Heliyon 7 (2021) e07754

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

Modeling e-Livestock Indonesia

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ARTICLE INFO

Keywords:
e-Livestock
e-Government
Soft systems methodology
Success factors
Business process model

ABSTRACT

The demand for beef resources in Indonesia is always increasing every year. However, Indonesia's national beef supply cannot meet those needs. The import of beef in large numbers likely to remain performed. The government has made various efforts to reduce imports and achieve self-sufficiency in beef. However, the government does not yet have a good identification, registration, documentation, and traceability system, so there is no truly valid data regarding the actual stock condition. Inaccuracy of data can lead to inappropriate policymaking in the livestock sector. Therefore, an e-Government initiative in the form of e-Livestock has been proposed. The definitions and success factors regarding e-Livestock have been revealed in our previous researches. Based on those researches, by using soft system methodology, hermeneutics, focus group discussion, and success factors, the business process models for e-Livestock in Indonesia will be created in this research. Apart from that, various kinds of recommendations for action to solve the problem will also be generated from this research. Those recommendations are about the functional requirement, the identification tool, the location numbering rule, the ownership documentation, the socialization of the e-Livestock, the institutional aspect of e-Livestock, the regulations underlie e-Livestock and the conceptual infrastructure diagram of e-Livestock. All of the business process models produced have been validated and their complexities are also calculated. Most of the business process model is very easy to understand. All the business process models and recommendations generated from this research can be a guide for the government when implementing e-Livestock.

1. Introduction

Indonesia is a large country with a huge population. A lot of Indonesian citizens like to eat beef. The need for beef in Indonesia is always increasing every year. However, Indonesia's national beef supply cannot meet those needs. The Indonesian government has made various efforts to meet the need without imports and achieve beef self-sufficiency, for example by opening various beef cattle breeding centers, such as the Technical Services Unit in Padangmangatas (Hardjosubroto 2004), opening the Superior Livestock Research Institute (it is called BPTU in Bahasa Indonesia) in various provinces, and opening the Regional Artificial Insemination Center (it is called BIBD in Bahasa Indonesia). Through the Directorate General of Livestock and Animal Health (DGLAH), the government of Indonesia has also launched the Beef Self-Sufficiency Program (it is called PSDS in Bahasa Indonesia) three times, i.e. PSDS 2005, PSDS 2010, and PSDS 2014. However, the targets of all PSDS are missed (Portal Informasi Indonesia 2018), the beef self-sufficiency is failed to be achieved and imports continue.

One of the reasons for the continued importation is the absence of accurate data on the national cattle stock so that the government always feels a shortage of stock and carries out imports. Executive Director of the Indonesian Meat Producers and Feedlot Association, and Chairman of the Indonesian Association of Cattle Breeders and Buffalo, Teguh Boediyana, in 2008, stated that Indonesia has no real data on cattle populations in the country so that it can lead to bias in the policymaking process (Boediyana 2008). Yusdja and Ilham (2004) also stated that the secondary data about the national cattle population which is available is doubtful.

Indonesia needs a system to manage the cattle data nationally. The system can utilize the Information and Communication Technology (ICT) that applied extensively at the country level. The system also must be able to report meaningful data. The availability of correct and concrete data on cattle populations can give better multi-year projections based on livestock domestic resources to achieve food security (Sinjal 2011). Not only to just record and report, in (Ramadhan and Sensuse 2011), it has been proposed in the form of a new paradigm in e-Government. The

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https://doi.org/10.1016/j.heliyon.2021.e07754
Received 15 April 2021; Received in revised form 3 May 2021; Accepted 9 August 2021

paradigm is called e-Livestock. Ramadhan and Sensuse (2011) have explained the e-Livestock position as the e-Government system so that e-Livestock will be the main focus in this research.

The previous research in (Ramadhan et al., 2012) has defined e-Livestock in Indonesia as an "e-Government system that is mandatory for the identification, registration, documentation, and traceability of cows in Indonesia, starting from birth to death". If we are using that definition, then it can be said that some countries have implemented things like e-Livestock, although they did not call it "e-Livestock". Some of those countries are the Netherland, Australia, and Japan.

Systems that have already been implemented by those above countries can not just be copied to be applied in Indonesia. The main stumbling block is the mismatch of the management pattern between the sophisticated big-holders that exist in developed countries and smallholders in developing countries (van Veen 2002). For example, in the Netherlands, "there are an estimated 30,000 cattle owners with 1.5 million cattle and an average of 50 cattle per farm" (van Veen 2002). Meanwhile, in Indonesia, it is estimated that there are only 2–3 cattle per farm (Badan Pusat Statistik, 2011). In addition to the differences in size and management pattern, the regulatory differences, the level of farmer education, and the social culture differences among developed countries and developing countries also have to be considered.

ICT has grown so rapidly, especially in today's Industry 4.0 era (Havle and Ucler 2018). Some of the technologies that underlie Industry 4.0 are machine learning, artificial intelligence, and the Internet of Things (Santos et al., 2021). Those technologies have proven to be suitable and appropriate for use in the private sector (Veile et al., 2020), but that does not mean that they can be directly used in the public sector. The application of ICT in Government needs to consider various broader aspects, such as culture, politics, economy, and financial readiness from the government (Heeks 2006). Especially in the field of animal husbandry, where the readiness of farmers to adopt technology is also a very important factor (Ramadhan et al., 2013). For example, Japan as one of the developed countries, still allows the use of traditional ear tags to identify their cows (NLBC 2020a). Another example, a mandatory animal product traceability system that applies nationally, has not yet been established in China due to technological and economic limitations (Bai et al., 2017). Therefore, careful consideration is needed about what technology will be used in the implementation of e-Livestock in Indonesia. The involvement of stakeholders from various fields is very necessary for the implementation of e-Government (Almukhlifi et al., 2019). Opinions and input from experts from across disciplines, especially from the fields of Government, ICT, and livestock are needed to find the right consensus on how e-Livestock in Indonesia should be.

It is implied in (Heeks 2006) that a lot of e-Government system initiatives are failing. To avoid failure, developers of an e-Government system should accommodate various kinds of success factors. In accordance with the multidisciplinary nature of e-Government, the success factors are not only related to ICT. Some success factors can be derived from social science, economics, politics, and so forth. Ramadhan et al. (2013) have succeeded in compiling and describing the success factors that must be present in the development of e-Livestock in Indonesia. All those success factors can be considered to model and create the e-Livestock system in Indonesia.

System development begins with a good understanding of how the business process of the environment that will use the system. Making a good model about the business process is very important so that the system can be built and run more directed and on track. If we reflect on the definition of e-Livestock proposed by Ramadhan et al. (2012), then at least 4 business process models are needed, ie. for identification, registration, documentation, and traceability activities. In the business process models, it is necessary to describe events, activities, actors, decision points, exclamations, and other things that are related to e-Livestock in Indonesia. Several other studies (ie. Santoni et al., 2015; Subagyo and Ardiansyah, 2020; Golubenkov et al., 2021) have attempted to enrich the knowledge on the discourse of e-Livestock. However, none of those studies have formulated the business process models of e-Livestock in Indonesia. In order for the business process models of e-Livestock in Indonesia to run well, it needs to be supported by various other factors. for example, the identification tool that is being used nationally, the rule about identification numbers, what data must be registered, who does the registration process, what is the form of documentation, infrastructure, and functional system requirements for traceability. Therefore, the research questions of this research are:

RQ1: How are the current conditions of the process of identification, registration, documentation, and traceability of cows in Indonesia?
RQ2: How are the business process models for the identification, registration, documentation, and traceability activities in the future implementation of e-Livestock in Indonesia?
RQ3: What should be considered regarding all e-Livestock business process models, in terms of identification tools, registered data, registration parties, forms of documentation, conceptual infrastructure design, and functional system requirements?

In order for business process models to be accepted by all stakeholders, especially by farmers, a good and targeted socialization process is needed (Ramadhan et al., 2013). In addition, it is also necessary to have a legal framework so that e-Livestock can be run properly. As stated in (Hassan and Lee 2018), that the Legal Framework is very important for the success of e-Government initiatives. Thus, other research questions from this study are:

RQ4: How to socialize the e-Livestock business process models to the stakeholders, especially to the farmers?
RQ5: How to accommodate e-Livestock busess process models in the legal framework?

The business process models that have been compiled also need to be validated. Several stakeholders need to be involved in the validation process to ensure that the business process is acceptable to all stakeholders. Multi-stakeholder involvement ensures transparency and fairness (Tanimoto 2019). In addition, the complexity of each business process model needs to be measured to see whether the proposed business process model is understandable or difficult. Business process models that are easy to understand will be easier to implement (Oukharijaneet al. 2018). Thus, other research questions from this study are:

RQ6: How to validate all of the business process models?
RQ7: What are the complexity of the business process models?

Currently, the Indonesian government (Ministry of Agriculture of the Republic of Indonesia 2019) has launched a new program to achieve beef self-sufficiency in 2026. Thus, all of the business process models and various other recommendations resulting from this research can help the Indonesian government to achieve the target of that new program. Further discussion in this study can be described in the form of a thematic picture in Figure 1.

2. Literature review

2.1. Related research on e-Livestock in Indonesia

Research on e-Livestock was initiated by Ramadhan and Sensuse (2011). At that time, Ramadhan and Sensuse proposed a new paradigm in e-Government called e-Livestock. They define e-Livestock as "an e-Government system that is used for recording, selecting, certifying, monitoring, and tracing livestock resources in a country" (Ramadhan and Sensuse 2011). They also said that "Animal that becomes a major focus in e-Livestock can be in the form of large animals such as cows or buffaloes" (Ramadhan and Sensuse 2011). Ramadhan and Sensuse (2011) used the

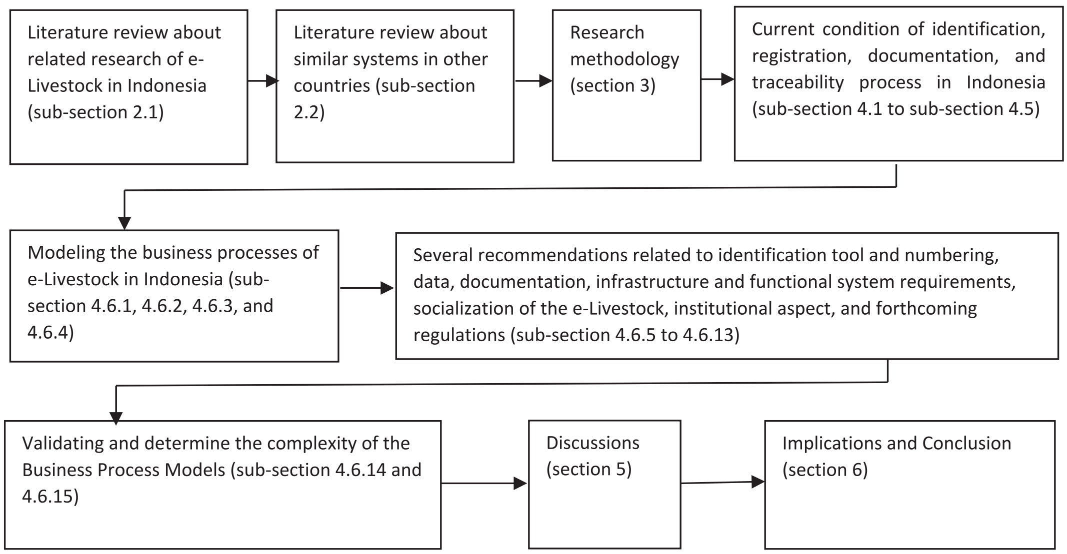

Figure 1. Thematic picture of this research.

CIPSODA checklist that comes from Heeks (2006), to explain the Capture, Input, Process, Store, Output, Decision, and Action of e-Livestock. They propose that the e-Livestock application can be in the form of Government-to-Government (G2G), Government-to-Business (G2B), and Government-to-Citizen (G2C) relationships (Ramadhan and Sensuse 2011). Their work is not mature yet back then, and still open for further research.

Ramadhan et al. (2012) made the e-Livestock paradigm more focused on Indonesia. Interpretive research is conducted by Ramadhan et al. (2012) to validated and adjusted the previous definition of e-Livestock. They asked opinions from experts and stakeholders of livestock in Indonesia. After going through the hermeneutic analysis process, then Ramadhan et al. (2012) defines e-Livestock for Indonesia as an "eGovernment system that is mandatory for the identification, registration, documentation, and traceability of cows in Indonesia, starting from birth to death". In addition to validation and definition improvement, Ramadhan et al. (2012) also succeeded in identifying 24 expected benefits of e-Livestock in Indonesia, and 24 challenges that have to be considered when implementing e-Livestock in Indonesia.

Based on the result of research that was conducted by Ramadhan et al. (2012), then Ramadhan et al. (2013) proposed a list of success factors that should be accommodated to make the e-Livestock in Indonesia successfully implemented. Those success factors are specific for e-Livestock and can assist all parties involved in the e-Livestock initiative in Indonesia.

Ramadhan et al. (2014) continued the research on e-Livestock by proposing Geographic Information System (GIS)-based Decision Support System (DSS) ability into the e-Livestock system. They said those abilities are added to attract the attention of the Indonesian government to adopt the e-Livestock system. It is expected that the government official can see the benefits of the e-Livestock system in decision making. However, eventually, at that time the e-Livestock system had not yet been implemented in Indonesia. Due to a political year, the adoption of the e-Livestock system stagnant. Then at the end of 2014, the PSDS that has been launched by the government also failed without having the chance to implement the e-Livestock.

Although the application of the e-Livestock system in Indonesia has not been implemented back then, the research on e-Livestock has inspired the birth of several related studies. Santoni et al. (2015) proposed an automatic identification system to recognize an individual cattle race using Gray Level Co-occurrence Matrix-Convolutional Neural Networks (GLCM-CNN). Santoni et al. (2015) claim that the proposed identification system can be used in the e-Livestock system in Indonesia. The highest accuracy obtained by Santoni et al. (2015) identification system is 93.763% accuracy. However, the proposed identification system needs a clear image of every cattle that should be taken by a sophisticated camera. Not to mention the long computation process, it can hinder real application in the field. In fact, if it is to be implemented simultaneously in all regions of Indonesia, an identification method that is cheap and easy to apply is needed.

Subagyo and Ardiansyah (2020) used the work of Ramadhan et al. (2011) about the e-Livestock paradigm as their reference in building the prototype of Integrated Livestock Recording Application with Animal Identification and Certification System in district level that is in the Kebumen district. However, the prototype is only for a small district level, specific for the local Kebumen situation only, and cannot be translated easily across all of Indonesia's territory. Indonesia is a large country with various cultures and geographical barriers, a more comprehensive consideration is needed if we want to apply such a system to all regions of Indonesia. In addition, the prototype has yet to be implemented on a real system and needs further testing.

Golubenkov et al. (2021) used the work of Ramadhan et al. (2014) about e-Livestock as their reference in conducting their research. They agree with Ramadhan et al. (2014) that a DSS can be built to help the government in decision-making relating to livestock. Golubenkov et al. (2021) built a Decision Support System for Veterinary Control, and the results are still in the form of a proposition DSS model. They said that there is still a need for further research to develop methods for preliminary data processing and to increase accuracy.

2.2. Similar systems in other countries

Several countries have implemented systems for identification, registration, documentation, and traceability for cows, for example, the Netherlands (RVO 2021a), Australia (Animal Health Australia 2015a), and Japan (NLBC 2020a). The comparison of the identification, registration, documentation, and traceability processes between the Netherlands, Australia, and Japan can be seen in Table 1. We choose to review the system in Netherland and Japan because both of them are developing countries and have a historical relationship with Indonesia. We also review the system in Australia because Australia is the biggest closest developing country of Indonesia and as a neighbor, we deem it

Table 1. Comparison of identification, registration, documentation and traceability processes.

No	Country	Identification	Registration	Documentation	Traceability
1	Netherlands	Yes; Using 2 regular ear tags	Yes; birth, cattle delivered to the UBN, cattle removed from the UBN, import, export, animal to the slaughterhouse, and death	Yes; A document called passport	Yes; https://mijn.rvo.nl/login%20and%20I%26R%20Animal%20app
2	Australia	Yes; Using RFID in the form of single ear tag, or a rumen bolus/visual ear tag combination	Yes; Especially in cattle movement	Yes; A document called NVD	Yes; https://www.nlis.com.au/
3	Japan	Yes; Using regular ear tag	Yes cattle are born (or imported), move-in/out incoming/outgoing transfer, and slaughtered/death	-	Yes https://www.id.nlbc.go.jp/top.html?pc
4	Indonesia	Will be investigated in this research. The result can be seen in sub-section 4.1 to sub-section 4.5			

necessary to study it. In addition, Australia is one of the pioneers of cattle traceback systems in the world (Animal Health Australia 2015a; Tonsor and Schroeder 2006).

