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Transparent distribution system design of halal beef supply chain

Juliza Hidayati[a], Rini Vamelia[a], Jihaad Hammami[b] and Endri Endri[c*]

[a]*Industrial Engineering Deparment, Universitas Sumatera Utara, Medan, Indonesia*
[b]*Department of Agro-Industrial Technology, IPB University, Bogor, Indonesia*
[c]*Universitas Mercu Buana, Jakarta, Indonesia*

A B S T R A C T

Halal food is food whose halal status is regulated by sharia institutions such as LPPOM MUI which is set by the government. The halal status of food must be traced from the process of raw materials, processing, packaging, transportation, and distribution to the final consumer. It is difficult to trace the certainty of halal food, especially beef in Medan City because the supply chain information from upstream to downstream is not transparent. To increase the transparency of beef status and increase consumer confidence, especially Muslim consumers, a distributed and transparent system is needed, where many parties can access the status of food at any time. So Blockchain technology is used to help track the halal status of beef along the supply chain. The purpose of this study is to design a system to obtain information certainty that beef distributed along the supply chain is halal and safe for consumption by utilizing Blockchain technology and to increase public safety and trust in the LPPOM MUI halal certification system. Based on the discussion and research analysis, it is known that the information in the halal beef supply chain in Medan City uses blockchain technology designed with a data security system using smart contracts, where information that has been stored cannot be changed by any party. so that there is a guarantee of information security in the beef supply chain in the city of Medan. This research is expected to support transparency, security, and certainty of information about halal beef in Medan City.

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1. Introduction

The development of the Halal industry is a big opportunity in Asia and Europe (Sayuti et al., 2021), where the world's halal sector is growing quite rapidly (Hasan, 2021). Because halal products guarantee the quality of a product that meets healthy, safe and intact living standards. In supporting the development of the halal industry, in 2003 the Thai government allocated funds to establish the "Halal Standards Institute of Thailand under the supervision of the Central Islamic Council of Thailand (CICOT) which aims to develop a Halal Science Center (Aminuddin, 2016). LPPOM MUI in North Sumatra Province is one of the Halal Certification Institutions that represents halal certification in Indonesia, especially North Sumatra Province which is currently closely related to market competition that is developing towards global halal competition (Shalihin et al., 2019). The demand for halal products, especially in the province of North Sumatra is very high (Shalihin et al., 2020) Based on data from the Central Statistics Agency (BPS) of North Sumatra Province in 2020, the population of Medan City is 2.7 million people and 1.6 million people or around 61% are Muslim (BPS, 2020).

Beef is a very promising economic commodity. The Head of the Food Crops and Horticulture Agency (TPH) of North Sumatra Province said that the demand for beef and buffalo in Medan City in 2020 was around 26 thousand tons, while what was fulfilled was only 17 thousand tons. It is estimated that the need for beef per person is 9.6 kg/year. To meet the remaining needs, 9 thousand tons of feeder cattle are imported in the form of beef and beef from outside North Sumatra (Kementan,

* Corresponding author Tel.: +628129204067
E-mail address endri@mercubuana.ac.id (E. Endri)

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2020). The difference in the amount of beef consumption with the amount of beef production causes a weak supply chain, although the amount of domestic production continues to increase, this amount has not been able to meet consumption needs. The supply chain consists of many stakeholders such as suppliers, manufacturers, retailers, operators, to consumers. The large number of actors in the supply chain results in very low information on guaranteeing halal beef. The implementation of traceability can create transparency in the supply chain. Conventionally available centralized traceability solutions are not preferred for supply chains as they are faced with many problems like data manipulation, single point of failure etc. (Sunny et al., 2020).

Only one animal slaughterhouse (RPH) in Medan has a halal certificate, while suppliers and retailers do not have a halal certificate. Transportation in the beef distribution network also carries other meats such as pork which can invalidate the halalness of beef. The identification of critical points in halal logistics service providers is found in three activities: 1) warehousing, 2) material handling and 3) transportation (Ma'rifat et al., 2017). The implementation of these three activities in the city of Medan still raises concerns about the halal guarantee of beef so that it raises doubts about consuming it. This requires transparent management of information between supply chain actors.

Blockchain is a distributed computing paradigm characterized by transparency, network-wide logging, low cost, high efficiency, and security. Blockchain adoption was initially pioneered as a financial technology (bitcoin) then as a supply chain technology (Koh et al., 2020). In general, transparency is the disclosure of information (Gligor, 2018; Fatmawatie & Endri, 2022).). Blockchain technology brings transparency and helps logistics professionals such as carriers, shippers and brokers to detect fraud early and prevent theft. Blockchain and smart contracts can be an effective solution to deal with the problems of counterfeiting, data security and privacy, operating costs, and bureaucratic barriers in the circular economy (Christidis, 2016; Saberi et al., 2019; Centobelli et al., 2022). There is an increase in customer confidence in each financial transaction to track product ownership (Jain et al., 2020; Indrasari et al., 2022).

