INTERNATIONAL JOURNAL OF eBUSINESS AND eGOVERNMENT STUDIES
Vol: 14 **No:** 4 **Year:** 2022 **ISSN**: 2146-0744 (Online) (**pp.** 151-173) **Doi:** 10.34109/ijebeg.202214207
Received: 21.08.2022 | **Accepted:** 17.11.2022 | **Published Online:** 31.12.2022

-RESEARCH ARTICLE-

ELECTRONIC-BASED INFORMATION FLOW MODEL DESIGN AS A BASIS FOR DETERMINING THE PRICE OF COFFEE BEANS IN TANAH KARO

Meilita Tryana Sembiring

Industiral Engineering, Universitas Sumatera Utara, Indonesia
Email: meilita@usu.ac.id
https://orcid.org/0000-0002-8427-7319

Letno Noventa Gurusinga

Industiral Engineering, Universitas Sumatera Utara, Indonesia
Email: letnogurusinga@gmail.com
https://orcid.org/0009-0000-3112-6878

Falda M Pasaribu

Industiral Engineering, Universitas Sumatera Utara, Indonesia
Email: falda.morihasian.10@gmail.com
https://orcid.org/0009-0000-8542-9268

Muhammad Riezky A. L

Industiral Engineering, Universitas Sumatera Utara, Indonesia
Email: muhammadriezky@yahoo.com
https://orcid.org/0009-0006-7581-2419

─Abstract─

Most of Indonesia's coffee is grown on smallholder farms, making it one of its most important plantation products. As a result of the lack of established quality standards for determining coffee pricing, price volatility at the collector level does not guarantee the prosperity of coffee growers. This project aims to develop a computerized method for determining the cost of coffee beans in Karo Regency. First, observations of three coffee collectors were made. The lack of information communication between farmers and collectors and the absence of quality homogeneity in pricing calculation were noted as concerns by researchers. This resulted in a range of coffee prices. So, it is essential to

Citation (APA): Sembiring, M. T., Gurusinga, L. N., Pasaribu, F. M., A. L., Riezky M. (2022). Electronic-Based Information Flow Model Design As A Basis for Determining The Price of Coffee Beans in Tanah Karo. *International Journal of eBusiness and eGovernment Studies, 14 (4)*, 151-173. doi:10.34111/ijebeg. 202214207

enhance the information flow and pricing system. The information flow is improved by developing an SNI-based coffee quality assessment form and applying a case diagram to evaluate the pattern of contact between collectors and growers. A Business Process Model and Notation (BPMN) analysis is performed to discover the optimal information flow inside the coffee supply chain. Using Mock-Up, the interface design of an electronic-based information flow model is developed to assist farmers and collectors in estimating coffee bean prices based on quality.

Keywords: Information Flow, Use of Case Diagram, Business Process Model and Notation (BPMN), Coffee Quality Standardization.

1. INTRODUCTION

Coffee is one of Indonesia's top plantation commodities; based on coffee exports, it was listed as the fourth largest agricultural commodity (particularly plantations) in Indonesia, following oil palm, rubber, and coconut, with an export value of 0.88 billion USD (Ministry of Agriculture, 2020). With a total export of 380,032.37 tons in 2019, Indonesia was the fourth largest coffee exporter in the world (International Coffee Organization, 2019). Indonesia produced 762,000 tons of coffee in 2020, with South Sumatra province (20%), Lampung province (15%), Aceh province (10%), and North Sumatra province (10%) producing the most (Central Agency on Statistics, 2020).

In Indonesia, coffee manufacturing is segmented into three categories based on company status. More than ninety percent of coffee output originates from smallholder plantations, with the remainder from huge governmental and private plantations (Prasetyo et al., 2022). This demonstrates that smallholder plantations play a significant role in Indonesian coffee production as they are dispersed throughout the country. Moreover, North Sumatra has the third highest number of smallholder coffee producers, totaling 7,403 tons in 2020. (Central Agency on Statistics, 2020).