Netherland is one of the first European Union (EU) member countries that introduced the regulations of animal health care (NRS 2000). The system in the Netherlands is called the Identification and Registration (I&R) system (Santman-Berends et al., 2016). All cattle in the Netherlands must have 2 (two) ear tags as an identification tool (RVO 2021a). An ear tag has to be applied to both ears within 3 working days after a calf is born (RVO 2021a). Then the calf must be reported with a birth notification in the I&R system (RVO 2021a). The ear tags used can be in the form of regular plastic ear tags or can also be RFID ear tags (RVO 2021b). This shows that the Netherlands does not force the use of sophisticated technology as an identification tool. Each animal is assigned a unique animal identification number (Santman-Berends et al., 2016). In addition, each location that maintains or stores cattle is also assigned an identification number in the form of a Unique Business Number (UBN) (RVO 2021d). Parties required to have UBN are livestock farmers, hobby animal keepers, slaughter sites, gathering places (e.g. a cattle market), and events (e.g. an inspection) (RVO 2021d).

In the Netherlands, the reporting (registration) process is carried out when (RVO 2021c): birth, cattle delivered to the UBN, cattle removed from the UBN, import, export, animal to the slaughterhouse, and death. The registration process is carried out through the I&R system website at the address https://mijn.rvo.nl/runderen-melden. Apart from using the I&R website, registration can also be done using the Business Management System (BMS) software that feeds data directly into I&R (RVO 2021c). A Voice Response System (VRS) can also be used to do the registration (RVO 2021c). Users can submit a birth, supply, removal, and death notification of cattle through the VRS (RVO 2021c). All of the cattle data can be traced through the I&R website. Every cattle in European Union (EU) member (including the Netherlands) has to be given documentation called a passport within 2 weeks of being born or imported, and the document must accompany the cattle whenever it is moved and be handed in on its death (EU 2017). The tracing process for cattle data can be done using the I&R website or through the I&R Animal app (RVO 2021e).

Since the 1960s, Australia has had a cattle-tracing system (Animal Health Australia 2015a; Tonsor and Schroeder 2006). Initially, the system was created to assist the bovine Brucellosis and Tuberculosis Eradication Campaign (BTEC) (Animal Health Australia 2015a). Then, in January 1999, the National Livestock Identification System (NLIS) was introduced voluntarily in the State of Victoria (Animal Health Australia 2015a; PwC 2006). NLIS then becomes mandatory in all states and territories of Australia since 2005 (Animal Health Australia 2015a; Schroeder and Tonsor 2012).

NLIS is the system that is used for the permanent identification and lifetime traceability of livestock in Australia (Animal Health Australia 2018). It is "s a permanent whole-of-life system that allows individual animals to be identified electronically and tracked from property of birth to slaughter" (Meat and Livestock Australia 2020). One of the animals recorded in the NLIS is the cattle (Animal Health Australia 2015b). There are two identifications carried out on the NLIS, namely identification of cattle and identification of a physical location for the cattle (Animal Health Australia 2018). The location where the cattle are born or kept is referred to as the "property" and is identified using a Property Identification Code (PIC) (Animal Health Australia 2018). All animals in a property must be identified with an NLIS accredited device (Integrity Systems Company 2019a). The accredited devices for cattle must be in the form of an RFID device (Integrity Systems Company 2019a). The RFID device can be either a single ear tag or a rumen bolus/visual ear tag combination (Integrity Systems Company 2019a). "Each RFID contains a microchip encoded with a unique number that is linked to the PIC of the animal's property of birth" (Animal Health Australia 2015b). Cattle can be electronically scanned as they move through the livestock chain (Animal Health Australia 2015b). Each time Cattle are moved off a PIC, for example through a buying and selling process, then the movement must be recorded on the NLIS Database (Integrity Systems Company 2019b). The NLIS Database is managed by NLIS.Ltd (Animal Health Australia 2015b).

To ensure the quality of cattle that is being moved, it needs to be accompanied by a document called the National Vendor Declaration (NVD). The document acts as movement documentation throughout the value chain (Integrity Systems Company 2019c). It communicates the food safety and treatment status of every cattle every time it moves along the value chain (Integrity Systems Company 2019c). It is a legal document that is key to Australian red meat's traceability and market access (Integrity Systems Company 2019c). The cattle data can be traced through the NLIS website, namely at https://www.nlis.com.au/.

In 2003, Japan enforces The Beef Traceability Law or the full name is "The Law for Special Measures Concerning the Management and Relay of Information for Individual Identification of Cattle" (NLBC 2018; The Beef Traceability Law 2003; Mathews 2008). Based on the law, each cattle must be identified and registered in a system called the Individual Cattle Identification Register (The Beef Traceability Law 2003; Fujimoto et al., 2020). The system is managed by a government agency called National Livestock Breeding Center (NLBC) (NLBC 2018).

The identification tool that is used in Japan can be in the form of a regular flexible plastic ear tag (NLBC 2020a). It is not required to use the RFID identification tool. Each ear tag is equipped with Individual Identification Numbers (The Beef Traceability Law 2003). Notification (registration) must be done when (NLBC 2018; NLBC 2020b): cattle are born (or imported), move-in/out incoming/outgoing transfer, and slaughtered/death. Based on The Beef Traceability Law (2003), those who do the notification are livestock managers who are livestock managers, importers, a person who has received cattle (e.g. buyers), and slaughterers. Notifications can be made through the notification web system at the address https://www.cid.nlbc.go.jp/wns/authentication.action (NLBC 2020c). Apart from the website, notifications can also be made via (NLBC 2020c): telephone voice answer system, dedicated software for reporting that is based on e-mail function (called LO System), intra report system using closed net (intranet), and fax. General users can trace cow data through the address https://www.id.nlbc.go.jp/top.html?pc.

Based on Table 1, it can be seen that regular ear tags are still used in the Netherlands and Japan. This is in accordance with what was stated by Bai et al. (2017), that regular ear tags are the most widely used identifications of animals in many countries. One of the reasons regular ear tags still in used is due to its low cost (Bai et al., 2017). Many researchers encourage that the tag costs have to be reduced (Awad 2016).

The use of RFID technology in ear tags is quite promising, but there are still many obstacles, especially in terms of cost and technical requirements (Islam and Cullen 2021). To run the RFID system properly, it is necessary to provide RFID tags (transponders), an RFID reader, and a management host or server (Awad 2016). these things make the application of RFID will require a greater cost than the use of regular ear tags. In addition, the RFID system also needs professional and skilled personnel (Qiao et al., 2021). A skilled person is needed to do the initial installation of the RFID ear tag, and it also requires continuous system operation and management (Awad 2016). The training cost for every farm owner should also be taken into consideration if the RFID-based identification system will be used as a national identification tool (Awad 2016). Moreover, several data security issues also restricted the applications of RFID, such as tag-content changes and the high possibility of system spoofing (Qiao et al., 2021).

In addition to the use of regular ear tags and RFID ear tags, the cattle biometrics and visual features have emerged as a promising cattle identification mechanism (Qiao et al., 2021). The new mechanism can be classified into four categories (Qiao et al., 2021): cattle muzzle (Kusakunniran et al., 2018), iris (Lu et al., 2014), facial (Kumar et al., 2017), and coat pattern (Andrew et al., 2016). However, that modern biometric-based methods still require further research before large-scale applications (Awad 2016). They also still need biometric databases, feature and algorithm standardization, and experimental benchmarks (Awad 2016).

From Table 1 it can be seen that all of the reviewed countries are do the registration process. Some of them are used a certain document that should accompany the cattle were ever it moves. All of the reviewed countries save their data into the database so that it can further be used for traceability. The use of ICT in the form of a database as data recording mediums can also be used to provide faster information retrieval, allow data standardization, and enable more detailed analysis (Islam and Cullen 2021). All of them used a website system to provide the traceability of their cattle data. Users can reach the system using internet technologies.

All of the systems that have been implemented in the Netherlands, Australia, and Japan are not immediately applicable in Indonesia. It is necessary to study more deeply what is the right approach for the situation in Indonesia. Therefore, we also try to compare several indicators that we think need to be considered when developing business process models for e-Livestock in Indonesia. Several indicators and their respective values for each country can be seen in Table 2. The year we chose was 2019 data, because in that year the data were available in full from the data sources that we used in this comparison.

Based on Table 2, it can be seen that Indonesia has a very small GDP per capita when compared to the Netherlands, Australia, and Japan. This shows that the factor of Indonesia's economic resources must be highly considered. The low purchasing power of farmers can hinder the implementation of e-Livestock if they have to buy certain expensive and burdensome equipment. The purchasing power of farmers can be seen based on the Livestock Farmers Exchange Rate (LFER), which is a value that indicates the exchangeability level of goods (products) produced by the farmers in the rural to the goods/services required for household consumption and for purposes in agricultural production processes (DGLAH 2020). Based on the 2020 Livestock and Animal Health Statistics document, issued by DGLAH (2020), it can be seen that the latest average LFER value in Indonesia is only 108.05 (DGLAH 2020). This value is still far from the target set by the Indonesian government, which is 115–120 (Suardika et al. 2015).

Farmers in Indonesia are dominated by small farmers who only have a few cows in their management. This is different from the characteristics of farmers in the Netherlands, Australia, and Japan who can have hundreds to thousands of cows in their management. As stated in the latest results of the Livestock Business Household Survey issued by the Indonesian Central Bureau of Statistics (CBS 2015), that of 5,077,045 beef cattle farming businesses in Indonesia, 99.96% are in the form of household farms. Then, 94.93% of them only rely on their own capital, did not receive any financial assistance, so it is difficult to develop their business let alone buy the latest technology. The document also shows that 30.70% of farmers in Indonesia have not completed primary school, while 44.65% have completed primary school. This means that only 24.65% of farmers have upper secondary education. In fact, only 1.74% managed to get a higher education. Thus, the application of sophisticated technology to farmers in Indonesia is not an easy thing. This was also confirmed in the results of the 2018 Inter-Censal Agricultural Survey which showed that 85.69% of livestock in Indonesia are not using agricultural technology (CBS 2019). So, in terms of developing e-Livestock in Indonesia, it is necessary to consider choosing a technology that is simple, easy to understand by farmers, and acceptable to farmers, so that they are willing to voluntarily follow the given business process models.

The livestock business in Indonesia is mostly done in rural areas. Some of them are still not reachable by electricity. Not all areas of Indonesia are covered by electricity. In terms of technology application, access to electricity is very important. In addition, based on Table 2, it can be seen that internet literacy in Indonesia is also very low. Only 48

Table 2. Comparison of several related indicators in the Netherlands, Australia, Japan and Indonesia.

No	Indicator	Netherlands	Australia	Japan	Indonesia	Source
1	GDP per capita (in US$)	52,295.0	55,057.2	40,113.1	4,135.2	WorldBank (2021a)
2	Total Population	17,344,874	25,365,745	126,264,931	270,625,567	WorldBank (2021b)
3	Rural population (% of total population)	8	14	8	44	WorldBank (2021c)
4	Access to electricity (% of population)	100.0	100.0	100.0	98.8	WorldBank (2021d)
5	Individuals using the Internet (% of population)	93	87	91	48	WorldBank (2021e)
6	Fixed broadband subscriptions (per 100 people)	43.63	34.73	33.50	3.80	WorldBank (2021f)

percent of Indonesia's population uses the internet. This is very different when compared to Netherlands, Australia, and Japan whose percentage is already above 85%. Thus, considering internet technology in the application of e-livestock will be a very challenging thing. Indeed, the use of the internet is a necessary thing, but it is also necessary to consider how to educate farmers on how to access and use it. Moreover, only 3.80 per 100 Indonesians have access to fixed broadband. So it seems that the choice of technology that relies on fixed broadband as an infrastructure backbone has not become the right choice in Indonesia at this time. Lightweight and accessible infrastructure with low bandwidth needs to be considered. Including, in this case, it is also necessary to consider that the data to be registered and passed will not burden the bandwidth. It seems that simple text data that is inputted through a website portal will be a reasonable choice. Another consideration is the shape of the Indonesian territory in the form of an archipelago consisting of thousands of islands, some of which are remote islands that are difficult to access. This, of course, is different from the Netherlands, Australia, and Japan. Therefore, simple business process models will be a good alternative for e-Livestock in Indonesia today. So that e-Livestock can be immediately implemented without being hindered by economic, educational, and technological barriers.

Currently, the Indonesian government has launched a new beef self-sufficiency program, namely the 2026 beef self-sufficiency program (Ministry of Agriculture of the Republic of Indonesia 2019). The fact that the PSDS 2014 (that is the beef self-sufficiency program of 2014) failed without having the opportunity to implement the e-Livestock system, has opened our hopes that research on e-Livestock in Indonesia can be reinstated to support this new program. This research of modeling e-Livestock Indonesia was carried out based on previous researches on e-Livestock. The experiences from the above countries are also taken into consideration. Until now, no journal or conference paper proposes the business process models of identification, registration, documentation, and traceability of e-Livestock in Indonesia. This research can fill that voids. The results of this research can also be a tool for the Indonesian government to achieve the target of the beef self-sufficiency program in 2026.

3. Research methodology

e-Livestock is considered as one of the e-Government initiatives. There are many aspects that must be considered in an e-Government initiative and can be very complex. The complete model of e-Government gives attention to political, economical, environmental, cultural, people, financial, and technical aspects (Heeks 2006). Those aspects can not be observed separately but should be observed as a whole, where there are a lot of interactions in it. Such characteristics can be solved using systems thinking.

e-Government consists of soft components and hard components (Heeks 2006). It could be argued that the soft components of e-Governments are people, information, and processes, whereas the hard components are the ICT being used (Potnis 2010). The soft components are likely inspired by social sciences, it covers social issues (Fasanghari and Habibipour 2009), it tends to be subjective, qualitative, and further highlights by the aspects of humanism (Heeks 2006). The hard component is inspired by engineering science, it tends to be objective, quantitative and further highlights by the technical aspects (Heeks 2006). The social and technical aspects of e-Government are deeply entangled (Iannaccia et al., 2019). However, it is implied by Heeks (2006), that the most critical factor to determine whether an e-Government system development fails or not is the soft component. Because the soft component is very dominating and is tend to be subjective, we suggest that one type of systems thinking, that is soft systems thinking, can be used in e-Livestock.

Systems thinking is best used on a problem that has many interdependencies (Richmond 1991). The greater interdependence in a problem, then systems thinking is more required (Richmond 1991). Another advantage of using systems thinking is that perspectives of different stakeholders can be considered in systems thinking (Larsson 2009). This advantage is what will be the basis of this research rationale to use systems thinking in a deal with conflict of interest that exists in e-Livestock.

There are two forms of systems thinking, i.e. hard systems thinking and soft systems thinking (Anandhi 2017). "Hard systems thinking assumes the world is mechanic, that is, contains systems which can be modeled and 'engineered'" (Mirijamdotter 1998). “Hard systems thinkers assume reality to be objective, that is the reality looks the same regardless of who is the observer” (Mirijamdotter 1998). Hard systems thinking is used to solve well-defined problems (Zeleznik et al., 2017). Hard system thinking argues that building the system simply requires using the proper elements, it views each element of a system as objectively ascertained (Anandhi 2017).

“Soft systems thinking do not assume that the world is systemic and well-ordered; on the contrary, it assumes social reality to be 'problematic', characterized by multiple angles of approaches and perspectives” (Mirijamdotter 1998). “The understanding of reality is dependent upon the observer, his interpretations and what he chooses to focus on” (Mirijamdotter 1998). It can be concluded that soft systems thinking tends to suitable for interpretive research, and suitable for complex problems (Nurani et al., 2018). It is suitable in the context that is systemic, complex, and not easily quantifiable (Weaver et al., 2018).

Checkland (2000) illustrates the differences between a hard system with a soft system. Some of the methodologies that can be used in hard systems thinking are Systems Analysis (SA), Operations Research (OR), and Systems Engineering (SE) (Jackson 2003). A methodology that is suitable for soft systems thinking is Soft Systems Methodology (SSM) as proposed by Checkland (1981). SSM can be used to examine complex socio-technical systems (e-Government) using systems thinking (Linders et al., 2018). It also includes and provides several tools for exploring, integrating, and accommodating diverse perspectives, experiences, and ideas (Linders et al., 2018).