2. Literature review

2.1 Supply Chain Management

Supply Chain is a network of all organizations and activities related to the flow and transformation of goods, information, and money (Hidayati & Hasibuan, 2019). Supply chain management is a method or approach to manage the flow of products, information and money in an integrated manner by involving parties from upstream to downstream consisting of suppliers, companies, distribution actors and consumers (Ricardianto et al., 2022a). Activities in supply chain management include product development, procurement of materials and components of a product, production planning, inventory control, distribution and product returns (Ricardianto et al., 2022b). The main objectives of supply chain management are delivery of products on time, reducing time and costs in meeting needs, centralizing planning and distribution activities, and managing good inventory management between suppliers (vendors) and consumers (buyers) (Delfani et a., 2022).

2.2 Blockchain Technology

Blockchain is a distributed database that functions like a ledger that allows information to be stored digitally and new information to be added and maintained to the ledger (Novianti et al., 2020), as well as a cutting-edge technology that has great potential to improve traceability performance by providing full security and transparency (Feng et al., 2020). In addition, blockchain is also a new technology that allows a new form of distributed software architecture and is positioned in the early stages of development (Della & Olliver, 2020). Blockchain technology shows a fast growth rate, both for applications and test markets (Merkx, 2019). Blockchain is also a technology aggregation of several individual technologies and is defined as a new technology layer for industrial applications by using five assets namely cryptography, protocols, software, computers and networks (Della & Olliver, 2020). Blockchain can be thought of as a secure distributed ledger that can record information about transactions between two parties. All records stored in the Blockchain can be easily verified and cannot be changed, so the integrity of all records is maintained. The data storage system on the Blockchain is immutable, in other words, the data entered in the Blockchain is permanent and secure (Novianti et al, 2020). Blockchain can serve as a tool to reduce uncertainty in the supply chain (Rao et al., 2021).

One of the important applications of Blockchain is Smart Contracts, where the relationship that defines the supply chain is set automatically, in the form of a program by automatically agreeing to conditions that have been previously agreed upon by supply chain actors. In a halal supply chain, the Blockchain system will represent physical assets in the form of digital identities, ownership of identities which can later be controlled by smart contracts to become rules (Abeyratne & Monfared, 2016). For example, the creation of a digital halal certificate, where the certificate will be automatically printed when the payment for the halal certificate process has been received.

2.3 Halal Terminology

In the view of Islam, choosing to consume something halal is a very important issue and is considered the core of religion, because everyone who will use or do, or consume is highly required by religion to first ensure it is halal (Nurhayati et al.,

2022). If it is halal then it is permissible to do, use or consume it, but if it is haram then it must be kept away from a Muslim. In Q.S. Al-Baqarah (2): 168 this is clearly stated. The content of the meaning of the verse commands all mankind to consume halal food. Especially for those who believe, of course it is more important and obliged to practice it.

2.4 Halal Supply chain Management

Halal supply chain management (HSCM) is a growing area of business and research (Haleem et al., 2020). Halal supply chain is a concept where halal is not only seen as raw materials and production processes, but also involved in supply chain processes (Aziz et al., 2021). Halal supply chain management arises because the demand for halal products is very high so that it can achieve halal integrity from the point of view of purchasing by consumers. Halal food must be handled with the right approach process, so it is necessary to take a new approach called the halal supply chain. This approach is the alignment of the system with the demand from customers and the halal industry. Consists of six important components that are integrated with each other, namely human resources, processes, environment, accreditation, logistics, and traceability (Novianti et al., 2020).

2.5 Halal Supply Chain Transparency

The demand for halal food continues to increase, but the halal authenticity of a product is a major problem for the food industry. This raises concern among Muslim consumers and raises curiosity about processed foods that contain prohibited substances that invalidate the halalness of the food. In recent years, a lot of information has emerged regarding pork and pork products being mixed in food and food products. There is an increasing trend in some countries to incorporate processed pork in their food products for financial gain (Fadzlillah et al., 2011). Muslim consumers need protection from non-genuine halal products. Therefore, information about the ingredients that make up a product and their sources must be presented to ensure the halalness of the product (Endri et al., 2020). Centralized information system storage relies on one organization to mediate sensitive and valuable information so it requires a lot of effort so that trust can be built by every actor in the halal supply chain.