Although most Indonesian coffee originates from smallholder estates, this does not guarantee the farmers' well-being. One explanation is that farmers do not have adequate access to the coffee market. Thus they are unaware of the quality and price of the coffee they sell (Nurullah, 2022). Coffee farmers typically sell coffee as coffee cherries or coffee beans. Farmers typically sell cherries within eight hours of harvesting them, and they get a lesser price than coffee beans (Tamru & Minten, 2023). The coffee beans have undergone peeling, sorting, and half-drying. Farmers may offer sub-district or district collectors coffee as coffee cherries (coffee fruit) or unhulled coffee. Wholesalers then resell the unhulled coffee, while factories purchase the coffee in cherry form for further processing (Rosiana, 2020).

Unfortunately, the retail price of coffee does not reflect the quality of coffee given by growers. Farmers typically sell coffee to collectors in exchange for a cash loan or out of emotion. This attachment renders farmers powerless in negotiations, compelling them

Vol: 14 **No:** 04 **Year:** 2022 **ISSN**: 2146-0744 (Online) (**pp.** 151-173) **Doi:** 10.34109/ijefs. 202214207

to accept the prices established by traders. Hence, coffee prices fluctuate at the collector level (Min, 2022). Owing to a lack of knowledge of the information quality criteria sought by large producers or end users, such as cafes and coffee stores, farmers lack a basis for determining the price of coffee they wish to sell (Sari et al., 2018). Farmers are undoubtedly harmed by the fluctuating purchasing price of coffee at the collector level, for which no clear norms exist. This may be because farmers cannot determine a fair price for the coffee quality they produce without defined standards (Bager, Singh, & Persson, 2022). This allows collectors to freely decide pricing irrespective of the quality of the coffee they get (Nasution & Rahmanta, 2022). This issue suggests that the coffee supply chain's information flow has not been effective.

Three elements must be considered in supply chain management: the flow of commodities (materials), money, and information (Chopra, 2019). Supply Chain Management is a huge and intricate process that relies on the cooperation of every partner, from supplier to manufacturer, to function well. Supply chain management strives to integrate all product or service movement operations, including information, finances, and other connected resources, from suppliers to customers (Hanaysha & Alzoubi, 2022). Consequently, it can be stated that the flow of information is one of the supply chain's most important components. Hence, it is necessary to guarantee that information flows efficiently throughout the supply chain, including the coffee supply chain (Nabila et al., 2021).

Effective electronic equipment (electronic connection) can solve the problem of supply chain information flow problem by facilitating data transmission (Vanpoucke et al., 2017). Information technology enables the integration of supply chain operations and promotes the integration of supply chain processes, including logistics and finance, from suppliers to customers. During these advancements, new technology, methods, and applications have arisen to permit quicker responses to consumer demands, better adaptability to market requirements, and the introduction novel practices at various process steps. In addition, businesses are increasingly utilizing e-business technologies, such as electronic auctions, electronic catalogs, and customer relationship management applications, to enhance their supply chain business processes (Zadeh et al., 2020). Incorporating electronic information flow into the coffee supply chain increases its efficiency.

Farmers in Karo Regency face the same hurdles in deciding coffee pricing and the supply chain for coffee. The problems in the management of the coffee supply chain in Karo Regency result from a lack of information flow, which in turn causes difficulties in establishing the price of coffee. Due to a lack of knowledge regarding the standardization of coffee pricing that collectors have established, farmers are unaware of the collectors' pricing system. Consequently, the purpose of this project is to offer a model for a platform that may integrate information on coffee standards and prices between farmers and collectors to assist farmers in determining the selling price of their coffee.

2. LITERATURE REVIEW

Many modeling notations and perspectives existed in 2001, contributing to the market fragmentation for process modeling (LópezPintado et al., 2019). Members of the Business Process Management Institute (BPMI), many of whom represented firms that contributed to the market's fragmentation, began discussing the idea of standardizing business-oriented techniques for visually representing process components and aligning the notation with an executable process language in this context (Augusto et al., 2019). This action was taken to standardize business-oriented methodologies for visually depicting process components and to match them with an executable process language. In May 2004, the BPMN 1.0 standard became available for review by the general public (Viriyasitavat et al., 2020). As a result, the fundamental purpose of the BPMN standard was to provide a notation that is simple for all business users to comprehend. This includes business analysts, who are responsible for creating the initial drafts of the processes; technical developers, who are responsible for implementing the technology that will perform those processes; and business people, who will manage and monitor those processes (Javidroozi et al., 2020).