Hirschheim et al. (1997) call SSM as one of the 'alternative' approaches in information system development. Apart from SSM, there are four other approaches that are also considered as alternatives to traditional approaches, namely the Interactionist approach, the Speech Act-based approach, the Trade Unionist approach, and the Professional Work Practices approach. The interactionist approach is more about the information system development approach without any concrete information system development methodology instance (Iivari et al., 1998). Meanwhile, SSM has a number of information system development methodology instances and has a number of strengths in the area of problem formulation (Hirschheim et al., 1997). From that standpoint, we argue that SSM is more suitable for this research, especially for one of this research objectives that is to draw the current problem that arises in livestock management in Indonesia and a clear methodological step is needed to guide the attempt. Furthermore, as explained by Iivari and Hirschheim (1996), the Interactionist approach has a strong orientation on the social aspects. Meanwhile, SSM has a balance orientation to technical aspects and also to social aspects (Iivari and Hirschheim 1996). From this point of view, we think that SSM is more suitable for this research because e-Livestock is an e-Government initiative. As explain by Heeks (2006) that the e-Government initiative has to consider technical and social aspects.

Like the Interactionist approach, the Speech Act-based approach is also has a strong orientation on social aspects, and no orientation to technical aspects (Iivari and Hirschheim 1996). The Speech Act-based approach also is considered a very complex approach, and it has led to a number of methodologies or methodology fragments (Hirschheim et al., 1997). On the other hand, SSM is relatively complete and has a well-documented methodology, furthermore, SSM is not only better than the Speech Act-based approach but also better than the other three approaches (Hirschheim et al., 1997). Based on those considerations we choose SSM than the Speech Act-based approach.

In contrast to SSM, which has a balanced orientation to technical and social aspects, the Trade Unionist approach has a more strong orientation to the technical aspect and a weak orientation to social aspects (Iivari and Hirschheim 1996). In the epistemology view, the Trade Unionist approach is primarily positivistic, while SSM has dualistic epistemology and accommodates interpretive views (Iivari et al., 1998). Because of those characteristics, we choose SSM in this research. SSM reflects the soft systems thinking that is related to the interpretive view. Again, e-Livestock as an e-Government initiative considers both technical aspects and social aspects that are suitable to the orientation of SSM.

The Professional Work Practices approach also includes both technical and social aspects (Iivari et al., 1998). However Professional Work Practices approach is more focused on the systems development profession than on the users (Iivari et al., 1998). This is different from our research concern, which takes into account the opinions of users, especially stakeholders of e-Livestock. Thus we chose SSM over the Professional Work Practices approach. In addition, SSM is also better in terms of a clear framework for the reflection and comparison from the experience, especially between the current condition and desirable outcome, as (Hirschheim et al., 1997) stated that "Almost ironically, the PWP approach has failed to see the importance of methods in this process of reflection and learning, not as methods to be followed obediently, but as intellectual frameworks with which the experience can be compared and reflected upon (cf. SSM above)."

Although SSM emerged a long time ago, many recent studies still adopt SSM, because SSM is very suitable for analysis and problem-solving in complex and messy situations (Kamari et al., 2017). Several recent studies that adopt SSM are like those done by Raharja et al. (2020) in agricultural technology, Zeleznik et al. (2017) in nursing education, Lami and Tavella (2019) in decision support research, Nurani et al. (2018) in fishery, Weaver et al. (2018) in responsible business practice, Hindle and Vidgen (2018) in business analytics, and Linders et al. (2018) in e-Government systems analysis.

We consider that the e-Livestock initiative involves technical and social aspects, complex, has many interdependencies, very problematical and its characteristics are very suitable for soft systems thinking. Based on our comparison to the other approaches and the evidence of successful cases in soft system thinking problems, then we decided to employ the 7 steps of SSM that were initially proposed by Checkland (1981).

The e-Livestock success factors that have been revealed by Ramadhan et al. (2013) were also used in this study and were mixed in the work of step 7 of SSM. Several new technologies may have emerged since the success factors were compiled. However, as stated by Bai et al. (2017) that sophisticated technology cannot be directly adopted, especially for massive use on a national scale. Economic limitations and large costs in the country must be considered (Islam and Cullen 2021; Bai et al., 2017). The large digital divide between regions in Indonesia (Agustina and Pramana 2018) also needs to be considered. In addition, until now there has been no other research that has revised the list of success factors that has been made by Ramadhan et al. (2013), especially for Indonesia. The success factors were compiled by involving 32 stakeholders and experts in the field of ICT and livestock in Indonesia. The success factor has accommodated broad aspects (technical and social aspects) in relation to e-Livestock in Indonesia. Thus the list of success factors will still be used in this research. We consider that Indonesia should start immediately, even if the technology requirements are simple. Huge quantum leaps and the imposition of high-level technology will slow the start of e-Livestock implementation. After e-Livestock is implemented in Indonesia, incremental improvement and further research can be carried out for the extension of e-Livestock.

In this research, the SSM will also be enriched with two other methods, which are the Focus Group Discussion (as suggested by Ramadhan et al. (2011)) and hermeneutics (as suggested by Sensuse and Ramadhan (2012)). The FGD will be used in step 7 of SSM. The hermeneutic will be blended in step 1 of SSM. The term hermeneutics is derived from the word 'Hermes', which is "the Greek god of communication, the borders, the limits" (Barojas 2008). It "represents the crossing of paths and the coincidence of moments" (Barojas 2008). Hermeneutics is usually used in interpretive research. Pedron and Saccol (2009) consider hermeneutics as a "philosophy of the interpretation of meaning".

Hermeneutics initially is about "a way of understanding textual data" (Myers 1997). Nowadays, hermeneutics also can be used for understanding a text analog (e.g. an organization or a record that has been created by authors) (Myers 1997). Hermeneutics was originally used to understand sacred texts and law. Hermeneutics is very related to the reading process (O'Farrill 2008). Stahl (2008) stated that hermeneutics is "the art of understanding of all communication, not just written text". Mottier (2005) said that can also be used to observe social practices.

Hermeneutics interpretation is conducted using a fundamental principle called the hermeneutic circle (Klein and Myers 1999). In this research, the hermeneutics interpretation will be conducted using the Atlas.ti software. Therefore, we will adopt several steps which are generally used in Atlas.ti that has been explained by Friese (2011). However, we adapt those steps to become 3 simple steps i.e.:

1. Preparing primary documents
2. Conducting coding process
3. Linking the codes into network and interpreting the network.

One of the foremost results in this research is the business process models of e-Livestock in Indonesia. As revealed by Recker et al. (2009), among the symbolic business process models, only Business Process Modeling Notation (BPMN) that able to cover all aspects of things. "BPMN appears to denote a considerable improvement compared to other techniques" (Recker et al., 2009). By taking into consideration what has been revealed by Recker et al. (2009), the Business Process Modeling Notation 2.0 (BPMN 2.0) will be used to deliver the business process models in this research. BPMN 2.0 is one of the most used notations in business process modeling. This notation is supported by the Object Management Group that consists of some leading companies in computer and information systems.

4. Results

4.1. Identifying the problem situation

As previously stated, the definition of e-Livestock in Indonesia is an "e-Government system that is mandatory for the identification, registration, documentation, and traceability of cows in Indonesia, starting from birth to death" (Ramadhan et al., 2012). Therefore in this sub-section, we want to identify how is the current condition of the identification, registration, documentation, and traceability of cows in Indonesia. To get the answers, some interviews with several stakeholders and experts of livestock in Indonesia are conducted. It is in line with the result of research by Ramadhan et al. (2013), that one of the success factors for e-Livestock in Indonesia is "User and Stakeholder involvement".

The list of the interviewees is shown in Table 11 in the Appendix. There are 28 experts and stakeholders of livestock in Indonesia who are interviewed. The 23 of them are interviewed face to face (recorded), and 5 are done online via email. The questions are also listed in the Appendix.

All of the questions are open, allowing the emergence of a variety of other questions spontaneously to enrich our interview. A summary of the answers from 28 stakeholders for the 5 questions above can be seen in Table 12 in the Appendix. Based on the summary of the results of interviews in Table 12, some terms need further exploration, for example, KUPS, Good Breeding Practice, Regional Regulation, Artificial Insemination (AI), and others. Therefore, we also collect and analyze the various regulations relating to such matters. Some of the other regulations that we think are relevant are also included in the analysis.

There are 207 relevant regulations included in the analysis. The regulation consists of various levels, ranging from national law (it is called "UU" in Bahasa Indonesia) to a letter of order from the Director of Directorate General of Livestock (it is called "Surat Edaran Dirjen

Peternakan" ini Bahasa Indonesia). For the regional regulations, we follow the approach of Seminar et al. (2010), that is by taking into account only 5 provinces that are known to have special attention to beef cattle.

In addition to those regulations, we also analyzed a wide range of other supporting documents, such as the result of research that have been conducted by the Directorate General of Livestock and Japan International Cooperation Agency (JICA) in 2010, ISO/SNI documents, the blueprint of PSDS, the profile of some UPTs and others. We included 162 additional documents in the analysis. Thus, in total there are 369 documents in the analysis, to find out how the current state of the identification, registration, documentation, and traceability of cows in Indonesia.

The 369 documents are analyzed using hermeneutic interpretation. There are three steps of this process, i.e.:

1. Preparing Primary Documents
   From about 369 documents that have been attained, we do some filtering mechanisms to choose some documents that are appropriate enough to become a Primary Document. We read and study the contents of all documents one by one, and see if the document indeed discussed in depth the interest. We remove documents that are no related or only discuss them briefly. We also consider the relationship among the documents when performing the filtering. From the results of this filtration process, it can be obtained 74 documents that are appropriate enough to become Primary Documents.
   Of 74 documents, there are 63 regulations and 11 supporting documents. At this step, we put all the 74 Primary Documents into Atlas.ti.
2. Conducting the Coding Process
   At this step, the coding process is conducted to the 74 Primary Documents. The coding process was done by giving some Codes to some words, phrases, sentences, paragraphs, or images that exist in the Primary Document.
   There are two main groups that are given a Code, i.e.:

   a. Entity
   In this group, there were 21 Codes made, that are BIB, BPTU, Other UPTs, UPTD, Dinas Kabupaten/Kota, Dinas Provinsi, Researcher, Company, Inseminator, Animal Quarantine, Kelompok Peternak, Cooperation, Animal Market, Pemerintah Pusat/Ditjen PKH, Cow, Farmer, Puskeswan, RPH, SMD, Public and Animal Health Officer.
   To avoid the loss of meaning, then we still use the original language of some codes when we refer to that codes in the subsequent explanations. However, to help English speaker, we put the meaning of those code in English in Table 3.
   b. Relation between two entities
   The relationship that is given a Code, is a relation that shows potential problems that are or might be or currently happening between the two entities.

3. Linking the codes into network and interpreting the network
   In the Atlas.ti, the parts that have been coded are called the Quotes. In this step, we read all Quotes, and then looking for their association with one another. we are not just looking for an association between Quotes that have the same Code, but also looking for an association between Quotes with different Codes. Based on the understanding of all Quotes, then we create a network among all Codes. We describe the network in the form of a Rich Picture Diagram as shown in Figure 2 in the next section.

4.2. Expressing the problem situation

This is the second step of SSM. Based on the results in the above subsection, we create a Rich Picture Diagram as shown in Figure 2. A relation is marked with an X, indicates potential or existing problems between the two related entities. A code number is given to each X, each of them then is explained in detail in the Appendix.

Table 3. The meaning of some codes in english.

Code	In English
BIB	Artificial Insemination Center (one kind of technical services unit in Indonesia)
BPTU	Superior Livestock Breeding Center (one kind of technical services unit in Indonesia)
UPT	Technical Services Unit
UPTD	Regional Technical Services Unit
Dinas Kabupaten/Kota	Regency/City Livestock Agency
Dinas Provinsi	Province Livestock Agency
Inseminator	Inseminator
Kelompok Peternak	Group of livestock owners
Pemerintah Pusat/Ditjen PKH	Central Government/Directorate General of Livestock and Animal Health (DGLAH)
Puskeswan	Animal Health Center
RPH	Slaughteringhouse
SMD	Bachelor that assigned by central government to build his village

4.3. Determining the root definition

In this third step, the CATWOE analysis is performed. The CATWOE analysis consists of (Checkland and Scholes 1999):

1. C, "Customer": The victims of the beneficiaries of T
2. A, "Actor": Those who would do T
3. T, "Transformation": The conversion of input to output. Input is the pre-existing condition of the system, while the output is the condition after a system is established.
   Transformation examples:
   a. Unpainted fence → Painted fence
   b. The usual governmental administration → The governmental administration is better after adapting the computer technology
4. W," Weltanschauung": The world view which makes this T meaningful in context.
   W is closely related to T. For the same system, the T can vary, depending on the W. For example, for a public library, T can be:
   a. Books and other materials on the shelves→ Books and other materials out in the local community
   b. Printed books → Online books
   Examples of W for the T in the previous explanation is:
   a. Amateur painter can paint the fence easily
   b. Computer technology can improve efficiency
5. O, "Owner": Whose who could stop T
6. E, "Environment constraints": Elements outside the system which it takes as given
   The result of CATWOE analysis for the e-Livestock are as follows:

1. C: Public, Pemerintah Pusat/Ditjen PKH, Dinas Provinsi, Dinas Kabupaten/Kota, Puskeswan, BPTU, BIB, Other UPTs, Cooperation, Company, Researcher, SMD, RPH, Farmer, Kelompok Peternak, Inseminator, Animal Health Officer, Animal Quarantine, Animal Market.
2. A: Livestock Registration Officer (PPT), Inseminator, Animal Health Officer, Pemerintah Pusat/Ditjen PKH, Dinas Provinsi, Dinas Kabupaten/Kota.
3. T: Cows data are unmanaged and can not be traced easily → Cows data are managed and can be traced easily
4. W: Information systems and information technology can make the management and tracking of data easier and efficient.
5. E: Local autonomy, Public Information Freedom, Indonesia has a wide area, Some of the areas in of Indonesia are hard to reach.

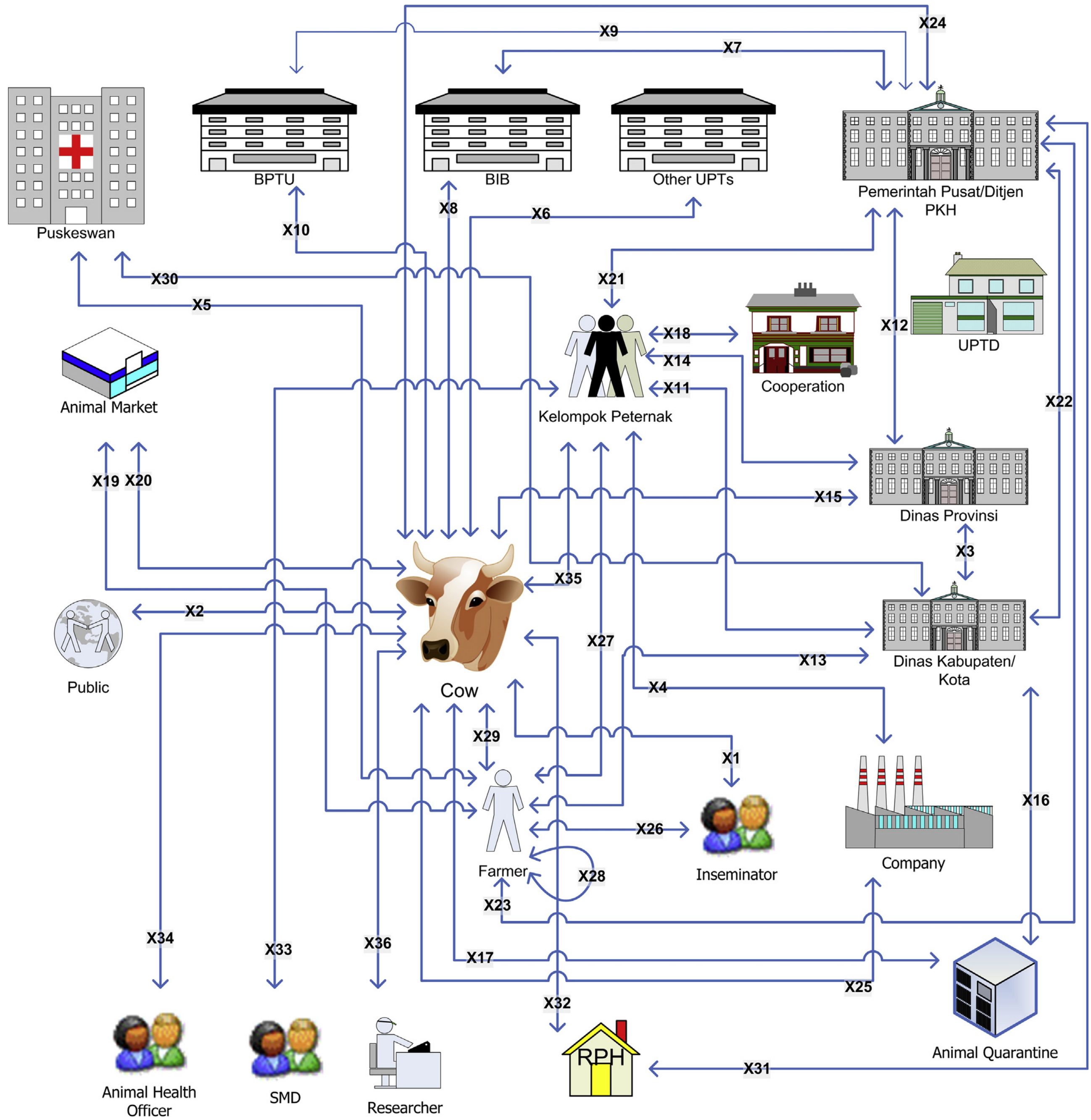

Figure 2. Rich picture diagram.