2.6 Halal Assurance System and Halal Product Assurance Act

The halal assurance system is a management system that is compiled, implemented and maintained by companies holding halal certificates to maintain the continuity of the halal production process in accordance with the provisions of LPPOM MUI. Products that have been certified, guaranteed and declared halal will get a halal certificate from MUI. Halal certificate is a written fatwa from MUI which states the halalness of a product according to Islamic law. Permits for the inclusion of the "Halal" label on product packaging from BPOM can be issued on condition that the product has obtained a halal certificate from the MUI fatwa commission. Halal labeling is under the authority of the government, namely the Food and Drug Supervisory Agency. LPPOM is legitimized as the institution responsible for the implementation of halal certification based on the Central MUI Decree No. kep 164/MUI/IV/2003. This Central MUI Decree refers to the Decree of the Minister of Health of the Republic of Indonesia No. 924/Menkes/SK/VIII/1996 concerning the inclusion of "Halal" text (Kemenkes, 2014).

3. Research Methodology

The data collection technique used in this study was a literature study related to the objects discussed in the study. In this study, researchers used secondary data in the form of book literature, local and international journals, e-books, citing statements from government and non-government actors from online articles, as well as other materials that support research such as the internet, newspapers, magazines, and mass media. both printed and online based. Data analysis carried out in this study was to determine the design of a transparent distribution system to find out information on halal beef in the city of Medan.

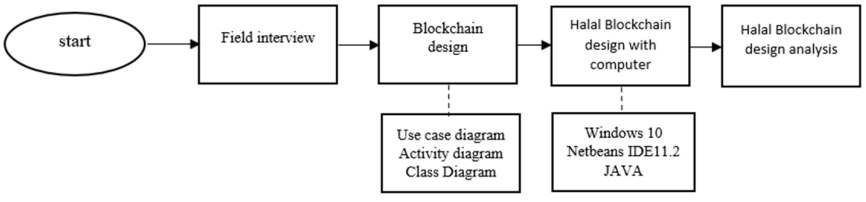

Fig. 1. Research methodology

The first thing to do is to conduct field interviews. Field interviews were conducted with beef supply chain actors in Medan City. After conducting interviews, a blockchain design was made using use case diagrams, activity diagrams, and class diagrams. The data obtained then with the help of a computer, an application can be made using a computer using the Windows 10 operating system and using the Netbeans IDE11.2 and JAVA applications. The application is then analyzed.

4. Research Discussion and Analysis

4.1. Field interview results

The following is a picture of the halal beef supply chain in the city of Medan based on results of interviews with beef supply chain actors.

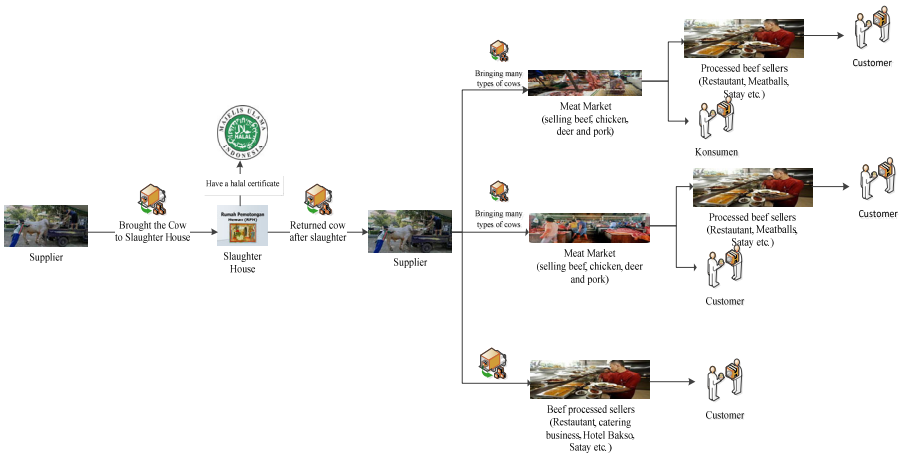

Fig. 2. Real Condition of Halal Beef Supply Chain Business Process in Medan City

As part of the supply chain management of halal products, halal logistics plays an important role in the process of storing, transporting, and distributing halal products to consumers. Halal transportation means that halal and non-halal goods are not mixed in handling equipment such as forklifts, trolleys, and pallets or in containers/public transportation vehicles. Based on Fig. 2. The real condition of the halal beef supply chain business process in Medan City is currently causing concern for Muslim consumers. This is because there is no certainty that the beef distributed to consumers is not contaminated with substances that invalidate its halal. Not all stakeholders in the beef supply chain have halal certificates.

