Prototype development of National Cattle Identification and Database System based on information technology

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Abstract. The population of cattle in Indonesia reaches 17 million in 2018, but until now Indonesia does not yet have an integrated identification and recording system for cattle between farmers and / or farmer groups and the government, in this case the Livestock Service Office. The objective of this research is to build a prototype of national cattle identification and database system based on information technology. The prototype development system uses a prototyping method, preceded by surveys and interviews with farmers in several locations, namely Kupang Regency, Kupang Municipality, Tuban, Bogor and Bojonegoro. The result of this research is a prototype of a national cattle identification and database system that can be accessed using computers and smartphones by actors in the livestock industry. Cattle will obtain an identity in the form of a code written into the RFID tag issued by the district or municipal Animal Husbandry Service and recorded in a database. The identity is unique, that no cattle will have the same identity and it is valid for life. Farmers, farmer groups and companies engaged in livestock farming will also be recorded in the database so that it will facilitate national cattle management. The resulting prototype will be a model of a livestock database system in Indonesia.

1. Introduction
The population of world beef cattle in 2015-2019 is concentrated in ten countries, with a total contribution of 94.38% to the world's population with an average of 994.51 million heads. The highest beef cattle population is owned by India with an average population of 303.76 million and contributing 30% - 54%, the second position is occupied by Brazil with a contribution value of 22.70% and an average population of 225.75 million heads, and China occupies the third position with a percentage contribution of 9.88% or an average population of 98.29 million heads. USA ranks fourth, contributing 9.33% with an average population of 93.83 million heads. In some cattle producing countries such as the United States, Canada, Australia, Brazil, it is mandatory or voluntary that each animal must have an identity so that it can be recorded in the national livestock database and facilitates livestock management [1,2].

Indonesia as a developing country, with a large population, has a beef cattle population in 2018 of 17,050,000 head and is concentrated in several livestock source areas, namely, East Java, Central Java, South Sulawesi, East Nusa Tenggara, West Nusa Tenggara, Bali and Lampung. The population of beef
The growth of beef cattle population in Indonesia continues to increase, both in Java and outside Java. Beef cattle breeding business has a very good prospects, because Indonesia is still lacks of beef; therefore, imports are still needed [1,2]. However, until now, Indonesia does not yet have a database of cattle that applies nationally and also does not have a nationally managed livestock identity standard. In terms of livestock management, to determine the cattle population, the Indonesian government must regularly conduct a national livestock census, which is conducted every five years.

Identification is the basis for having an accurate record of livestock performance and allows producers to maintain records of livestock origin, date of birth, production records, medical history and a number of other important management information. Accurate records will provide sufficient information for producers to make decisions [3,6,15]. In most cases, producers must have the speed to identify the animal. That good identification system can make this job easier and more efficient. Identification is also important to indicate animal ownership or to indicate herd of origin [8]. Currently, Indonesia does not have a standard for national livestock identity and does not yet have a national livestock database, especially for cattle. Therefore, it is necessary to have a cattle identification system and an integrated national livestock database system so that livestock management will be better [13-16]. The system being developed is expected to provide various benefits for the government, breeders and the community in order to easier the government to monitor the development of cattle nationally, breeders can manage their livestock better and the public can obtain information about cattle more accurately.

The purpose of this research is to design a prototype national livestock database system that can be accessed by breeders on an individual, livestock group and company scale. The public can also access information to find out information about cattle in Indonesia.

2. Research Methods
This research was conducted for 18 months from July 2018 to December 2019 in several cities, namely Kupang Regency and Municipality (NTT), Jonggol District, Bogor Regency, Tuban Regency, and Semanan District, Bojonegoro Regency. Kota Kupang (NTT), although not the area with the largest cattle population in NTT, has port facilities, making it the main area for inter-island cattle delivery. Meanwhile, Tuban Regency is one of the regencies in East Java Province with the largest cattle population. The first phase of the field survey was carried out in NTT (Kabupaten and Kota Kupang) and then continued in Jonggol District, Bogor Regency, Tuban Regency and Semanan District in Bojonegoro Regency. The steps taken were to make observations in the field on how the recording of the breeders’ animals was carried out, then conduct an analysis of the construction of a livestock database, design the system, collect information and resources needed to make a prototype, and evaluate the system. The design of this national livestock database is carried out using a System Development Life Cycle (SDLC) approach using a prototyping model

2.1. Data Collection
A semi-structured interview with breeders and cattle groups as well as the Provincial, District and Municipal Livestock Office in 5 (five) areas, was used for data collection process. Interviews were conducted to determine the process of recording cattle owned by breeders and how to control and supervise the cattle owned by breeders.
2.2. Prototype Model

The development of a database system prototype and national cattle identity uses a prototyping approach. The prototyping model is a software development method where the Developer and customers can interact with each other during the system development process. The stages in developing a prototype model include listening to users, building, repairing the system, testing the system to users, and controlling the system [10,11]. The system development using prototype model can be seen in Figure 1. [8]. The research begins with identifying problems, collecting data, analyzing the needs of livestock identity systems and national databases, designing systems using UML, designing databases, designing livestock database user interfaces, and conducting tests. Data collection is conducted by using the method of observation, interviews and literature study.