4.4. Constructing conceptual model

The conceptual model consists of the minimum activities that must exist for Transformations (T) can occur (Checkland and Scholes 1999). "The models consist of some activities, each with a significant verb, structured in a logical sequence and representing those minimum activities that are necessary to achieve the transformation enshrined in the root definition" (Jackson 2003). Only verb or verb phrase that can be used in the conceptual model (Kang and Hu 2010). Activities in the conceptual model are ordered by a logical sequence (Kang and Hu 2010). Generally, the amount of activities in the conceptual model is 7 +/- 2 (Checkland and Scholes 1999). Based on the CATWOE analysis and the definition of e-Livestock, then the conceptual model for e-Livestock is as shown in Figure 3.

4.5. Comparing conceptual model with the real world and make a list of changes that should be done

These are the fifth and sixth steps of SSM. As demonstrated by Checkland and Scholes (1999), the comparison is done by creating a table that consists of several columns. Generally, there are two columns, one column represents the activity in the conceptual model and the other column is explains the current state of the related activity.

The results of this comparison will bring up a list of changes that must be made to the current conditions so that the system successfully be implemented. Ngai et al. (2012) showed that the list of changes is also directly shown in the comparison table, which is in the third column. In this step, we will adopt it. The changes that "feasible and desirable" are listed and considered (Checkland 1981). This list of change can help

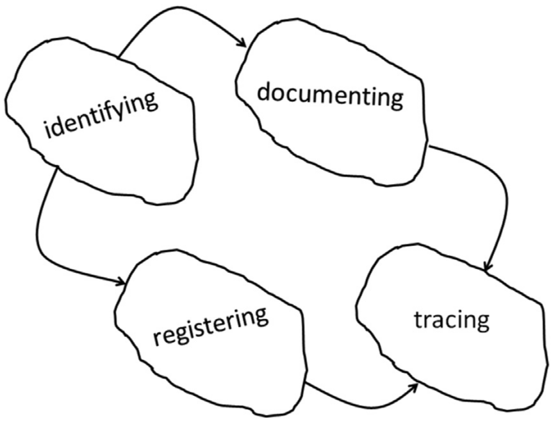

Figure 3. Conceptual model.

government institution to build a “Good planning”, that is also one of the success factors for e-Livestock in Indonesia. The results of the comparison between the conceptual model and the real world can be seen in Table 4.

In addition to the existing list of changes in Table 4 above. Some other changes that are feasible and desirable are:

9. Define the functional system requirement of the e-Livestock
10. Making suggestions of what things should be considered when socializing the e-Livestock
11. Revealing the institutional aspect of e-Livestock
12. Making suggestions on what things should be accommodated in the forthcoming regulations that will underlie e-Livestock
13. Create a conceptual infrastructure diagram
14. Validating the models
15. Determine The Complexity of Business Process Models

4.5.1. Identification: current conditions in the real world

Some regions in Indonesia already identified using an ear tag (see Figure 4), the burn stamp (see Figure 5), the cutting ears (Figure 6), or painting (see Figure 7). All of them are done it locally or limited as personal interest In the guideline that is issued by the government, there are also be suggested a variety of identification tools, such as a regular ear tag, as set out in the Guideline of Artificial Insemination Optimization (Pedoman Optimalisasi Inseminasi Buatan) and also in the Guidelines for Beef Cattle Performance Test (Pedoman Pelaksanaan Uji Performan Sapi Potong) (see the example in Figure 8). By contrast, in the Minister of Agriculture Regulation No.: 40/Permentan/PD.400/9/2009, the identification tool that is used is a microchip/Radio Frequency Identification (RFID). Even so, it turns out, that the microchip is still shaped like a regular ear tag.

Figure 4. Ear tag.

4.5.2. Registration: current conditions in the real world

Currently, there are some government regulations that regulate what is to be registered from a cow. However, the business process of registration activities is not explained. Those regulations are specific only for the particular activity, e.g. for breeding. Because there are no regulations that force registration for all activities, registration is only done locally and individually.

Some of those regulations are:

1. Technical Guidelines for the Development of Beef Cattle Breeding (Pedoman Teknis Pengembangan Pembibitan Sapi Potong) in 2012. The data that needs to be registered are: name/number of ear tag; elders (mother and father); birth (date, birth weight and sex); weaning (day, weaning weight); mating (date of mating and the

Figure 5. Burn stamp.

Table 4. The comparison between the conceptual model and the real world.

No	Activity	Current conditions	List of changes
1	Identifying	Not all of the Customers do the identification, the identification tool is not uniform, and the business process for identification is not clear. More explained in Subsection 4.5.1.	1 Modeling the business processes of the identification activities 2 Determining the identification tool that applies nationally 3 Defining the rules for location identification numbering
2	Registering	Not all of the actors do the registration, the data that need to be registered are not clear, and the business process for registration is also not clear. More explained in Subsection 4.5.2.	4 Modeling the business processes of the registration activities 5 Determining what data should be registered
3	Documenting	Not all customers formally do the documentation, the existing forms of documentation vary, the business process of documentation that applies nationally is not clear. More explained in Subsection 4.5.3.	6 Modeling the business processes of the documentation activities 7 Determining the form of ownership documentation
4	Tracing	The business process of tracking (traceability) nationwide is unclear. It can even be said the search process can not be done at all because there is no system that can accommodate it.	8 Modeling the business processes of the tracing activities

Figure 6. Cutting ears.

Figure 7. Painting.

Figure 8. The form of the proposed ear tag in the Guideline of Artificial Insemination Optimization (Pedoman Optimalisasi Inseminasi Buatan).

male/straw code); productivity: birth weight, weaning weight (205 days), weight in 365 days etc.; health status (illness, vaccination, treatment); and mutatiton.

2. Guidelines for Integrated Management of Breeding Cattle (Pedoman Pelaksanaan Manajemen Pembibitan Ternak Terpadu) in 2012. The data that needs to be registered are: pedigree; mating (date of mating/given AI and the male/straw code); give birth (number, date); the birth of the child (date of birth, birth weight); performance measurement, such as the date of measurement, body weight, chest circumference, body length, shoulder height, and it done at the age of weaning (4 months), age 1 year, the age of 1.5 years, and 2 years; Disease (vaccination, treatment); mutation.
3. Guidelines for Beef Cattle Performance Test (Pedoman Pelaksanaan Uji Performan Sapi Potong) in 2012. The data that needs to be registered are: race; age; gender; identification of the cattle; birth; pedigree; weight; hump height; chest circumference; the length of the body; name and address of the owner.
4. The Minister of Agriculture Regulation No.: 36/Permentan/OT.140/8/2006. The data that needs to be registered are: origin; date of birth; date of mating; the elders information; important properties of the breeding value of each type of livestock.
5. The Minister of Agriculture Regulation No.: 54/Permentan/OT.140/10/2006. The data that needs to be registered are: race; pedigree; mating (date; male; AI/natural mating); birth (date, weight); weaning (date, weight); give birth (date; parity); feed (type, consumption); vaccination, treatment (date, kind of treatment); mutation.

4.5.3. Documentation: current conditions in the real world

Based on the results of the interview, the business process of documentation that applies nationally is not clear. Not all customers formally do the documentation, they usually do that in the form of livestock cards (Kartu Ternak). Only a few of them have already done locally or limited as personal interest. There are some forms of existing documentation (Seminar et al., 2010). Some examples of them can be seen in Figure 9.

4.6. Doing various actions to implement the listed changes

In this step, 10 other open questions are asked to the interviewees that are listed in Table 11 in the Appendix. The questions are intended to get their suggestions about the forthcoming implementation of e-Livestock in Indonesia. All of the answers are then transcribed and taken into consideration in the following sub-sections. Those 10 questions are:

1. If e-Livestock is implemented, by taking into account the readiness of infrastructure, education level of farmers, costs, etc., what is the appropriate way or identification tool that should be used and applied uniformly throughout Indonesia? Why?
2. If e-Livestock is implemented, what needs to be registered (recorded) from a cow?
3. If e-Livestock is implemented, what are the pieces of information that need to be written in ownership documents? Are the registered pieces of information should be written again? Or is there any other opinion?
4. If e-Livestock is implemented, who has the right to do the identification and registration? Is it just the officers? Or farmers also allowed?
5. If e-Livestock is implemented, what institutions should manage the system? How?
6. If e-Livestock is implemented, are farmers/owners of cows in Indonesia ready? Otherwise, how to make them ready?
7. If e-Livestock is implemented, how are the business process of identification activities? Starting from the cow was born/imported until it is given an identification tool.

For example, are farmers contact the officer by phone, and then the officer comes with an ear tag and attaches it to that cow? Or are there any other suggestions?

8. If e-Livestock is implemented, how are the business process of registration activities? For example, during the sale (change of ownership), are only buyers that required to report? Or both buyers and sellers? Or are there any other suggestions?
9. If e-Livestock is implemented, how are the business process of documentation activities? Starting from the cow was born/imported until the farmers/its owners are given an ownership document.

   For example, is the officer escorted the document when the calf was born? Or the farmer should take it from the office? Or are there any other suggestions?
10. If e-Livestock is implemented, how is the business process of traceability? For example, are every person may view the history of a cow directly through the system? Or just the officers? Or are there any other suggestions?

Figure 9. Various forms of livestock cards in Indonesia.

4.6.1. Modeling the business processes of the identification activities

From our previous research in Ramadhan et al. (2013), it was revealed that one of the success factors for e-Livestock in Indonesia is by "Make better business process". However, as has been revealed in Table 4, there is no business process that exists in relation to the identification, registration, documentation, and traceability of cows in Indonesia. Thereby, the business process models that are built in this research are novel in Indonesia, so that we can not compare them with others to see which one is better. However, all of the business process models in this research will be validated in sub-section 4.6.14.

Another success factor for e-Livestock in Indonesia is "The system accommodates the data communication other than through the internet (flexible), particularly in terms of "notifications" process" (Ramadhan et al., 2013). In accordance with that success factor, that is the business process models, it can be seen that the owner/farmer can send a message to the officer through any flexible communication line. We also adopt what has been done in Japan, where farmers can contact the officers in several other ways, namely by telephone and fax. We also consider some suggestions from the interviewees, especially that related to how to do the identification, registration, documentation, and traceability process.

We have taken into consideration the experiences in Netherlands and Japan, that identification is given when cattle are born or imported. It is also in accordance with the success factors by Ramadhan et al. (2013) that the e-Livestock should also do the identification when "the cows were born" and when "the cows entering Indonesia (import)". Furthermore, identification at birth can occur in two circumstances, i.e.: birth inside government institutions, and birth outside government institutions. The business process models for the identification of the three possibilities can be seen in Figures 12, 13, 14, 15, 16, 17 in the Appendix.

4.6.2. Modeling the business processes of the registration activities

We can see in Table 2, that registration is carried out in the Netherlands and Japan during birth, import, move-in/out, slaughterhouse, and death. Ramadhan et al. (2013) also revealed that there are seven events that must be registered to make e-Livestock successful, ie: "when the cows were born", "when the cows were imported", "each time the cows changed its ownership", "each time the cows give birth", "when the cows are slaughtered", "death or missing", and "the cows getting treatment (eg medicine)". In this sub-section, by considering some suggestions from the interviewee (e.g. G4 and C2), we add one other event, that is when the cow is given an AI.

We divide the event of ownership change into two types: outside the Animal Market and inside the Animal Market. We also divide the event of death into two types: death in the slaughtering house and death outside the slaughtering house. Especially for the change of ownership, some interviewees suggest that the parties that should be required to report the change of ownership are the buyer. This is consistent with the experience that has occurred in Japan. Therefore, this approach will be used in this research.

Some of the events have been included in the previous business process models, that are in the identification activities. Therefore, in this sub-section, there will only present the business process models of other remaining events. Those business process models can be seen from Figure 18 to Figure 31 in the Appendix.

4.6.3. Modeling the business processes of the documentation activities

Based on Table 2, Netherlands, Australia, and Japan use some sort of documentation that accompanying the cow. Based on the result of the interviews, most of the interviewees suggested that publication of the documentation is done at birth and import. Those suggestions are accommodated in this research. However, The business process models for documentation activities are combined with the business process models for identification activities. Those happen because when doing the identification, the documentation process is also carried out in the form of a livestock ownership document. Those business process models can be seen in Figures 12, 13, 14, 15, 16, 17 in the Appendix.

4.6.4. Modeling the business processes of the tracing activities

There is a country that frees every person to access the system and view the data (e.g. Japan), and there is a country that uses a closed system (e.g. Australia). Based on the result of the interview, several interviewees want e-Livestock are open and its data is accessible to everyone. However, according to the Law of Public Information Freedom (UU No. 14 Tahun 2008), which regulates public information, it is stated that some data are classified as public information and some are not. An example of information that should not be opened is information that can uncover the country's wealth.

Thus, we make two business processes models, i.e.: for all Customers and for a government institution. Only authorized personnel and government institution that is allowed to see the detailed data. The general customers who require detailed data should ask a government institution. Furthermore, the government institution can decide whether the data can be given or not by considering the Law of Public Information Freedom (UU No. 14 Tahun 2008). Both business process models can be seen in Figure 32 and Figure 33 in the Appendix.

4.6.5. Define the functional system requirement of the e-Livestock

Based on a wide range of business process models that have been created, it can be obtained some functional system requirements for e-Livestock. From the business process models of the identification activities, it can be concluded that the system e-Livestock should provide:

- A function to authenticate a user
- A function to enter new cow's data
- A function to update existing cow's data (general cow's data)
- A function to print the KKT

By taking into account the other business process models of other activities, then some other functional system requirements for e-Livestock are:

- A function to update AI history
- A function to update health history
- A function to update death information
- A function to show the public cow's data

By taking into account some problems that have been revealed in the step 2 of SSM above, then some additional functional system requirements for e-Livestock are:

- A function to show the data of cow that is affected by some particular disease within a particular area
- A function to show the data about the Kelompok Peternak within a specific area
- A function to show detailed information about farmers or companies within a specific area
- A function to show the data about cow population within a specific area
- A function to show the data about cow population that being raised in specific location
- A function to show the data about the productivity of cows within a particular area
- A function to show the AI implementation data within a specific area
- A function to show the data of local beef cow within a specific province
- A function to show the information about the cow which has to go into a province as well as the cow location
- A function to show the ownership change data within a particular area
- A function to show the detailed information about slaughtering data within a specific area
- A function to show calf birth data within a specific area (male and female cattle)

A use case diagram can be used to depicts all of the above functional requirements of the e-Livestock. A use-case diagram consists of an entity (system, subsystem, or class), actors, use cases, and their relationships (Alhir 2002). An actor is someone or something (e.g. other entity) that interacts with an entity (the system) and stands outside the system (Kruchten, 2003). A noun phrase should be used to be the name of an actor and that name should describe in “a way that captures the actor's responsibilities and characteristics based on the context in which the actor resides” (Alhir 2002). Alhir (2002) also revealed that a more generalized actor can be used to represents some other actors that have common behaviors.

A use case is “a unit of behavior or functionality provided by an entity as a service to actors” (Alhir 2002). Kruchten (2003) said that a use case should provide an “observable result of value” to its actors. A phrase that consists of a verb followed by nouns should be used as the name of a use case, and it should “indicating what is achieved via the use case's sequence of actions from the perspective of its initiating actor and described in a way that captures its purpose” (Alhir 2002). A single small step like "delete a line item" or "print the document" can not become a use case (Larman 2001). A use case probably consists of five or ten steps (Larman 2001). On the other hand, a use case should also not represents somethings that take days (e.g. "negotiate a supplier contract") (Larman 2001). In this sub-section, all of the use cases is the use case that can provide an observable result of value. The use case diagram of e-Livestock in Indonesia is depicted in Figure 10.