4.2. Blockchain Design

In designing Blockchain-based supply chains, technology in the form of Netbeans IDE 11.2 and JAVA applications is used by using the following methods:
a. *Use Case Diagram*
b. *Activity Diagram*
c. *Class Diagram*

To find out the beef sold in the market is halal meat that has gone through an administrative process that is in the blockchain system, a sign is given to the meat in the form of a label on the one from the supplier according to the purchase amount. The label contains information on the amount of beef purchased, where the beef was purchased and the time of purchase. The following is a flowchart of the Design Blockchain process for the halal beef supply chain in Medan City.

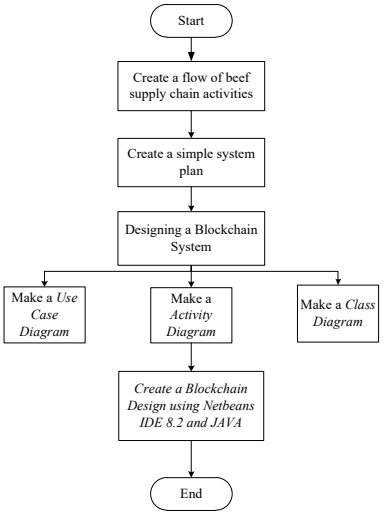

Fig. 3. Flowchart of Data Processing Use Case Diagram

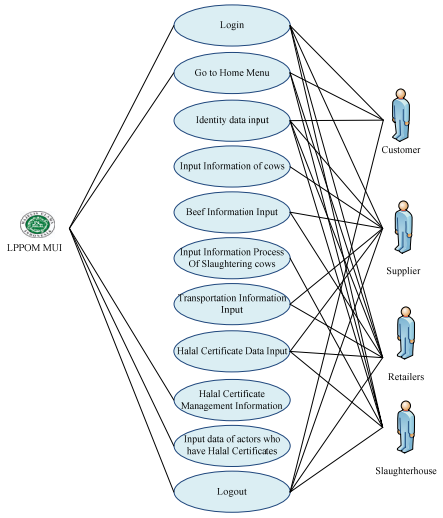

Fig. 4. Use Case Diagram

4.2.1 Use Case Diagram

Use Case Diagram is a modeling used to identify the behavior of a system that will be made (Iswari et al., 2020). Use Case Diagrams describe who the users in the system are and what users can do to the system. The actors involved in the Use Case Diagram have two characteristics, namely actors outside the system being developed and actors interacting with the system being developed (Iswari et al, 2020). The following is a Use Case Diagram of a Blockchain-based halal beef supply chain. Use Case Diagram created to describe the new system. For more details can be seen in Table 1.

1. Actor Identification

The following is the identification data of actors in using Blockchain to obtain halal certainty for beef in the city of Medan.

Table 1
Actor Identification

	Actor	Description	Activity
1	LPPOM MUI	Input data and information on halal certificates	1. Log in to the official Blockchain website 2. Login 3. Enter the home menu containing the data display requirements for halal certificate management, actors who have halal certificates and fees 4. Clicking on the options menu and entering data correctly
2	Supplier	Input identity data and halal beef information	1. Log in to the official Blockchain website 2. Login 3. Enter the home menu containing the input data display for Supplier Identity, Beef Information, Beef Information, Transportation Information and Halal Certificate Information 4. Clicking on the options menu and entering data correctly
3	Retailer	Input identity data and halal beef information	1. Log in to the official Blockchain website 2. Login 3. Enter the home menu containing the display of retailer identity data input, beef information, transportation information and halal certificate information 4. Clicking on the options menu and entering data correctly
4	RPH (Slaughterh ouse)	Input identity data and input information on beef cutting process	1. Log in to the official Blockchain website 2. Login 3. Enter the home menu containing the input data display for the identity of the abattoir, information on the beef slaughter process and information on halal certificates 4. Clicking on the options menu and entering data correctly
5	Customer	Input identity data and purchase halal beef	1. Log in to the official Blockchain website 2. Login 3. Enter the home menu containing the display of Customer Identity data input and purchase information 4. Clicking on the options menu and entering data correctly

2. Identify Use Cases

The following is Use Case Identification data in using Blockchain to obtain halal certainty for beef in Medan City.