Business process modeling was developed to provide a deeper knowledge of business processes (Kocbek et al., 2015). Business process modeling concludes with a process model. This model consists of activity models and execution restrictions between them (Mutarraf et al., 2018). Typically, it is represented by actions and events coupled with control flows (Tomaskova & Kopecky, 2020). These processes can be modeled using a variety of process modeling languages, often known as techniques or notations. It is vital to consider the choice of language, as not all modeling languages are suitable for usage in all phases of the process (Tomaskova et al. 2019). Due to this, there was an urgent need for the standardization of modeling languages, which had to match the standards of formality and expressiveness (Javidroozi et al., 2020).

The Business Process Model and Notation (BPMN) standard (LópezPintado et al., 2019) was demonstrated to be the most effective means of communication between information technology (IT) and business when compared to alternative graphical languages for BPMo already in use (Augusto et al., 2019). BPMN also offers a high level of expressiveness and facilitates the usage of numerous domain-specific extensions. BPMN is also supported by many commercial and open-source technologies (Mutarraf et al., 2018). Due to the variety of constructs, BPMN may be deemed a difficult notation (Tomaskova & Kopecky, 2020). The core question "how and why is BPMN used?" remains unsolved despite this. According to Javidroozi et al. (2020), the practical application of BPMN has not been exhaustively studied. In addition, there is a lack of consistent findings, despite the vast amount of work on this topic, dating back to 2004, when the first version of BPMN was published, and continuing to the present day.

In the 4.0 version of industry and the supply chain, mechanization, automation, the internet of things (IoT), and decision software-assisted tools are at the center (Frederico, 2021). Most of the concepts, processes, and tools are centered on applying emerging technology to industry and supply chain improvement. Recent technical advancements, such as updated information networks, software applications, and digital and connected industrial facilities, are examined in greater detail (Dossou, 2018). The social and environmental challenges are merely alluded to, without specifics, to be assimilated as the essential component of the transformation and evolution of industries (Makris et al., 2019). Supply chain 4.0 is the integration of manufacturing and communication technologies that increases the outputs of traditional supply chain systems through autonomous actions independent of location, pervasive integration, various automated services, and the capacity to respond contextually to customers' needs and demands (Frederico et al., 2020).

Supply chain 4.0 is also referred to as the fourth industrial revolution. The introduction of supply chain 4.0 produces a disruption that compels companies to reassess the architecture of their existing automated supply chain (Frederico et al., 2020). As a result of consumers' expectations of speed, dependability, and transparency, a substantial amount of new methodologies have emerged to modernize traditional operations. Not only must supply chains adapt, but they also can significantly improve operational efficiency and use the benefits offered by emerging digital supply chain business models (Dossou, 2018). This is in addition to the requirement for supply chains to change already. Supply chains will need to become more fluid, quick, transparent, and precise for the benefits to materialize.

Kabanjahe is the capital of one of the regencies in the province of North Sumatra, Karo. Karo Regency is geographically located in the Bukit Barisan mountain range (Jesisca & Hafid, 2020). Most of its landmass is mountainous, making it perfect for coffee cultivation. This is evident from the fact that the output of Karo coffee has increased steadily over the past five years (BPS, 2020). Farmers choose numerous elements and marketing channels, including the quantity of production, the quality of production, the price provided, and the existence of a grain coffee processing sector, when setting the price of coffee (Taib & Purnama Dini Hari, 2019). According to the research that has been cited, one of the factors influencing coffee pricing is the quality of the coffee itself; therefore, farmers should be allowed to sell or receive coffee prices based on the quality they supply.