4.6.6. Determine what data should be registered

In Section 2.2, it can be seen that the systems in the three developing countries are only registered things that are simple but useful. For example, all of those countries do not require the registration of cow weight. In this section, we also considered several comments from interviewees. Those comments can be seen in Table 13 in the Appendix. Based on the result of interviews in Table 13, it can be concluded that for the macro scale in a country, it should be noted that only the things that are important and feasible that need to be registered. From Table 13, it can be synthesized that some data that should be registered are: productivity of cow, date of giving birth, the number of calves born (male cattle and female cattle) on every birth process, pedigree, cow's health, race, cow's owner, location, straw, date of birth, ownership history.

Based on the explanations in sub-section 4.5.1, it is known that there are some regulations that give an indication of what should be registered from a cow. However, all of those regulations are more focused on breeding activities. Whereas this research has the objective for all cows in Indonesia, for breeding, cow-calf operation, or fattening. Therefore, we propose that only certain things are to be registered.

In this sub-section, we also consider two success factors of e-Livestock in Indonesia, that are (Ramadhan et al., 2013): “Each cow is given a unique identification number”, “The information required to determine the productivity of cows should be registered (eg number of giving birth, etc.)”, “Identification number of the mother is also registered” and “Record the medical history, especially in certain diseases”. By considering that three success factors, the comments from interviewees, and taking into account some of the regulations that already exist in Indonesia, it can be proposed some few things that should be registered from a cow, i.e:

1. Livestock Identification Number (Nomor Identifikasi Ternak-NIT)
2. Citizen Identification Number of the owner (IDL/KTP)
3. Birth date/Import date
4. The date when give birth
5. The number of calves born (male cattle and female cattle) on every birth process.
6. AI history (Straw code, AI date, Officer's ID that handles the AI process)
7. History of ownership change (date, IDL/KTP of the previous owners, IDL/KTP of the next owner, and Officer's ID that handles the ownership change)
8. Race
9. NIT of the mother
10. Date of slaughtered/death
11. Cause of death

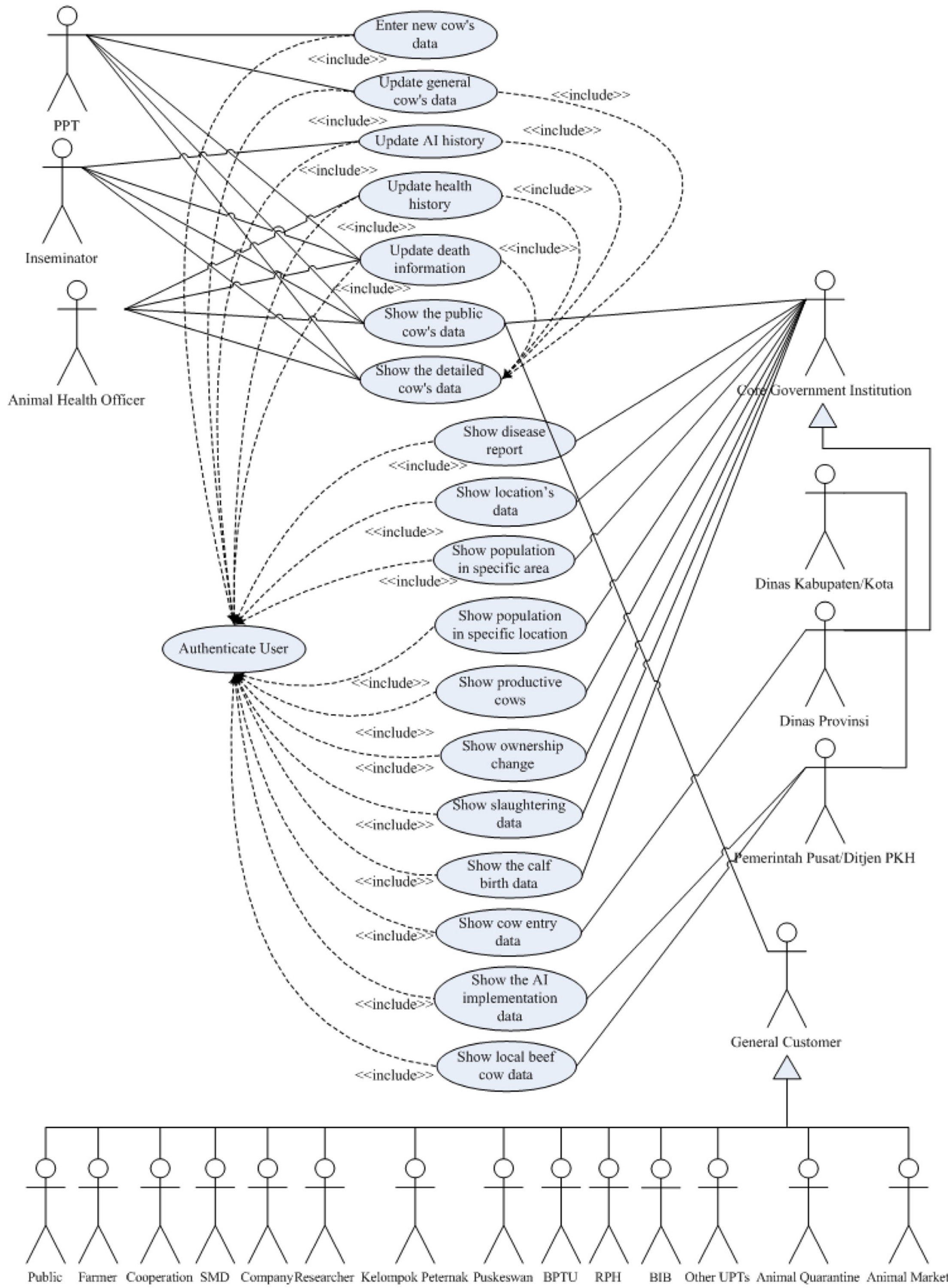

Figure 10. The use case diagram of e-Livestock in Indonesia.

12. Officer's ID that handles the death of cow
13. Health history (diagnose, treatment and Officer's ID that handles the health inspection)
14. Phenotype information (shape of the face, color, the existence of a hump, foot accessory)
15. Ownership status

In addition to cow data, it should also be registered the data about the location of the cows. This is also what has been done in the Netherlands and Australia. After also analyzing the input from interviewees, we propose things that need to be registered from a location are:

1. Citizen Identification Number of the owner (IDL/KTP)
2. Contact name
3. Province
4. Regency/City
5. Address
6. Phone/Mobile Number
7. Officer's ID that handles the location data

4.6.7. Determine the identification tool that applies nationally

According to the result by Ramadhan et al., (2013), one of the success factors for e-Livestock in Indonesia is "Identify all cows". Another success factor is "The identification method and tool are apply uniformly throughout Indonesia". Thus, on this occasion, we will try to analyze what kind of identification tools can be proposed to be used uniformly throughout Indonesia.

Based on interviews with experts and stakeholders, there are several proposed standard identification tools. A3, A4, C3, G8, G10, and G11 suggest that regular ear tag can be used as the standard identification tool. A2 proposes the use of a regular ear tag or necklace. A1 also proposes the use of the necklace as the standard identification tool. G9 proposes that the burn stamp method can be used as a standard. R5 proposes the use of a cow's fingerprint or retina as the standard identification tool. A5, A6, A7, C1, C2, C4, G7, R1, R2, R3, and R4 prefer to use the RFID ear tag as the standard identification tool. G2, G4, G6, and A4 are hesitant to choose between RFID ear tag or regular ear tag. Generally, they hesitate because RFID ear tag requires a very large cost. The other interviewees, i.e. G1, G3, and G5 are not proposing any tools. The distribution of the identification tools that are suggested by experts and stakeholders can be seen in Table 5.

"Best practice consideration" is one of the success factors for e-Livestock in Indonesia (Ramadhan et al., 2013). In Table 2, we can look at the identification tools that are used in 3 major countries. There are two commonly used identification tools, ie. a regular ear tag (eg in Japan) or an ear tag in the form of RFID (eg in Australia). From an economic perspective, the RFID ear tag may be very burdensome. Moreover, based on the results of the research by Seminar et al. (2010), it is known that several animal husbandry departments of a regency/city in Indonesia do not own a computer, much less the RFID Reader tool.

Australia is an example of a country that requires the use of RFID. The price of one RFID tag is about AUD. 3.60 or about Rp. 35,997. So, if the Indonesian government would provide subsidies of around 10.574 million cows in Indonesia, then it cost about Rp. 380.6 billion. The RFID needs a reader. The price of a single reader is AUD. 359 or Rp. 3,589,641. If the regency/city having 5 Animal Registration Officers (in Indonesia it is called PPT), and there are 497 regencies/cities in Indonesia, it would require a cost of Rp. 8.9 billion for the procurement of readers. We also need an applicator to install the RFID to the ear of the cow. The price of an applicator is AUD. 79 or about Rp. 789,921. As a result, the total cost will about Rp. 1.963 billion.

From an economic perspective, regular ear tags are relatively cheaper. Japan is an example of a country that uses regular ear tags nationwide. The cost for an ear tag is around 131 yen, or about Rp. 15,851. Therefore, if the Indonesian government would provide subsidies of around 10,574,000 cows in Indonesia, it will cost only about Rp. 168 billion. Regular ear tags do not require a reader, so the cost is Rp. 0. The applicator of the regular ear tag costs only 6,300 yen or about Rp. 762,300, it is estimated that it cost Rp. 1.894 billion for applicator procurement.

From the above considerations, we propose to use regular ear tags as an identification tool for cows in Indonesia. That cheap option can support one of the success factors for e-Livestock in Indonesia, that is "Enough funding" (Ramadhan et al., 2013). It also in line with the Guideline of Artificial Insemination Optimization (Pedoman Optimalisasi Inseminasi Buatan (IB) Tahun 2012) and also with the Guidelines for Beef Cattle Performance Test (Pedoman Pelaksanaan Uji Performan Sapi Potong Tahun 2012). Both guidelines propose the use of regular ear tags. By considering the list of success factors for e-Livestock in Indonesia (Ramadhan et al., 2013), we also suggest that the ear tag should fulfill some of the requirements, ie: "it is not easily broken" and "it should be standardized and accredited by the competent authority". The numbering standard that has been depicted in Guideline of Artificial Insemination Optimization (Pedoman Optimalisasi Inseminasi Buatan) can be used as Livestock Identification Number (Nomor Identifikasi Ternak-NIT) and should be printed in the ear tag.

4.6.8. Defining the rules for location identification numbering

According to the result by Ramadhan et al. (2013), one of the success factors for e-Livestock in Indonesia is "Identify the farmers/the owners of cows ". The identification of farmer or owner can be done by giving them some sort of location identification number.

Identification numbering rules contained in the Guideline of Artificial Insemination Optimization (Pedoman Optimalisasi Inseminasi Buatan) can be adopted for location identification numbering. There are four parts numbering rules in that guideline, that are: Provincial Code, Regency Code/City Code, Year of Birth, and Cow Number. In this case, we can modify them. The second last number is depicted as the year of the establishment of the location and the last cow number part is replaced by location number. We call this location identification numbering "Identifikasi Lokasi (IDL)".

The IDL is applied to UPT, UPTD, Company, Kelompok Peternak, or other entity that is not an individual person. For entities in the form of individual persons, such as village farmers, the location identification numbering can be replaced by an ID card number (KTP). Therefore there are two location identification numbering that can be accepted in e-Livestock, i.e: IDL and KTP.

4.6.9. Determining the ownership documentation

Based on the discussion in Section 4.5.3, there are several forms of documentation in the form of livestock card (Kartu Ternak) that has been used in some regions in Indonesia. DGLAH also has issued a guide that stated about the livestock card, that is in the Guideline of Artificial Insemination Optimization (Pedoman Optimalisasi Inseminasi Buatan).

From Table 2, there is one country that does not use documentation, which is Japan. However, the other countries still use documentation. Based on the results of interviews, several interviewees suggested that documentation is needed, but in minimalist form. Some suggestions from interviewees that support this approach can be seen in Table 6.

According to Ramadhan et al. (2013), there are two success factors of e-Livestock in Indonesia that are related to ownership documentation, i.e: "Every farmer/owner is given a cow ownership documents", and "Ownership document may only be issued and filled by competent authorities". That two success factors are also taken into considerations in this sub-section.

It can be suggested that everything that is already registered into the system through the registration process is no longer included in the documentation. We call this ownership documentation as Livestock Ownership Card (Kartu Kepemilikan Ternak-KKT). We propose that the KKT contains only some things that are really important, i.e:

1. NIT,
2. Ownership History (the date of ownership change, IDL/KTP of the previous owner, IDL/KTP of the next owner)
3. Notification information (the date of notification, kind of notification)
4. Officer ratification

Table 5. The distribution of the identification tools that are suggested by experts and stakeholders.

RFID ear tag	Regular ear tag	Necklace	Burn stamp	cow's fingerprint or retina	Not propose any tools
A5, A6, A7, C1, C2, C4, G7, R1, R2, R3, and R4	A2		G9	R5	G1, G3, and G5
	A3, A4, C3, G8, G10, and G11	A1			
G2, G4, G6, and A4					

Table 6. Some comments from interviewees that support the existing of a minimalist documentation.

No	Code	Comments (in Bahasa Indonesia)	Translated in English
1	A5	"… jadi kartu itu dibuat sesimpel mungkin, semudah mungkin, makin ribet makin susah."	"the card is made as simple as possible, as easy as possible"
2	C3	"Saya lebih condong yang penting saja di kartu, misalnya nomornya sekian. Saya punya sapi ini no sekian, umur sekian, ear tag itu pasti pakai nomor tanggal, jadi kalau lihat ear tag seperti NIP, kalau itu seperti itu sudah ada, tidak perlu detail. Prinsipnya jangan dipusingkan dengan sistem ini, karena tidak ada manfaatnya buat mereka, tapi harus diberi wacana bahwa ini akan bermanfaat buat Anda. Belilah sapi, persyaratan yang dibeli hanya sapi yang tercatat."	"I prefer only the important things on the card, for example, the number. For example, cow number, age, ear tag number, no details are needed. The principle is not to mess around with this system, because there is no benefit for the farmer, but there must be a discourse that this will be beneficial for the farmer. Cows that can be bought are only registered cows. "
3	G2	"Ya sebangsa seperti KTP, mungkin tidak harus semua, ya kayak kitalah."	"similar to a human ID card"
4	R4	"Semakin simple, semakin berjalan, semakin kompleks sejak awal sudah tidak berjalan. "	"The simpler it is, the more it runs, the more complex it is, so it doesn't work from the start. "

4.6.10. Making suggestions of what things should be considered when socializing the e-Livestock

There will be challenges in the implementation of e-Livestock. There are some challenges associated with the government, and some other challenges are more related to the non-governmental (e.g. farmers). Thus, there are two socialization efforts, the training activities for government officials, and campaign activities for the non-governmental entities.

One of the success factors for e-Livestock in Indonesia is the "System campaign" (Ramadhan et al., 2013). In this research, the meaning of the campaign is an attempt to disseminate the system so that the potential customers want to use the system, and will follow all of the business processes. The campaign process is very important for the success of the system.

The campaign may be performed through a variety of common activities, such as through advertisements in the media, farmers groups gathering activities, farmers counseling, and so forth. However, the focus of the attention in this subsection is about the key points of what can be a guide in preparing the campaign. The content of campaign materials can explain about:

1. There is no tax on the e-Livestock activity.
2. Cows that included in e-Livestock does not mean it become the government's cow
3. Cows that take part in e-Livestock will get all the government services, for example, AI, health service, etc.
4. Cows that included in e-Livestock will be valued higher, etc

Some of the losses they would face if they do not participate can also be delivered. There are some disadvantages if cow owner is not willing to participate in the e-Livestock, i.e.:

1. They will not get any government services, such as health care and AI
2. They will lose the opportunity to raise the price of their cow
3. They will not get a chance to gain KKT so that the ownership status of their cow is doubtful
4. They can not sell their cow in the animal market because it does not has a clear identity
5. They can not slaughter their cow in the slaughterhouse because it does not has a clear identity
6. Their cow will be rejected in the animal quarantine because it does not has a clear identity
7. They will lose market access for their customers who are very aware of the traceability for food safety

One other success factor for e-Livestock in Indonesia is "Using an incremental model of socialization" (Ramadhan et al., 2013). That means the socialization should be gradual and continuous. The training and campaign should be delivered step by step so that all of the participants can understand all of its content.

Another two success factors for e-Livestock in Indonesia are "The presence of supporting regional policies" and "The involving in e-Livestock should be free for farmers/owners" (Ramadhan et al., 2013). However, some policies in the local area are seem can hamper the e-Livestock initiative. For example, the West Sumbawa Regency Regulation No. 16 of 2007 and Magelang Regency Regulation No. 13 of 2001 still requires farmers to pay a certain amount to get the livestock card. This of course makes farmers became not enthusiastic and can hinder the implementation of e-Livestock.