Table 2
Use Case Identification

No	Use Case	Description
1	Login	LPPOM MUI, Suppliers, Retailers, RPH, and Customers enter the main page by entering the correct name and password
2	Menu home LPPOM MUI	LPPOM MUI enters the home menu which contains data options for actors who have Halal certificates, requirements for obtaining halal certificates and fees for processing halal certificates
3	Halal certificate management information	LPPOM MUI enters the Information menu for halal certificate management to input data correctly
4	Information on actors who have halal certificates	LPPOM MUI enters the Information menu for actors who have halal certificates to input data for actors who have halal certificates
5	Supplier home menu	The supplier enters the home menu which contains options for inputting supplier identity data, input beef information, input beef information and input transportation information to input data correctly
6	Input supplier identity data	The supplier enters the Input supplier identity data menu to enter the supplier identity data correctly
7	Input cow information	The supplier enters the Cow Information Input to input data related to the cow that is slaughtered correctly
8	Input beef information	The supplier enters the Beef Information Input to input data related to beef that has been cut correctly
9	Input transportation information	The supplier enters the Transportation Information Input to input the transportation data used and the distribution of beef from the abattoir to retailers
10	Retailer home menu	The retailer enters the home menu which contains the options for Inputting retailer identity data, Input beef information and Input transportation information to input data correctly
11	Enter retailer identity data	The retailer enters the Enter retailer identity data menu to enter the retailer identity data correctly
12	Input beef information	Retailers enter Beef Information Input to input data related to beef that has been cut correctly
13	Input transportation information	Retailers enter the Transportation Information Input to input the transportation data used and the distribution of beef from suppliers to customers
14	RPH home menu	The RPH enters the home menu which contains options for Inputting RPH identity data and Input Information on the beef slaughter process to input data correctly
15	Input RPH identity data	The RPH enters the menu Input the identity data of the RPH to enter the identity data correctly
16	Input information on beef cutting process	RPH enters the Input menu for beef slaughter process information to input data related to the beef slaughter process
17	Customer home menu	The customer enters the home menu which contains the Input customer identity data and purchase information options to input the data correctly
18	Input customer identity data	The customer enters the Input Customer identity data menu to enter the identity data correctly
19	Purchase information	The customer enters the Purchase Information menu to input purchase data correctly
20	Logout	LPPOM MUI, Suppliers, Retailers, RPH and Customers leave the system

4.2.2. Activity Diagram

Activity Diagram is a diagram that describes the dynamic nature of a system in the form of a flow model and activity-to-activity control. Activity Diagrams are used to model workflow diagrams or business processes and operations internally (Iswari et al., 2020). The following is the LPPOM MUI Login Activity Diagram (See Fig. 5). The Activity Login diagram illustrates the activities of LPPOM MUI to enter the main menu. Where must fill in the name and password correctly.

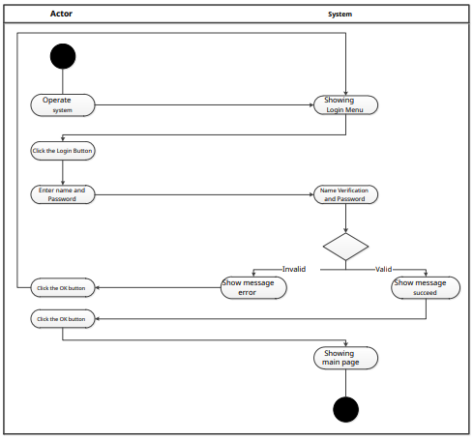

Fig. 5. LPPOM MUI Login Activity Diagram

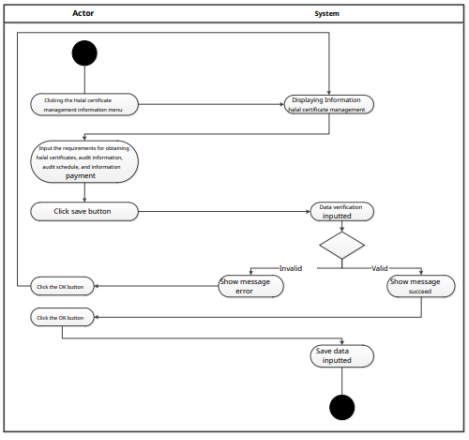

Fig. 6. Activity Diagram of Halal Certificate Management Information

Fig. 6 describes the Activity Diagram Halal certificate management information.

