, namely the farmer, feedlot, industry, and retailer. The result showed that the blockchain can create a transparent and efficient supply chain through sharing data between the stakeholders.

Keywords: beef, blockchain technology, supply chain, traceability system

1. Introduction
Beef one of the foods that have high nutritional value, especially the protein that makes it preferred by consumers to fulfill the daily nutritional needs, so the demand for beef continues to increase. According to the directorate general of food and animal health, the amount of demand for beef in 2016 was 675,220 tons, while beef production was 441,761 tons. Based on the data, it can be seen that beef production is not proportional to the level of consumption. The lack of fresh meat supply is influenced by several factors, including the low level of domestic meat production, the lack of transportation to distribute livestock from production centers to consumption centers, and the long chain of local beef trading systems.

Another challenge in a beef supply chain is food safety. This is related to the characteristic of beef which is easily damaged so that it requires extra handling in its distribution. A traceability system is needed to monitor product movements along the chain to ensure quality products to consumers. Traceability is a tool that can help an organization operate in the food or feed supply chain to achieve the results that have been identified in the management system [6]. The main purpose of the traceability system is to report and design material, process, and product distribution processes to consumers. By using a good traceability system, leakage or inefficiency in a supply chain can be avoided.
One of the technologies that can be used is Blockchain technology. The blockchain is basically a new database, where data is stored chronologically according to the time sequence. In general issues, blockchain as a public ledger or general ledger that records all transactions in general and can be seen by everyone involved. With blockchain technology, all beef data will be accessible to all group members including consumers.

The outline in this paper consists of an introduction, research methodology in section 2, the result in section 3, and section 4 is the conclusion of this paper.

2. Research Methodology
The research design of the beef supply chain traceability system based on blockchain is described as follow:

2.1. Identification System
The identification system is done to understand the initial problems in the system. We need to define the system by identifying the stakeholder, rule, role, mission, input, and output.

2.2. Analyze the interaction between stakeholder
This step is done by modeling using unified modeling language (UML) with use case diagram which then followed by modeling in BPMN 2.0 and simulated to answer system requirement. The use case diagram is composite attribute that describes the interaction between the actors involved in the system. Actors can consist of people, places, events, and real or virtual objects [11]. The use case diagram shows the attributes that exist in the system along with their functions.

2.3. System Analysis and Design
BPMN 2.0 is used to design the model. System analysis and design are started by making a flowchart. The flowchart describes the stakeholders, role, process, data, and information. System analysis is conducted to parse a system to be studied into components so it the interactions between components and their environment can be seen [3].

3. Result and Discussion
3.1 Identification System
Identification of the system was begun by making the input-output diagram. Then determined the system requirements and entities to build the system, such as stakeholders, input, output, rule, purpose, and role (fig. 1).

Input output diagram is a component needed to build a system in beef supply chain. Input output diagram describes the system requirements, role, mission, objective, threat, and opportunities. Based on fig. 1, we can see that beef supply chain traceability system based on blockchain need an input such as, an age of the cattle, weight, sex, delivery and receiving dates, health history, and barcode. This input was collected by stakeholder involved. There are four stakeholders, namely farmer, feedlot, slaughterhouse, and industry. Farmer (Breeder) are actors who will input the cattle data into the system, feedlot is actors who will input data related to health history of the cattle, the slaughterhouse is actors who will input the date of receiving the cattle, and input the history of cattle before being a slaughter. The industry is actors who will input the data of meat processing and packaging, and also make the barcode. This stakeholder will interact with each other in building the system.
The beef supply chain traceability system based on blockchain there is an object that is to capturing data and tracing process. The resources of this system are document and measurement data. The environmental regulation became a threat for this system because if the adoption of blockchain is increased, the energy burden will become more considerable. There is likely to be a lot of opposition as far as blockchain technology large-scale implementation is concerned.

3.2 Analyze the interaction between stakeholder
Use case diagrams show interactions between actors or "species". In the beef supply chain traceability system, there are four actors involved, namely cattle farm (breeder), feedlot, and meat industry. Activities in the system are begins by initiating transactions by the cattle farm, then the cattle farm will broadcast the details of the transaction to be carried out. After the transaction is broadcast, all stakeholders must approve the activity and then the block will be formed. Each stakeholder inputs data related to each activity and the data is transparent so it can be seen all over the chain. After uploading the data, each actor is required to verify the activities that have been done in the supply chain processes. After all, transactions are verified, the block will be given a special code as a seal so that the data that has been arranged into blocks cannot be lost and cannot be changed. The Interaction between actors was described in the use case diagram (fig. 2).
3.3. System Analysis and Design

System analysis and design are modeled in BPMN 2.0 and the software used is power designer, where the model is right if the output contains zero error (s) and zero warning (s). The business model is divided into a four-lane that represents the supply chain actor in a beef supply chain. The business process is linked procedures or activity which aims to achieve overall business goals, defines the functional roles and relationship in the context of an organizational structure [3]. The results of the business process were described in fig. 3, 4, 5 and 6.

Figure 2. Use case diagram.
Figure 3. The BPMN of the cattle breeder.

Figure 4. The BPMN of feedlot.
Based on the results of BPMN that have been made, it can be seen that the system begins with the breeder receiving orders, and then broadcasting it to all stakeholders. If the transaction is approved by all actors, the transaction is considered valid and can proceed. If the transaction is disapproved, then the transaction will be canceled. After the transaction approved, the stakeholders will log in into the application to start entering data related to their activity. At the industry level, data that has been...
uploaded by previous stakeholders will be checked again, and then the industry will transform the data into a barcode that will be attached to each product package.

4. Conclusion
This study analyzes the needs of the blockchain system that will be applied to the beef supply chain and knows the interaction between stakeholders in the system. The result is that in producing blockchain system output in the beef supply chain, several inputs are needed, namely the beef supply chain structure and activities for each actor. Four stakeholders involved in the system, namely cattle breeder, feedlot, slaughterhouse, and industry. The goal is to build a beef supply chain traceability system using blockchain, two resources namely document and measurement data. The environment regulation is a threat for the system, while commerce and corporation are the opportunities for the system. Based on the analysis using BPMN 2.0, it is known that there was four stakeholder taking the role in traceability system based on blockchain technology. The result showed that the blockchain can create a transparent and efficient supply chain through sharing data between the stakeholders.

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