In accordance with the law about local autonomy (UU No. 32 of 2004), both of the above regional regulations are legal and the local governments have the right to make it. However, for the success of the e-Livestock, the central government should initiate a variety of approaches, so that local governments want to review it again. This can support the realization of one other success factor for e-Livestock in Indonesia, that is the "Supportive government policy" (Ramadhan et al., 2013).

4.6.11. Revealing the institutional aspect of e-Livestock

One of the success factors for e-Livestock in Indonesia is "The process of identification and registration can only be done by an authorized institution/officer" (Ramadhan et al., 2013). That success factor is also supported by several comments from interviewees that can be seen in Table 14 in the Appendix. We also take into consideration the experiences from Japan that also use a manager to handle the identification and registration activities of farmers.

Based on the result of the interviews, there are two major groups of interviewees. The first is the interviewees who want the establishment of a new institution that is specifically dedicated to handling e-Livestock (i.e. A5, A6, C1, C3, G4, G11, R3, R4, R6). The second group proposes that it is better if we utilize the existing government institutions (i.e. A1, A2, A4, A3, A7, C2, C4, G1, G2, G3, G5, G6, G7, G8, G9, G10, R1, R2, R5).

Creating a new institution is economically costly and there will be many obstacles politically. Therefore, we adopt the second option, which is to utilize the existing institutions, but by adding a few adjustments. As a consequence, we will not explain in detail the existing institution relationships. We will not change those relationships. We use the existence of provincial agency and regency/city agency relationship so that the lines of command and coordination of existing agencies can be preserved and directly utilized.

We propose that each regency/city can be added a new officer called Livestock Registration Officers (Petugas Pencatatan Ternak-PPT). One PPT can cover one or more small areas (sub-district/sub-district/village), depending on the policy of the regency/city, by taking into account the area condition and the distribution of farmers in that regency/city. A PPT must have adequate computer skills and have enough understanding about cows. PPT should have a bachelor's degree. Each PPT raised by the regency/city is should be registered to DGLAH to get an official ID number, the username, and the password of the e-Livestock system.

There were two groups of PPT under the regency/city, i.e static PPT, and dynamic PPT. Static PPT is placed at two locations, i.e.: animal quarantine and slaughterhouse. Dynamic PPT has a duration of action to go around in their area for 3 days, then 1 day at the animal market and 1 day at her/his office just to enter and update the data. Dynamic PPT work schedules are adapted to the schedule of the local animal market. Dynamic PPT acts as a manager for several locations. Dynamic PPT is also divided into two types: dynamic PPT that specifically handles the cows that are come from government grants, and dynamic PPT that handles non-governmental cows. In addition to the PPT under the regency/city, each UPT (e.g. BPTU, BIB, and Other UPTs) that raising cows is also required to have at least 1 PPT or 1 existing staff that appointed to become PPT in its location.

In addition to PPT, there are two other officers who have the authority to register data into the e-Livestock system. The two officers are Animal Health Officer and Inseminator. Nonetheless, the two officers had no authority to conduct identification. The existing institutional aspects that govern the two officers were also not altered. They have simply added a new task, which is to register the AI activity or animal health inspection into the e-Livestock systems.

Moreover, according to the result by Ramadhan et al. (2013), one of the success factors for e-Livestock in Indonesia is "Training". Therefore, PPT, Animal Health Officer, and Inseminator need to be trained so that they can use the system properly. With a trained officer, it can guarantee the validity of the data that are entered into the e-Livestock system.

DGLAH should conduct periodic inspections of the implementation of e-Livestock every year. This can help the process of monitoring and evaluation. For example, the execution of the Identification and Registration system in the Netherland is checked every year by the local offices by visiting between 15 and 20 percent of the farms (Wismans 1994). In Denmark, the authorities inspect 3 % of all cattle holdings every year (DVFA 2012). Periodic inspections can be used to assess the performance of the officers as well as checks the validity of the data entered. Percentage of cows/number of livestock owners who will be inspected can be determined and assessed through subsequent research.

4.6.12. Making suggestions on what things should be accommodated in the forthcoming regulations that will underlie e-Livestock

In order to guarantee the success of e-Livestock, it requires a "Legal framework" that regulates it in practice (Ramadhan et al., 2013). To attract the farmer, the legal framework should state about the "Reward for the farmer who willing to get involved" in e-Livestock Ramadhan et al. (2013). In accordance with the other success factor for e-Livestock in Indonesia, the legal framework should also state that "The system is mandatory" Ramadhan et al. (2013).

By considering several articles in the Indonesian Laws No 18 of 2009 on Animal and Animal Health as well as the content of the Beef Traceability Law in Japan and the EU Regulation No. 1760/2000 that is enforced in Europe, it can be proposed a few things that need to be accommodated in the forthcoming regulation of e-Livestock (see Table 7).

4.6.13. Create a conceptual infrastructure diagram

Some of the e-Government initiatives, when it was first built, was built in a centralized manner (Heeks 2006). At this starting point, we propose that e-Livestock is built centralized. The e-Livestock should be established online on the internet. The e-Livestock conceptual infrastructure diagram can be seen in Figure 11.

Table 7. Some things that should be accommodated in the regulation of e-Livestock.

No	Do	Don't	Should
1	Requiring every person and legal entities that have cows to do the identification	Prohibit any individuals and legal entities to sell the cow without a valid identification tool and a valid KKT	Set about the legitimate form of ear tags
2	Requiring every person and legal entities that have a cow to report to PPT about these following events: birth; ownership change; and death outside the slaughtering house	Prohibit any individuals and legal entities to slaughter the cow out of the slaughtering house	Set about NIT
3	Requiring every person and legal entities that have a cow to report to the Animal Health Officer if there is a sudden death of a cow	Prohibit any individuals and legal entities to release the ear tag that has been installed/recognized by PPT	Set about IDL
4	Requiring every UPT to appoint or designate a PPT for its institution		Set about duties and functions of the Inseminator in relation to e-Livestock
5			Set about duties and functions of the Animal Health Officer in relation to e-Livestock
6			Set about duties and functions of the PPT
7			Set about KKT
8			Set about the business process of identification
9			Set about the business process of registration
10			Set about what data should be registered
11			Set about the public cow's data
12			Set about the position of DGLAH, provincial, and regency/city agencies in relation to e-Livestock.

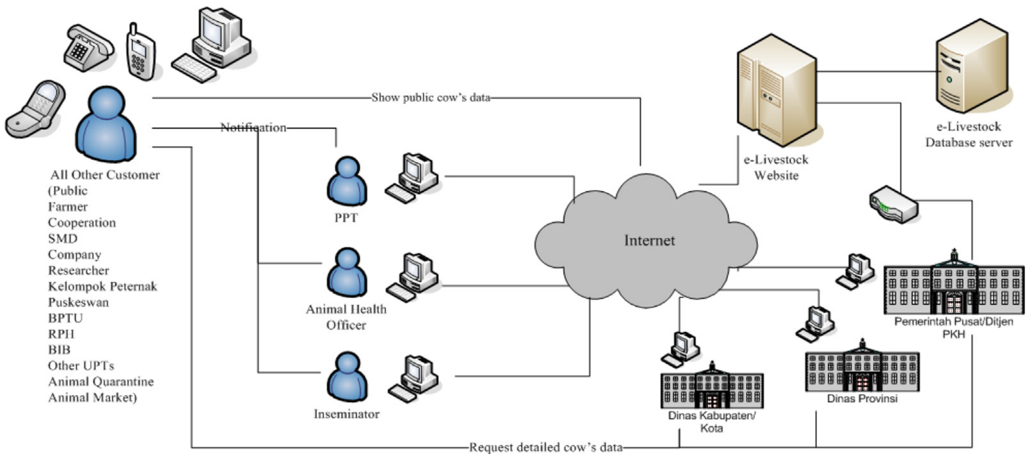

Figure 11. Conceptual infrastructure diagram.

4.6.14. *Validating the models*

The models can be validated indirectly, "by checking whether the stakeholders agree that the views created from the models are correct representations of the actual or intended situation" (Lankhorst 2005). The validation of the model must be done by someone who knows the horizontal workflows of the business well (Castela et al., 2002).

The validation process should be conducted in limited groups (Lankhorst 2005). "'Feedback rounds' involving a larger number of people, by e-mail or printed documentation, do not really work" (Lankhorst 2005). To get a worthed feedback, it is better to discuss the models face to face with some key people (Lankhorst 2005). "Make sure the 'opinion leaders' in an organization agree to the model" (Lankhorst 2005).

By taking into consideration all of the above suggestions, we organized a Focus Group Discussion (FGD0 to validate all of the models. FGD was chosen because it has several advantages. Edmunds (1999) said that "probing and clarification of the participants' comments are easy to do in FGD". Focus groups are best used when the concept or idea that will be evaluated is new (Edmunds 1999; Greenbaum 1998) and "when the best evaluation comes from letting the target customer view the concept" (Edmunds 1999). FGD also can be conducted when investigating complex behavior and motivations and when we want to understand diversity (Morgan 1998).

Simulation can be used in the model validation (Janssen et al., 2002). One of the standard features of simulation is visualization (Janssen et al., 2002). Janssen et al. (2002) used animation to visualize their simulation. Janssen et al. (2002) shows the animation to the stakeholder so that the stakeholder can assess what are the benefits and weaknesses of the business process. By taking Janssen et al. (2002) work as an example, we also built some simple animations of each business process model. The animations have been shown to all of the FGD participants.

There are 8 experts and stakeholders that are involved in the FGD. The information about those 8 involved experts and stakeholders can be seen in Table 8. A code is given to each of them to ease further explanations. To increase the dependability and transferability of the research, we also have recorded the FGD process. We then transfer the recorded audio into text form. In general, all of the FGD participants agree with all proposed models. They suggest that all of the models should be implemented immediately in Indonesia.

4.6.15. *Determine The Complexity of Business Process Models*

As one of the foremost results of this research, then we pay more attention to the business process models. The business process models should be "easy to understand and easy to maintain" (Gruhn and Laue 2006). The models must be "readable and useable" (Lankhorst 2005). "The readability and usability of the models are, to a large extent, determined by the complexity of the models" (Lankhorst 2005).

In this subsection, to calculates the complexity of business process models, we use the Control-Flow Complexity (CFC) measure that has been explained in detail by Cardoso (2005). CFC measure seeks to evaluate the complexity of business process models without direct execution of that business processes (Rolon et al., 2009). It has been validated theoretically by Cardoso (2005) and validated empirically by Cardoso (2006) and Rolon et al. (2009).

The formula of the CFC consists of three components, ie. the XOR-split, OR-split, and AND-split constructs as follows (taken from (Rolon et al., 2009)):

- XOR-split Control-flow Complexity. Determined by the number of mental states that are introduced with this type of split. The function $CFC_{XOR\text{-}split(a)}$, where a is an activity, computes the control-flow complexity of the XOR-split a. For XOR-splits, the control-flow complexity is simply the fan-out of the split.

Table 8. The information about experts and stakeholders that involved in FGD.

No	Code	Gender	Academic Background	Decision
1	FGD1	M	Professor	Agree
2	FGD2	M	Professor	Agree
3	FGD3	M	Bachelor	Agree
4	FGD4	F	Master	Agree
5	FGD5	M	Doctor	Agree
6	FGD6	M	Doctor	Agree
7	FGD7	M	Bachelor	Agree
8	FGD8	M	Bachelor	Agree

$$CFC_{XOR-split}(a) = fan\_out(a)$$

- OR-split Control-flow Complexity. Determined by the number of mental states that are introduced with the split. For OR-splits, the control-flow complexity is $2^{(n-1)}$, where n is the fan-out of the split.

$$CFC_{OR-split}(a) = 2^{fan\_out(a)-1}$$

- AND-split Control-flow Complexity. For an AND-split, the complexity is simply 1. The process designer needs only to consider and analyze one state that may arise from the execution of an AND-split construct since it is assumed that all the outgoing transitions are selected and followed.

$$CFC_{AND-split}(a) = 1$$

Mathematically, the Control-Flow Complexity metric is an additive equation. This is done by simply adding the CFC of all the split constructs and is calculated as follows (Rolon et al., 2009):

$$CFC = \sum CFC_{XOR-split}(a) + \sum CFC_{OR-split}(a) + \sum CFC_{AND-split}(a)$$

Basically, "the greater the value of the CFC, the greater the overall structural complexity of a business process models" (Rolon et al., 2009). However, Sánchez-González et al. (2011) has proposed the threshold and the meaning of the value CFC for each pair of start event-stop event as depicted in Table 9. For example, a business process model can be considered "easy to understand" if there are no more than 12 *xor* nodes, 2 *or* nodes, and 1 *and* nodes (Sánchez-González et al., 2011). If there is a sub-process, then the CFC of the sub-process is taken into account in its above pair start event-stop event (Sánchez-González et al., 2011).

By taking into consideration of all the business process models that have been proposed and by breaking them by each pair start event-stop event (including their sub-process), then the results of the CFC measure of e-Livestock in Indonesia can be seen in Table 10. From Table 10, it can be seen that most of the business process models are "very easy to understand". It is in line with the reflection to the result of FGD, that the experts and stakeholders can understand and agree with the existing business process models. Thus, it can be expected that all business process models can also be understood and properly implemented by the Indonesian government.

5. Discussion

5.1. How are the current conditions of the process of identification, registration, documentation, and traceability of cows in Indonesia?

Currently, all the main activities of e-Livestock, ie. identification, registration, documentation, and traceability have not been carried out properly (see Table 4). Not all of the livestock actors in Indonesia do the identification, registration, and documentation. Based on the results of interviews, it is known that the business processes for all of those activities in Indonesia are not clear. Only a few of them have been done it locally or limited as personal interest. Moreover, the way and the identification tool are not uniform. The data registered are vary depending on the wishes of the owner (Seminar et al., 2010). The existing forms of documentation also vary and differ. Last, the search process for traceability can not be done at all because there is no system that can accommodate it.

5.2. How are the business process models for the identification, registration, documentation, and traceability activities in the future implementation of e-Livestock in Indonesia?

This research succeeded in creating clear business process models for each of e-Livestock activities. This research also successfully produced various recommendations so that all of the business process models can run well. Based on the resulting business process models, it can be seen that the identification process can occur within the government institution or outside the government institution. When a cow is born in a government institution, a special officer, namely PPT (see sub-section 4.6.11), will immediately attach ear tags to the new calf. Furthermore, PPT registers data related to the new calf into the e-Livestock system. PPT also then printed a document called KKT, as a livestock ownership document. Then the printed KKT is stored by the administrative division within the government institution.

If the cow is born outside the government institution, then the farmers or other entity outside the government institution must immediately contact the PPT in their area. The livestock owner can contact the PPT in any way he can. The PPT then goes to the location of the livestock owner, attaches ear tags, and makes temporary records on paper. The PPT will then return to the office to register the data related to the newborn calf into the e-Livestock system, as well as print the KKT. In the end, the PPT will go to the livestock owner at another opportunity to hands over the KKT, and the livestock owner will then keep the KKT.

When an import occurs, the identification process also needs to be carried out. The process begins with the submission of the cow to animal quarantine. Then the Animal Quarantine Officer will check whether the cow has an identification device or not. If the identification device has not been installed, the officer will first attach the ear tag to the imported cow. Furthermore, the Animal Quarantine Officer performs the data registration process into the e-Livestock system and prints the KKT. The Animal Quarantine Office hands over the KKT to the importer and then the importer keeps the KKT.

It can be seen that the registration process is directly involved in the identification process, ie. when the cow is born and at the time of import. In addition, based on the business process models, there are several other activities that involve the registration process. The first is when there is a process of buying and selling cows outside the Animal Market. The process was initiated by a Buyer who reported to PPT that he had just bought a cow. Then the PPT goes to the buyer and checks the validity of the ear tags attached to the cow and checks the validity of the KKT that accompanies the cow. If both of those are valid, then the PPT will make a temporary record on paper. PPT will return to his office to register for data changes into the e-Livestock system. During the registration process into the system, it may be found that the data previously recorded at the Buyer's location is not valid. If it is valid, the PPT then goes to the buyer and updates the data on the KKT owned by the buyer.

If the buying and selling process takes place in the Animal Market, then the PPT who is in charge of standby at the Animal Market will immediately check the validity of the ear tags and KKT on the spot. If it is valid, a registration process for data changes will be carried out into the

Table 9. Threshold value for each Levels of understandability (Sánchez-González et al., 2011).

No	Levels of understandability	$CFC_{Xor\text{-}Split}$	$CFC_{Or\text{-}Split}$	$CFC_{And\text{-}Split}$
1	Very easy to understand	6	1	1
2	Easy to understandable	12	2	1
3	Moderately understandable	22	6	3
4	Difficult to understand	31	9	4
5	Very difficult to understand	46	14	7

Table 10. The results of CFC measure of e-Livestock in Indonesia.