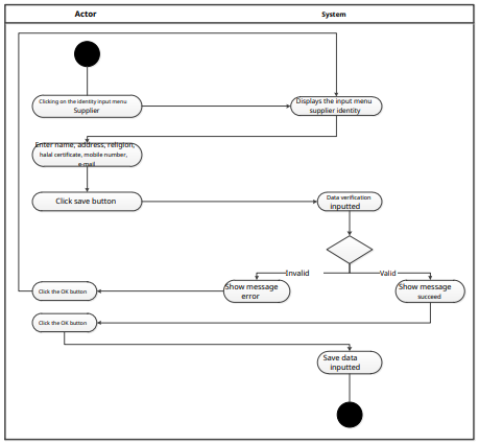

Fig. 7. Activity Diagram Input Supplier Identity Data

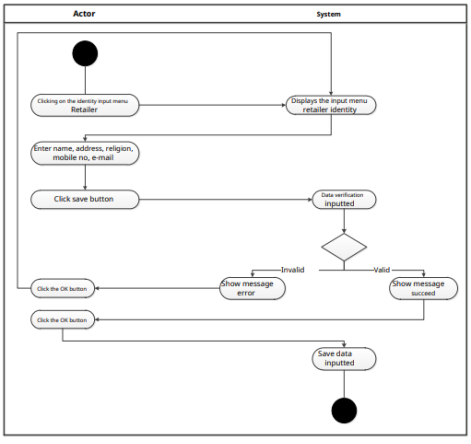

Fig. 8. Retailer Identity Diagram Activity

Activity diagram of supplier identity data input describes the activity of the supplier to fill in the supplier identity correctly. Fig. 7 shows an Activity Diagram of supplier identity data input. Activity Diagram of the identity of the retailer describes the activities of the retailer to fill in the identity of the supplier correctly.

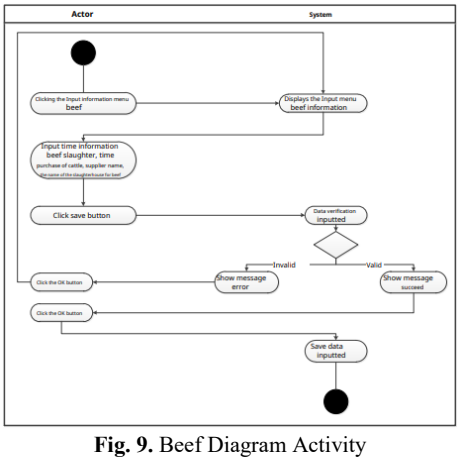

Fig. 9. Beef Diagram Activity

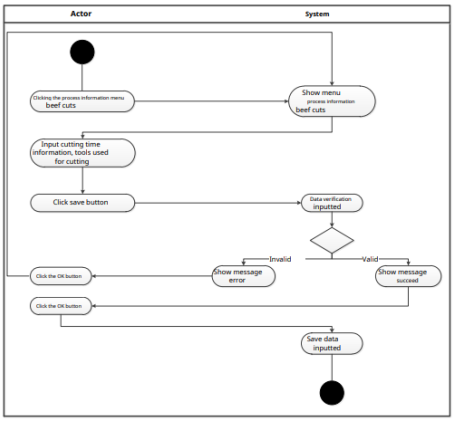

Fig. 10. Activity Diagram of Beef Slaughter Process Information

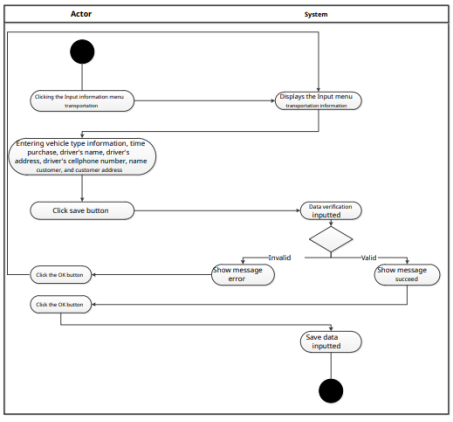

Fig. 11. Activity Diagram of Transportation Information Input

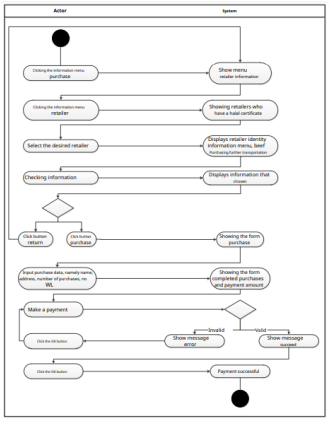

Fig. 12. Purchase Activity Chart

Fig. 8 is an Activity Diagram of a retailer identity diagram. Activity Diagram Input Beef information describes the activities of retailers to input information on beef slaughter time, beef purchase time, supplier name, name of beef slaughterhouse. Fig. 9 is an Activity Diagram for beef input. Activity Diagram input Information on the beef slaughtering process describes the activities of the abattoir to input the time of slaughter, the tools used for slaughter. Fig. 10 is an Activity Diagram input Information on the beef cutting process. Activity Diagram Input Transportation information describes the activities of retailers to input beef distribution information from suppliers to customers. The information entered is the type of vehicle, the time of purchase, the name of the driver, the address of the driver, the mobile number of the driver, the name of the customer, and the address of the customer. Fig. 11 is a picture of the activity diagram for the input of transportation information. Activity Diagram Purchase information describes the activities of the customer to make a purchase. The customer inputs the purchase amount and delivery address. The following is an Activity Diagram of purchasing information.