3. Design of Prototype National Cattle Identification System and Database

After identifying the needs by conducting observations and interviews, the next stage is to carry out modeling using the Unified Modeling Language (UML) and continue to do the coding or construction of prototyping stages in programming or coding. In developing a web-based cattle database using the PHP programming language with the PostgreSQL database while for android-based mobile applications, it uses the flutter framework. In developing prototypes of cattle identification numbers and livestock databases, it focuses on how farmers can register their cattle and the district or municipal offices can issue cattle identification numbers which will then be written into an RFID tag which will then be attached to the ears of cattle by field officers from Animal Department. Field officers from district or municipal offices are usually an extension officers/health workers/veterinarian who have been trained in handling animal health. The database framework of national cattle identification number and database is centralized database [14] can be described in Figure 2 below.
3.1. Cattle Identity (ID)

In order to build a national cattle database, cattle must be registered and have a cattle identity number as a sign that the cattle have been registered and recorded in the national livestock database. For this purpose, it is necessary to have a cattle identity number that is owned by every cattle born in Indonesia. To be able to interact with the system each farmer must register himself in the National Livestock Database system. If the farmer is registered, the farmer can register the cattle that were born to get the identification number of the cattle he has. For breeder identity, the farmer can use the breeder's ID number. For cattle, because in Indonesia the identity code number for cattle has not yet been implemented, the author proposes a national cattle identity numbering standard. According to ISO 3166 the code for livestock is 15 digits beginning with the Country code [14]. The author proposes that the livestock identification number be started with a country code using 3 digits and followed by 5 digits which is the village code and the last 7 digits are the order of cattle registered in the village. So, in one village, there are 9,999,999,999 livestock identities that can be issued by the district or municipality offices. An example of a proposed national cattle code can be seen in Figure 3. Based on the proposal, if there are cattle that has code 360823890000001, it means that the cattle were born in Naioni village, Ayak district, Kupang district, NTT province, and is the first cattle to be registered in the village.
The cattle identity can be obtained by the farmer by registering the cattle he owns via a smart telephone or computer, then the district/municipality office through the field officer/veterinary officer/animal health officer approve the farmer's application and issue the livestock identity and write it down on the RFID tag, then attach it to the cattle's ear. The process for registering new cattle can be seen in Figure 4. After the cattle have obtained an identity, breeders can enter their cattle data into the national livestock database system. The Livestock Service Office, field officers or the community can view the summary of data entered by the farmer into the system via the web page. Registered farmer can record every treatment of their cattle into the national database system. In the future, cattle identity will be needed to build traceability system where cattle identity becomes a mandatory [7,12].

In the prototype national livestock database there are several actors who are directly connected to the system, namely the Animal Department, Breeders based on field observations. Breeders are divided into 3 types, namely Individual Breeders, Breeders who are members of livestock groups and Breeders in the form of legal entities (companies). Animal Health officers are service employees who will be in charge of issuing and installing RFID tags on cattle. Service administrators are system administrators who verify data and allow the creation of user accounts. The public can access the system to get information about cattle. Figure 5 is a Use Case diagram that illustrates how users interact with the system and shows the functions and features of the application from the user's side. Use case diagrams can also be used to see user interaction with the system [8]. In this use case, there are 3 actors, each of whom has different access rights, namely the Office (Service administrator, Veterinarian/health worker/Field Officer), Cattle Breeder, and Community.
3.2. Entity-Relationship Diagram (E-RD)

The purpose of this national livestock database system is to record the cattle owned by farmers so that they can be more easily managed and the system can be further developed to build a traceability system. The ER diagram in the construction of this national livestock database can be illustrated as in Figure 6.

Figure 5. Use Case Diagram of National Cattle Identification Number and Database
Figure 6. ER diagram of the National Cattle Identification System and Database

4. Development of Prototype National Cattle Identification System and Database

The developed prototype national cattle identification and database system are then implemented in a web-based application. This national cattle identity system and database uses to publish and record the identity of cattle, cattle care, cattle health carried out by farmers and health officers from the department. The public can obtain general information about the population and individual information of the cattle (type, birth weight, weaning weight, feed and health) and by entering the RFID number, scanning the RFID and QR-code on the ear tag. An application-based system on Android-based mobile devices was also developed for individual farmers to make it easier to enter data. Figure 7 shows an Android-based application interface for the farmer actor.
To be able to access the system each actor must register himself so that they are registered in the system. After verification and approval by the system administrator completed, the actor can enter the system and can access the system according to their access rights. Figure 8 shows Registration Form for Farmers, Animal Groups and Animal Husbandry Companies in the system.

After being registered, the farmer can register his cattle. Figure 9 shows the application response when the farmer registers his cattle. After the farmer registers his cattle, the animal health officer or
The veterinarian will issue cattle identification number in the form of an RFID Tag. The result is shown in Figure 10. Figure 11 is the form used to input cattle health condition by Veterinarian. In this example a farmer named AsepHidayat whose address is in Bogor Regency, Jonggol District, Jonggol Village, registers his livestock. The registered livestock will appear in the menu of the veterinarian / veterinarian. The veterinarian will verify and issue a livestock identity number in the form of an RFID code, which is 36016830000003 (which means that the animal was born in Jonggol village and is the 3rd cattle in the village).

![Figure 9. Form Health Officer to issue Animal Identity Number](image)

![Figure 10. Result of Animal Identity Number](image)
Figure 11. Form used by Veteranarian to input cattle health condition

5. Conclusion
The prototype of national cattle identification and database system can store cattle data and issue a cattleID number which is then written into the RFID and QR code. The code can be accessed to find out information about individual cattle. Farmers to manage their cattle can use this system, and the government can use it to monitor cattle nationally. Adding actors involved in the beef supply chain can further develop this system into a cattle traceability system. This database system can be accessed using web-based applications. For some actors it can be accessed using android-based apps. The general public can use this application to find out information about cattle, by using an application based on an Android-based smartphone so that information about cattle becomes more transparent.

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