No	Business process models	$CFC_{Xor\text{-}Split}$	$CFC_{Or\text{-}Split}$	$CFC_{And\text{-}Split}$	CFC	Understandability
1	The business process model for the identification activity (birth inside Government Institutions) **source**: Figure 12 + its sub process (Figure 13)	4	0	1	5	very easy to understand
2	Business process model for identification activity (birth outside Government Institutions) **source**: Figure 14 + its sub process (Figure 15) **source**: Figure 16 + its sub process (Figure 17)	4	0	1	5	very easy to understand
3	Business process model for the identification activity at imports	6	0	0	6	very easy to understand
4	Business process model for the registration activity (ownership change outside the Animal Market) **source**: Figure 18 + its sub process (Figure 19)	8	0	1	9	easy to understand
5	Business process model for the Registration activity (ownership change inside the Animal Market) **source**: Figure 20 + its sub process (Figure 21)	8	0	1	9	easy to understand
6	Business process model for insemination activities **source**: Figure 22 + its sub process (Figure 23)	4	0	0	4	very easy to understand
7	Business process model for health care activities **source**: Figure 24 + its sub process (Figure 25)	4	0	0	4	very easy to understand
8	Business process model for slaughtering activity at slaughtering house **source**: Figure 26 + its sub process (Figure 27, Figure 28, Figure 29)	18	0	0	18	moderately understandable
9	Business process models for death outside slaughtering house **source**: Figure 30 + its sub process (Figure 31)	4	0	0	4	very easy to understand
10	Business processes model for tracing activity other than by Government Institutions. **source**: Figure 32	0	0	0	0	very easy to understand
11	Business processes model for tracing activity by Government Institutions. **source**: Figure 33	4	0	0	4	very easy to understand

e-Livestock system, then the data on the KKT will also be updated. Everything is done directly at the Animal Market location. The registration process when buying and selling is also carried out in the Netherlands (RVO 2021c), Australia (Integrity Systems Company 2019b), and Japan (NLBC 2020b).

The registration process is also required when artificial insemination occurs. It started with the livestock owner contacting the Inseminator that the cow needed to be inseminated. Then the inseminator goes to the location of the livestock owner, carries out the insemination process, and makes temporary records on paper. Furthermore, the inseminator will carry out the data registration process into the e-Livestock system at his office. A relatively similar business process will be carried out in terms of when livestock require health services. However, in this case, the officer who does the registration is the Animal Health Officer.

No less important is the registration process when a cow dies or is slaughtered. If the cow is going to be slaughtered, the owner of the cow will bring the cow and the KKT to the slaughterhouse. The PPT on duty at the slaughterhouse then checks the validity of the cow. Next, PPT will check whether the cow is a productive cow. If the cow is still productive, it will be checked whether there is financial assistance from the government to buy the cow. If there is government funding assistance, the productive cows will be purchased and their ownership status changed to become the property of the slaughterhouse. This is done to support the Indonesian government's program to maintain a productive cows population. On the other hand, if the cow is not a productive cow, the cow can be slaughtered, the data in the e-Livestock system will be changed, and the accompanying KKT can be destroyed.

If the cow dies outside the slaughterhouse, the livestock owner must immediately contact the nearest PPT, Inseminator, or Animal Health Officer. The contacted officer must immediately come to the location of the livestock owner, examine the cause of death, and then record the death data into the e-Livestock system. The KKT accompanying the cow was also destroyed.

In terms of traceability, based on the resulting business process models, there are two processes for tracing cow data in the e-Livestock system. That is, if the tracing is done by a general user, then the user can enter the identification number of the cow and view public data related to the cow. This public data is only in the form of general data and is not detailed. Meanwhile, if the person doing the tracing is a government institution officer, more detailed data can be seen.

5.3. What should be considered regarding all e-Livestock business process models, in terms of identification tools, registered data, registration parties, forms of documentation, conceptual infrastructure design, and functional system requirements?

There are countries that require sophisticated identification tools, such as in the form of Radio Frequency Identification (RFID) ear tags, for example in Australia (Integrity Systems Company 2019a). However, there are also some countries that can accept regular visual ear tags as implemented in Japan (NLBC 2020a) and the Netherlands (RVO 2021b). We have considered the cost of implementing the identification tool in the field and also the readiness of the stakeholders. We have taken into consideration the availability of systems and processes in local conditions. Based on the research that has been carried out including the results of the analysis of all stakeholder inputs and considerations from the economic side, regular ear tags are the most appropriate for Indonesia's current condition.

The rule about identification numbers depicted on the identification tool has been successfully defined in sub-section 4.6.8, so it can be applied uniformly throughout Indonesia. Some countries also require numbering for the location where the cow is located, for example in the Netherlands (RVO 2021d) and Australia (Integrity Systems Company 2019c). Based on the results of this research, Indonesia should also adopt what was done in the Netherlands and Australia, that is also necessary to give identification numbers to livestock owners, whether they are individual owners or in the form of institutions.

The data that must be recorded in the registration process has been successfully determined in sub-section 4.6.6. The livestock ownership document (namely KKT) have to depicts several required data that are revealed in sub-section 4.6.9. Only 3 three actors can do the input and update data in the system and print or destroy the KKT, ie PPT, Inseminator Animal Health Officer.

Furthermore, to facilitate the execution of each business process, a system is needed that can accommodate those business process models. All the functions needed in the e-Livestock system have been successfully shown in Figure 10. There are 19 use cases that the e-Livestock system must accommodate. There are 5 main actors who will use the e-Livestock system, namely PPT, Inseminator, Animal Health Officer, Core Government Institution, and General Customer. The Core Government Institution can show publics and detailed data. While General Customer can only show public data. The functional requirements depicted in this Figure 10 are core functions, the system developer may add several other functions to complement the e-Livestock system.

Some countries provide a centralized web-based system for registration as well as for traceability, for example in Australia and Japan. Indonesia can also adopt a web-based implementation. As stated by Yousafa and Xiucheng (2018) a web-based system is very suitable to be applied in a very large area. Based on the results of this research, the suitable infrastructure for Indonesian conditions is in the form of a centralized system as shown in Figure 11. The e-Livestock centralized system is placed on a server that is connected to a central database server. Both servers are managed by the central government/DGLAH. All other entities, whether government institutions or not, can then access the e-Livestock system website via the internet. The use of internet technology is very suitable for the vast territory of Indonesia and across islands. All types of livestock owners can contact the PPT, Inseminator, and Animal Health Officer using any means of communication they have. Furthermore, PPT, Inseminator, and Animal Health Office will access the e-Livestock system via the internet.

5.4. How to socialize the e-Livestock business process models to the stakeholders, especially to the farmers?

In order for all e-Livestock business processes to run properly, a combination of persuasive and repressive measures is needed. Persuasive measures are carried out using the socialization technique described in sub-section 4.6.10. The main target of the socialization activity is the farmer as the most affected party by the existence of e-Livestock. Things that are an advantage if they are involved in e-Livestock are put forward. Some concerns that may arise with the existence of e-Livestock are also minimized and clarified.

5.5. How to accommodate e-Livestock busess process models in the legal framework?

The repressive measures can be carried out with a clear law underlying the implementation of e-Livestock. As stated by Ramadhan et al. (2013) that legal framework support is needed to ensure that all business processes are carried out properly and are followed by all relevant parties. As shown in the results in Table 7, there are 4 mandatory things that need to be regulated in the forthcoming regulation. In addition, a minimum of 3 prohibitions and 12 other detailed rules related to the implementation of e-Livestock are required. The results of this research can be the basis for the preparation of the next regulation, various other considerations can be added in further research.

5.6. How to validate all of the business process models?

As explained in the sub-section 4.6.14., all business process models produced have been successfully validated by involving various stakeholders in the livestock sector. The stakeholders involved have excellent educational levels ranging from bachelor to professor. This shows that academically all these stakeholders, in addition to their experience, also have sufficient scientific background. All stakeholders agree with the resulting business process models.

5.7. What are the complexity of the business process models?

The complexity of all business process models also turns out to be mostly “very easy to understand”. All of the complexity can be seen in Table 10. Thus, it can be expected that all business process models will be understood by all parties that will be involved in e-Livestock. As suggested by Oukharijaneet al. (2018), the “very easy to understand” results can ease the implementation of e-Livestock in Indonesia. Thus, all business process models should be immediately carried on in Indonesia.

6. Implications and conclusion

This research has resulted in business process models of identification, registration, documentation, and traceability of e-Livestock in Indonesia. In addition, several other recommendations have been delivered, those can be used in the actions to solved the problem situation, ie. the use case diagram; the proposed identification tool; the location numbering rule; the ownership documentation suggestion; the suggestions of what things should be considered when socializing the e-Livestock; the institutional aspect of e-Livestock; the suggestions on what things should be accommodated in the forthcoming regulations that will underlie e-Livestock; and the conceptual infrastructure diagram.

This research has enriched the research repertoire of e-Livestock. The business process models produced are novel contributions for e-Livestock in Indonesia. It has shown that the SSM can be used in modeling a complex e-Government system, especially which is a new paradigm such as e-Livestock. The use of success factors as guidance is proven can simplify the process of modeling and prepare other recommendations. Combining SSM with FGD and hermeneutic has also proven can be done and can be a reference for other research.

All of the business process models have been validated by experts who are competent using the FGD process. The complexities of the business process models also have been calculated and most of them are “very easy to understand”. This will allow all business process models to be implemented promptly by the government. All other recommendations that have been produced in this research can also be a guide for the government when implementing e-Livestock. Thus, the closest further practical implication following this research is to build the implementation plan of e-Livestock, several ways can be considered, ie. pilot project and refinement. The business process models and various other recommendations generated from this study can help the Indonesian government to achieve the target of beef self-sufficiency in 2026.

Declarations

Author contribution statement

A. Ramadhan: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

A. M. Arymurthy, D. I. Sensuse, Muladno: Conceived and designed the experiments.

Funding statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability statement

The data that has been used is confidential.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

Supplementary content related to this article has been published online at https://doi.org/10.1016/j.heliyon.2021.e07754.

References

Agustina, N., Pramana, S., 2018. Key determinants of information and communications technology (ICT) development in Indonesia at 2012-2015. In: The Proceedings of the 8th Annual Basic Science International Conference, pp. 152–161.
Alhir, S.S., 2002. Guide to Applying the UML. Springer-Verlag New York, Inc, USA.

Almukhlifi, A., Deng, H., Kam, K., 2019. Critical factors for the adoption of e-government in developing countries: validation of a measurement model. In: Proceedings of the 12th International Conference on Theory and Practice of Electronic Governance, pp. 397–407.
Anandhi, A., 2017. CISTA-A: conceptual model using indicators selected by systems thinking for adaptation strategies in a changing climate: case study in agro-ecosystems. Ecol. Model. 345, 41–55.
Andrew, W., Hannuna, S., Campbell, N., Burghardt, T., 2016. Automatic individual holstein friesian cattle identification via selective local coat pattern matching in RGB-D imagery Image Processing (ICIP). In: 2016 IEEE International Conference, pp. 484–488.
Animal Health Australia, 2015a. Livestock Traceability History [online], available: https://www.animalhealthaustralia.com.au/what-we-do/biosecurity-services/national-livestock-identification-scheme/livestock-traceability-history/.
Animal Health Australia, 2015b. NLIS Cattle [online], available: https://www.animalhealthaustralia.com.au/what-we-do/biosecurity-services/national-livestock-identification-scheme/nlis-cattle/.
Animal Health Australia, 2018. National Livestock Identification System [online], available: https://www.animalhealthaustralia.com.au/what-we-do/biosecurity-services/national-livestock-identification-scheme/.
Awad, A.I., 2016. From classical methods to animal biometrics: a review on cattle identification and tracking. Comput. Electron. Agric. 123, 423–435.
Badan Pusat Statistik, 2011. Pendataan Sapi Potong, Sapi Perah, Dan Kerbau 2011 (PSPK2011). Badan Pusat Statistik, Jakarta, Indonesia.
Bai, H., Zhou, G., Hu, Y., Sun, A., Xu, X., Liu, X., Lu, C., 2017. Traceability technologies for farm animals and their products in China. Food Contr. 79, 35–43.
Barojas, J., 2008. Problem solving and writing II: the point of view of hermeneutics. Latin Am. J. Physchol. Edu. 2 (1), 6–14.
Boediyana, T., 2008. Sekilas Tentang Peternakan Sapi Potong di Indonesia [online], available: http://agribisnews.com/agribis-sapi-potong/29-sekilas-tentang-peternakan-sapi-potong-di-indonesia.pdf.
Cardoso, J., 2005. Control-flow complexity measurement of processes and Weyuker's properties. In: Proceeding of 6th International Enformatika Conference. Transactions on Enformatika, Systems Sciences and Engineering, 8, pp. 213–218.
Cardoso, J., 2006. Process control-flow complexity metric: an empirical validation. IEEE International Conference on Services Computing. IEEE SCC 06, Chicago, USA, pp. 167–173.
Castela, N., Tribolet, J., Guerra, A., Lopes, E., 2002. Survey, analysis and validation of information for business process modeling, complexity metrics for business process models. In: Proceeding of 4th International Conference on Enterprise Information Systems, pp. 1–9.
CBS, 2015. Analisis Rumah Tangga Usaha Peternakan di Indonesia Hasil Survei Rumah Tangga Usaha Peternakan 2014. Central Bureau of Statistics of Republic of Indonesia.
CBS, 2019. Results of Inter-censal Agricultural Survey 2018 A2-Series. Central Bureau of Statistics of Republic of Indonesia.
Checkland, P., Scholes, J., 1999. Soft Systems Methodology in Action. John Wiley & Sons, Inc, USA.
Checkland, P., 1981. Systems Thinking, Systems Practice USA. John Wiley & Sons Ltd.
Checkland, P., 2000. Soft systems methodology: A thirty year retrospective. Sys. Res. Behav. Sci. 17, S11–S58.
DGLAH, 2020. Livestock and Animal Health Statistics 2020 Directorate General of Livestock and Animal Health of Republic of Indonesia.
DVFA, 2012. Livestock Identification, Registration and Traceability [online], available: http://www.foedevarestyrelsen.dk/english/Animal/AnimalHealth/Prevention_control_animal_diseases/Livestock_identification_registration_and_traceability/Pages/default.aspx.
Edmunds, H., 1999. The Focus Group Research Handbook. McGraw-Hill, USA.
EU, 2017. Regulation (EC) No 1760/2000 – EU System for the Identification and Registration of Bovine Animals and the Labelling of Beef and Beef Products [online], available: https://eur-lex.europa.eu/summary/EN/l12064.
Fasanghari, M., Habibipour, F., 2009. E-government performance evaluation with fuzzy numbers. In: Proceedings of International Association of Computer Science and Information Technology - Spring Conference. IEEE Press, pp. 231–235.
Friese, S., 2011. ATLAS.ti 6 Concepts and Functions. ATLAS.ti Scientific Software Development GmbH, Germany.
Fujimoto, Y., Ito, H., Higuchi, H., Ohno, H., Makita, K., 2020. A case-control study of herd- and cow-level risk factors associated with an outbreak of Mycoplasma mastitis in Nemuro, Japan. Prev. Vet. Med. 177.
Golubenkov, A., Alexandrov, D., Misra, S., Abayomi-Alli, O., Leon, M., Ahuja, R., 2021. Decision support system on the need for veterinary contro of passing livestock and farm produce. In: Singh, P.K., Noor, A., Kolekar, M.H., Tanwar, S., Bhatnagar, R.K., Khanna, S. (Eds.), Evolving Technologies for Computing, Communication and Smart World. Nature Singapore Pte Ltd, pp. 517–525.
Greenbaum, T.L., 1998. The Handbook for Focus Group Research. Sage Publication, Inc, USA.
Gruhn, V., Laue, R., 2006. Complexity metrics for business process models. In: Proceeding 9th International Conference on Business Information Systems (BIS 2006), pp. 1–12.
Hardjosubroto, W., 2004. Alternatif Kebijakan pengelolaan Berkelanjutan sumberdaya genetik Sapi Potong lokal dalam SistemPerbibitan Ternak Nasional. In: "Lokakarya Nasional Sapi Potong" Conference.
Hassan, M.H., Lee, J., 2018. Policymakers' perspective about e-Government success using AHP approach: policy implications towards entrenching Good Governance in Pakistan. Transforming Gov. People, Process Policy 13 (1), 93–118.
Havle, C.A., Ucler, C., 2018. Enablers for industry 4.0. In: Proceedings of 2nd International Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT).
Heeks, R., 2006. Implementing and Managing eGovernment an International Text. SAGE Publications, London, England.
Hindle, G.A., Vidgen, R., 2018. Developing a business analytics methodology: a case study in the foodbank sector. Eur. J. Oper. Res. 268, 836–851.
Hirschheim, R., Iivari, J., Klein, H.K., 1997. A comparison of five alternative approaches to information systems development. Aust. J. Inf. Syst. 5 (1).
Iannaccia, F., Seepma, A.P., de Blok, C., Resca, A., 2019. Reappraising maturity models in e-Government research: the trajectory-turning point theory. J. Strat. Inf. Syst. 28, 310–329.
Iivari, J., Hirschheim, R., 1996. Analyzing information systems development: a comparison and analysis of eight IS development approaches. Inf. Syst. 21 (7), 551–575.
Iivari, J., Hirschheim, R., Klein, H.K., 1998. A paradigmatic analysis contrasting information systems development approaches and methodologies. Inf. Syst. Res. 9 (2), 164–193.
Integrity Systems Company, 2019a. Animal Identification [online], available: https://www.integritysystems.com.au/identification–traceability/animal-identification/.
Integrity Systems Company, 2019b. Buying, Selling and Moving Livestock [online], available: https://www.integritysystems.com.au/identification–traceability/buying-selling-moving/.
Integrity Systems Company, 2019c. National Vendor Declaration (NVD) [online], available: https://www.integritysystems.com.au/on-farm-assurance/national-vendor-declaration-nvd/.
Islam, S., Cullen, J.M., 2021. Food traceability: a generic theoretical framework. Food Contr. 123.
Jackson, M.C., 2003. System Thinking Creative Holism for Managers. John Wiley & Sons Ltd, England.
Janssen, M., Wagenaar, R., Beerens, J., 2002. Towards a flexible ICT-architecture for multi-channel E-government service provisioning. Proceedings of the 36th Hawaii International Conference on System Sciences. IEEE Press, pp. 286–300.
Kamari, A., Corrao, R., Kirkegaard, P.H., 2017. Sustainability focused decision-making in building renovation. Int. J. Sustain. Built Environ. 6, 330–350.
Kang, B., Hu, J.L., 2010. Research and improvement of the logistics system based on soft systems methodology. In: Proceedings of IEEE International Conference on Advanced Management Science (ICAMS), 1. IEEE Press, pp. 117–120.
Klein, H.K., Myers, M.D., 1999. A set of principles for conducting and evaluating interpretive field studies in information systems. MIS Q. 23 (1), 67–94.
Kruchten, P., 2003. Rational Unified Process, the: an Introduction, third ed. Addison-Wesley, USA.
Kumar, S., Singh, S.K., Singh, R., Singh, A.K., 2017. Recognition of cattle using face images. In: Animal Biometrics. Springer, pp. 79–110.
Kusakunniran, W., Wiratsudakul, A., Chuachan, U., Kanchanapreechakorn, S., Imaromkul, T., 2018. Automatic cattle identification based on fusion of texture features extracted from muzzle images. In: 2018 IEEE International Conference on Industrial Technology (ICIT). IEEE, pp. 1484–1489.
Lami, I.M., Tavella, E., 2019. On the usefulness of soft OR models in decision making: a comparison of Problem Structuring Methods supported and self-organized workshops. Eur. J. Oper. Res. 275, 1020–1036.
Lankhorst, M., 2005. Enterprise Architecture at Work: Modelling, Communication, and Analysis. Springer-Verlag, Germany.
Larman, C., 2001. Applying UML and Patterns: an Introdution to Object-Oriented Analysis and Dedsign and the Unified Process. Pearson Education, Inc, USA.
Larsson, M., 2009. Learning Systems Thinking the Role of Semiotic and Cognitive Resources. Ph. D. dissertation. Lund University, Sweden.
Linders, D., Liao, C.Z.-P., Wang, C.-M., 2018. Proactive e-Governance: flipping the service delivery model frompull to push in Taiwan. Govern. Inf. Q. 35, S68–S76.
Lu, Y., He, X., Wen, Y., Wang, A.P.S., 2014. New cow identification system based on iris analysis and recognition. Int. J. Biometrics. 6, 18–32.
Mathews, J.A., 2008. Towards a sustainably certifiable futures contract for Biofuels. Energy Pol. 36, 1577–1583.
Meat & Livestock Australia, 2020. Market Programs [online], available: https://www.mla.com.au/research-and-development/market-compliance/preparing-for-market/market-programs.
Ministry of Agriculture of the Republic of Indonesia, 2019. Kementan Optimis Target Swasembada Daging Sapi 2026 Tercapai. https://ditjenpkh.pertanian.go.id/kementan-optimis-target-swasembada-daging-sapi-2026-tercapai.
Mirijamdotter, A., 1998. A Multi-Modal Systems Extension to Soft System Methodology. Ph. D. dissertation. Lulea Tekniska Universitet, Sweden.
Morgan, D.L., 1998. Planning Focus Group. Sage Publication, Inc, USA.
Mottier, V., 2005. The interpretive turn: history, memory, and storage in qualitative research. Forum Qual. Soc. Res. 6 (2). Art. 33.
Myers, M.D., 1997. Qualitative research in information systems. MIS Q. 21 (2), 241–242.
Ngai, E.W.T., Chester, K.M.T., Ching, V.S.M., Chan, K., Lee, M.C.M., Choi, Y.S., Chai, P.Y.F., 2012. Development of the conceptual model of energy and utility management in textile processing: a soft systems approach. Int. J. Prod. Econ. 135, 607–617.
NLBC, 2018. Service of Individual Identification Information of Cattle [online], available: http://www.nlbc.go.jp/en/service.html.
NLBC, 2020a. Types of Ear Tags and How to Wear Them [online], available: https://www.id.nlbc.go.jp/pdf/202008Manual_for_farmer_2.pdf.