4.2.3. Class Diagram

Class diagrams describe the structure of the system in terms of defining the classes that will be created to build the system. Class diagram modeling in a system can provide an overview of the relationship between classes of a system, also provides an explanation of class rules and responsibilities (Syarif & Nugraha, 2020). Fig. 13 presents is an image of the Halal Beef Blockchain Design Class Diagram.

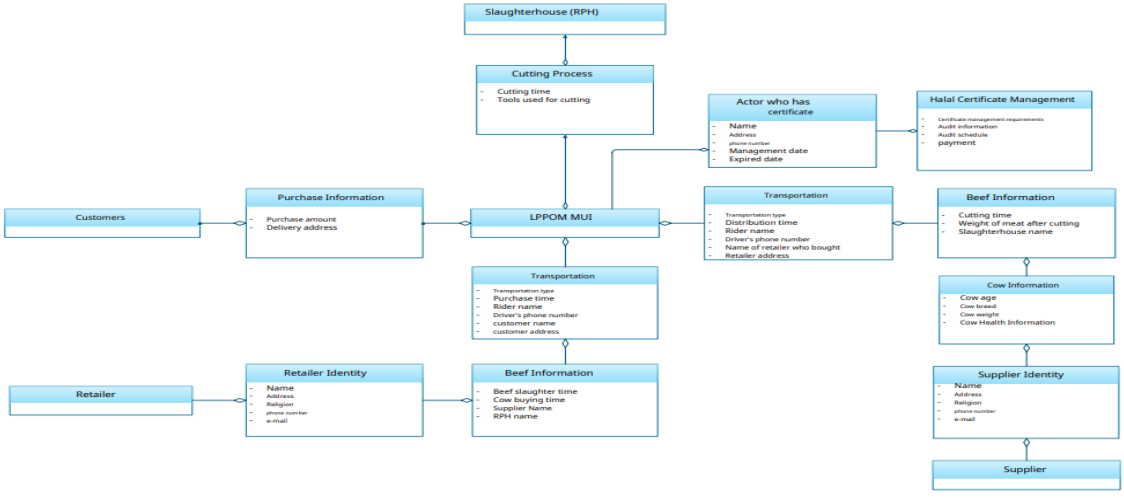

Fig. 13. Class Diagram

4.3. Halal Beef Supply Chain Blockchain Design

The following are the computer equipment needed to assist in the design process of the halal beef blockchain supply chain

4.3.1. Operation System (Windows 10)

Fig. 14 is an image of the operating system specification (windows 10) used to assist the design process of the halal beef blockchain supply chain.

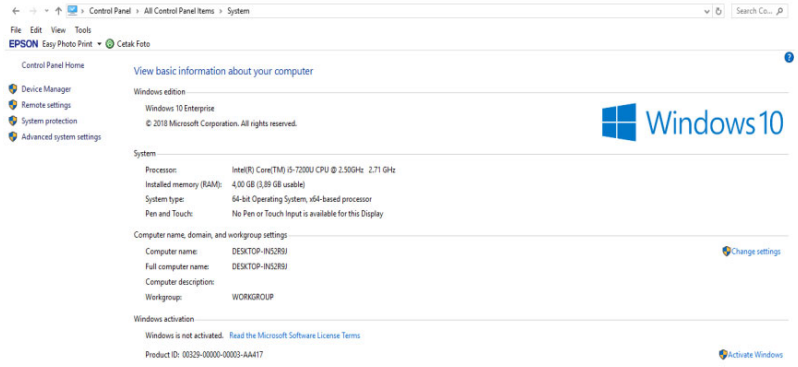

Fig. 14. Windows 10 Specification

4.3.2. Netbeans IDE11.2

Fig. 15 is an image of the Netbeans IDE 11.2 specification which is used to assist the design process of the halal beef blockchain supply chain.