NLBC, 2020b. In Such Cases, You Need to Notify (Report) to the Livestock Breeding Center [online], available: https://www.id.nlbc.go.jp/pdf/202008Manual_for_farmer_1.pdf.
NLBC, 2020c. Notification (Report) Mechanism and Method [online], available: https://www.id.nlbc.go.jp/pdf/202008Manual_for_farmer_3.pdf.
NRS, 2000. The Royal Dutch Cattle Syndicate (NRS) [online]. Available : http://park.org/Netherlands/pavilions/typical_dutch/cows/cattle/nrs/.
Nurani, T.W., Wahyuningrum, P.I., Wisudo, S.H., Gigentika, S., Arhatin, R.E., 2018. Model designs of Indonesian tuna fishery management in the Indian Ocean (FMA 573) using soft system methodology approach. Egyptian J. Aquatic Res. 44, 139–144.
O'Farrill, R.T., 2008. Information literacy and knowledge management: preparations for an arranged marriage. Libri. 58, 155–171.
Oukharijane, J., Yahya, F., Boukadi, K., Abdallah, H.B., 2018. Towards an approach for the evaluation of the quality of business process models. In: Proceedings of the IEEE/ACS 15th International Conference on Computer Systems and Applications (AICCSA).
Pedron, C.D., Saccol, A.Z., 2009. What lies behind the concept of customer relationship management? Discussing the essence of CRM through a phenomenological approach. Braz. Adm. Rev. 6 (1), 34–39.
Portal Informasi Indonesia, 2018. Mengejar Swasembada Daging Nasional. https://indonesia.go.id/narasi/indonesia-dalam-angka/ekonomi/mengejar-swasembada-daging-nasional.
Potnis, D.D., 2010. Measuring e-Governance as an innovation in the public sector. Govern. Inf. Q. 27, 41–48.
PwC, 2006. Report of Findings from a Review of the Operation of the National Livestock Identification System. PricewaterhouseCoopers.
Qiao, Y., Kong, H., Clark, C., Lomax, S., Su, D., Eiffert, S., Sukkarieh, S., 2021. Intelligent perception for cattle monitoring: a review for cattle identification, body condition score evaluation, and weight estimation. Comput. Electron. Agric. 185.
Raharja, S., Marimin, Machfud, Papilo, P., Safriyana, Massijaya M.Y., Asrol, M., Darmawan, M.A., 2020. Institutional strengthening model of oil palm independent smallholder in Riau and Jambi Provinces, Indonesia. Heliyon 6.
Ramadhan, A., Sensuse, D.I., 2011. e-Livestock as a New Paradigm in e-Government. In: Proceedings of the 3rd International Conference on Electrical Engineering and Informatics (ICEEI 2011), 1. IEEE Press, pp. 1–4.
Ramadhan, A., Muladno, Sensuse, D.I., Arymurthy, A.M., 2012. E-livestock in Indonesia: definition adjustment, expected benefits, and challenges. In: Proceeding of the International Conference on Advanced Computer Science and Information System. ICACSIS, pp. 137–142.
Ramadhan, A., Sensuse, D.I., Arymurthy, A.M., 2011. A proposed methodology to develop an e-Government system based on Soft Systems Methodology (SSM) and Focus Group Discussion (FGD). In: Proceedings of 2011 International Conference on Advanced Computer Science and Information System (ICACSIS). IEEE Press, pp. 147–152.
Ramadhan, A., Sensuse, D., Muladno, I., Arymurthy, A.M., 2013. Success factors for e-livestock in Indonesia. J. Comput. Sci. 9 (3), 383–390.
Ramadhan, A., Sensuse, D.I., Pratama, M.O., Ayumi, V., Arymurthy, A.M., 2014. GIS-based DSS in e-Livestock Indonesia. In: Proceedings of 2014 International Conference on Advanced Computer Science and Information System (ICACSIS). IEEE Press, pp. 84–89.
Recker, J., Indulska, M., Rosemann, M., Green, P., 2009. Business process modeling- A comparative analysis. J. Assoc. Inf. Syst. Online 10 (4), 333–363.
Richmond, B., 1991. Systems Thinking Four Key Questions. High Performance Systems, Inc.
Rolon, E., Cardoso, J., García, F., Ruiz, F., Piattini, M., 2009. Analysis and validation of control-flow complexity measures with BPMN process models. In: Proceeding of the 10th Workshop on Business Process Modelling, Development, and Support, pp. 1–13.
RVO, 2021a. Runderen Merken [online], available: https://www.rvo.nl/onderwerpen/agrarisch-ondernemen/dieren-houden/identificatie-en-registratie-dieren/runderen-merken.
RVO, 2021b. Leveranciers en goedgekeurde oormerken voor runderen [online], available: https://www.rvo.nl/sites/default/files/2017/03/Overzicht-leveranciers-en-goedgekeurde-sets-oormerken-voor-runderen.pdf.
RVO, 2021c. Runderen Melden [online], available: https://www.rvo.nl/onderwerpen/agrarisch-ondernemen/dieren-houden/identificatie-en-registratie-dieren/runderen-melden.
RVO, 2021d. Dierlocatie UBN registreren en wijzigen [online], available: https://www.rvo.nl/onderwerpen/agrarisch-ondernemen/dieren-houden/identificatie-en-registratie-dieren/dierlocatie-ubn-registreren-en-wijzigen.
RVO, 2021e. App I&R Dieren [online], available: https://www.rvo.nl/onderwerpen/agrarisch-ondernemen/dieren-houden/identificatie-en-registratie-dieren/app-ir-dieren.
Sánchez-González, L., Ruiz, F., Garcia, F., Cardoso, J., 2011. Towards thresholds of control flow complexity measures for BPMN models. In: Proceedings of the 2011 ACM Symposium on Applied Computing (SAC), TaiChung, Taiwan, pp. 1445–1450.
Santman-Berends, I.M.G.A., Brouwer-Middelescha, H., Van Wuijckhuisea, L., de Bont-Smolenaarsa, A.J.G., Van Schaika, G., 2016. Surveillance of cattle health in The Netherlands: monitoring trendsand developments using routinely collected cattle census data. Prev. Vet. Med. 134, 103–112.
Santoni, M.M., Sensuse, D.I., Arymurthy, A.M., Fanany, M.I., 2015. Cattle race classification using Gray level Co-occurrence Matrix convolutional neural networks. In: Proceeding of International Conference on Computer Science and Computational Intelligence (ICCSCI 2015), 59. Procedia Computer Science, pp. 493–502.
Santos, L.M.A.L.D., da Costa, M.B., Kothe, J.V., Benitez, G.B., Schaefer, J.L., Baierle, I.C., Nara, E.O.B., 2021. Industry 4.0 collaborative networks for industrial performance. J. Manuf. Technol. Manag. 32 (2), 245–265.
Schroeder, T.C., Tonsor, G.T., 2012. International cattle ID and traceability: competitive implications for the US. Food Pol. 37, 31–40.
Seminar, K.B., Sumantri, C., Jakaria, Ramadhan, A., 2010. Basic Study on Identification and Registration System for Local Beef Cattle Breeding. PT. Primakelola Agribisnis Agroindustri. Bogor. Indonesia.
Sensuse, D.I., Ramadhan, A., 2012. Enriching soft systems methodology (SSM) with hermeneutic in e-government systems development process. Int. J. Comput. Sci. Issues 9 (1).
Sinjal, D., 2011. PSDS 2014 Dengan Input Data Yang Benar. AGRINA Online [online], available: http://www.agrina-online.com/show_article.php?rid=20&aid=2860.
Stahl, B.C., 2008. Information Systems Critical Perspectives. Taylor & Francis, London, England.
Suardika, P., Ambarawati, I.G.A.A., Sudarma, I.M., 2015. The effectiveness of beef cattle business partnerships on the income of livestock farmers in timor Tengah Utara district, Nusa Tenggara Timur province. Jurnal Manajemen Agribisnis 3 (2), 155–162.
Subagyo, U., Ardiansyah, D., 2020. Prototype of integrated livestock recording application with animal identification and certification system in Kebumen. J. Phys. Conf.
Tanimoto, K., 2019. Do multi-stakeholder initiatives make for better CSR? Corp. Govern. 19 (4), 704–716.
The Beef Traceability Law, 2003. The Law for Special Measures Concerning the Management and Relay of Information for Individual Identification of Cattle, Japan.
Tonsor, G.T., Schroeder, T.C., 2006. Livestock identification: lessons for the U.S. Beef industry from the Australian system. J. Int. Food & Agribus. Mark. 18 (3/4), 103–118.
van Veen, T.W.S., 2002. International livestock development and animal recording systems. Some experiences from the World Bank. In: Proceedings of the FAO/ICAR 2002 Seminar, pp. 37–53.
Veile, J.W., Kiel, D., Muller, J.M., Voigt, K.-I., 2020. Lessons learned from Industry 4.0 implementation in the German manufacturing industry. J. Manuf. Technol. Manag. 31 (5), 977–997.
Weaver, M.W., Crossan, K., Tan, H.B., Paxton, S.E., 2018. A systems approach to understanding the perspectives in the changing landscape of responsible business in Scotland. Eur. J. Oper. Res. 268, 1149–1167.
Wismans, W., 1994. The importance of a closed I &R system for cattle and a central database in The Netherlands. In: Proceedings of National Livestock ID Symposium.
WorldBank, 2021a. GDP Per Capita (Current US$) - Indonesia, Australia, Netherlands, Japan [online], available: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?end=2019&locations=ID-AU-NL-JP&start=1960.
WorldBank, 2021b. Population, Total - Indonesia, Australia, Netherlands, Japan [online], available: https://data.worldbank.org/indicator/SP.POP.TOTL?end=2019&locations=ID-AU-NL-JP&start=1960.
WorldBank, 2021c. Rural Population (% of Total Population) - Indonesia, Australia, Netherlands, Japan, Japan [online], available: https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?end=2019&locations=ID-AU-NL-JP&start=1990.
WorldBank, 2021d. Access to Electricity (% of Population) - Indonesia, Australia, Netherlands, Japan [online], available: https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?end=2019&locations=ID-AU-NL-JP&start=1990.
WorldBank, 2021e. Individuals Using the Internet (% of Population) - Indonesia, Australia, Netherlands, Japan [online], available: https://data.worldbank.org/indicator/IT.NET.USER.ZS?end=2019&locations=ID-AU-NL-JP&start=1990.
WorldBank, 2021f. Fixed Broadband Subscriptions (Per 100 People) - Indonesia, Australia, Netherlands, Japan [online], available: https://data.worldbank.org/indicator/IT.NET.BBND.P2?end=2019&locations=ID-AU-NL-JP&start=1998.
Yousafa, S., Xiucheng, F., 2018. Halal culinary and tourism marketing strategies on government websites: a preliminary analysis. Tourism Manag. 68, 423–443.
Yusdja, Y., Ilham, N., 2004. Tinjauan Kebijakan pengembangan agribisnis Sapi Potong. Jurnal AKP 2 (2), 183–203.
Zeleznik, D., Kokol, P., Vosner, H.B., 2017. Adapting nurse competence to future patient needs using Checkland's Soft Systems Methodology. Nurse Educ. Today 48, 106–110.