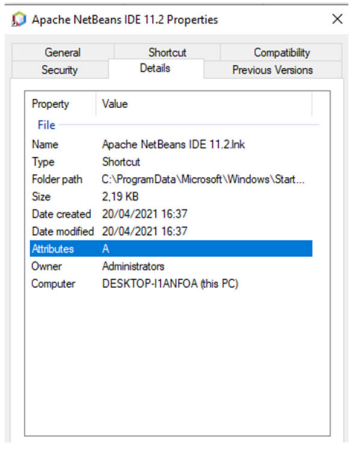

Fig. 15. *Netbeans IDE* 11.2 Specification

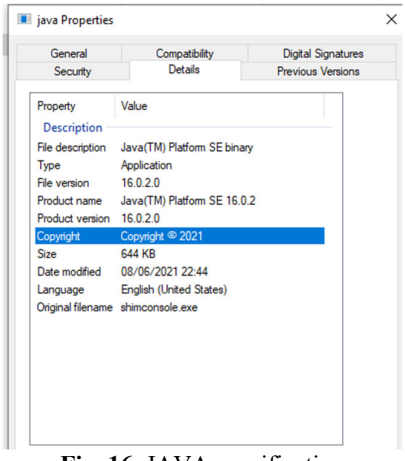

Fig. 16. JAVA specification

4.3.2. JAVA

The following is an image of the JAVA specifications used to assist the design process of the halal beef blockchain supply chain. Fig. 16 is a flow of Blockchain-based halal beef supply chain activities

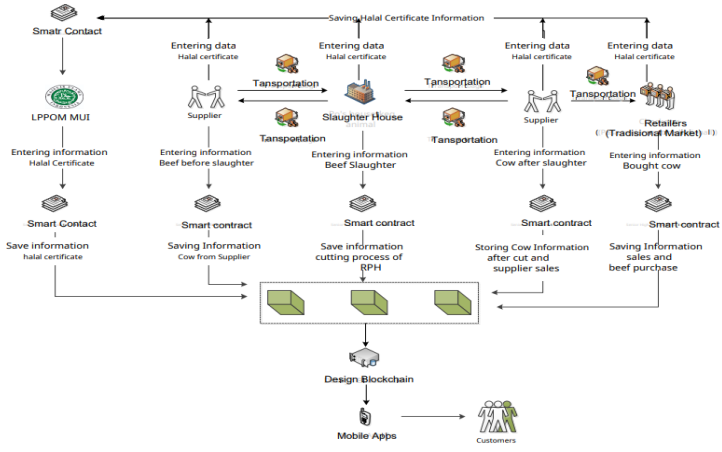

Fig. 17. Blockchain-Based Halal Beef Supply Chain Business Process Design in Medan City

There are several parties in the Blockchain-based halal beef supply chain network, namely:

1. Market

The market is a party that plays an important role in the halal beef supply chain. The parties that cover the market are suppliers, abattoirs and retailers. This party will market beef to consumers either directly or indirectly.

2. Consumers

Consumers in the supply chain can be classified into household consumers, catering consumers, and restaurant consumers. Household consumers are consumers who carry out consumption activities for products or services to meet their own family needs. Catering consumers are consumers who carry out consumption activities to meet food needs according to customer orders. Restaurant consumers are consumers who carry out consumption activities for resale restaurants. Household consumers, caterers, and restaurants can get beef directly in the market or from slaughterhouses with a certain minimum purchase amount.

3. LPOM MUI

LPOOM MUI is a third party in the halal beef supply chain network.

4.4. Blockchain Design Analysis

People in the city of Medan have concerns about the halalness of beef. The Blockchain system can be applied throughout the beef supply chain in Medan City to obtain halal certainty. The Blockchain system can be viewed on the official website of LPPOM MUI Medan City which is a medium of information for beef consumers. The Blockchain system can be installed on the website to make it easier for LPPOM MUI to monitor the halalness of beef and consumers to get certainty about the halalness of the beef they will consume. To enter the blockchain system, actors must first be registered in the system which is managed by LPPOM MUI Medan City. Blockchain system access can only be done by actors who have registered and joined the Blockchain-based beef supply chain system, this is done to maintain the security of the Blockchain system.

5. Conclusion

Based on the processing and analysis that has been carried out in the study, the following conclusions are obtained:

1. The Blockchain Technology System is installed on the official LPPOM MUI Medan website to increase public safety and trust in the halal certification system of a product
2. Transparency and data security in the blockchain-based beef supply chain flow can reduce doubts, especially the Muslim community in consuming beef in Medan City
3. Information in the supply chain for halal beef in Medan City using Blockchain Technology is designed with a data security system using smart contracts, where the information that has been stored cannot be changed by any party.

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