Moreover, coffee supply chain activities involve multiple parties, including producers, collectors, processors, and distributors (Aziz et al., 2022). Hence, assessing the flow of products, cash, and confidential information from each partner is essential to the coffee supply chain. Especially for the flow of information in the supply chain, all stakeholders must incorporate technology (Septarianes et al., 2020). The influence of supply chain 4.0 emphasizes that technology in the supply chain will revolutionize the supply chain

Vol: 14 **No:** 04 **Year:** 2022 **ISSN**: 2146-0744 (Online) **(pp.** 151-173) **Doi:** 10.34109/ijefs. 202214207

paradigm by integrating information flow at a supply chain hub. Supply chain 4.0 will increase the effectiveness and efficiency of supply chain implementation. Consequently, supply chain 4.0 implementation is crucial (Ferrantino & Koten, 2019).

3. RESEARCH METHODOLOGY

3.1 Coffee Production in Karo Regency

The Karo Regency region is between 200 and 1,500 meters above sea level. It is surrounded by Langkat and Deli Serdang regencies to the north, Dairi and Samosir regencies to the south, Deli Serdang and Simalungun regencies to the east, and Nangroe Aceh Darussalam province to the west. Figure 1 provides additional information on the location of the Karo Regency.

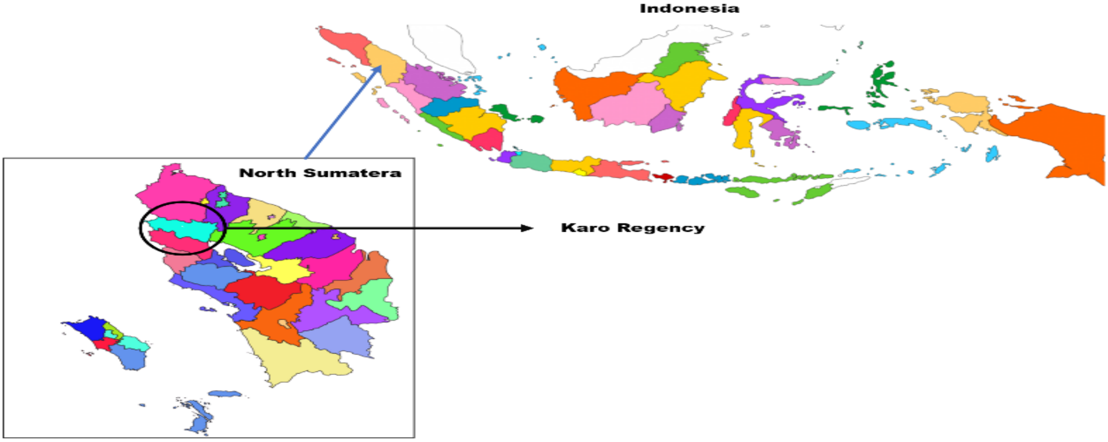


Figure 1. Karo Regency Administration Map

64.22% of the Karo Regency's people are employed in agriculture, and 13,142 families are coffee farmers. Each subdistrict contains coffee plantations, with the Tigapanah subdistrict containing the greatest coffee plantation area in the Karo district. The majority of Karo's coffee growers are traditional coffee farmers.

In addition, the poverty rate in Karo Regency in 2020 was 8.70%. This number is slightly lower than the 8.75% poverty rate in the province of North Sumatra. It suggests that coffee producers in Karo Regency are still considered to be impoverished. Thus, it is anticipated that this research will enhance the well-being of coffee farmers in the Karo Regency (BPS, 2020).

3.2 Coffee Pricing

Price determination for coffee is inextricable from the function of each participant in the supply chain. Generally, the price changes of Arabica coffee at the producer level mirror the price changes at the producer level during the previous period (Nasution, 2022). The results of both short-term and long-term projections indicate that farmers as producers have a very poor negotiating position when establishing the price of their products (Nasution & Rahmanta, 2022).

3.3 Coffee Supply Chain

In addition, it is essential to examine the coffee supply chain's supply chain pattern to determine the behavior of each stakeholder and the issues that lead the supply chain to become ineffective (Pangestuti et al., 2020). Thus, it is vital to have a platform to integrate information into the supply chain so that all stakeholders receive the same benefits and the supply chain becomes effective.

Farmers sell coffee beans to (i) collectors, (ii) product-processing units (UPH), and (iii) roasteries (specialty coffee shops) according to three distinct patterns (Darwis et al., 2020). Each of these marketing patterns is handled differently. In each pattern, all agents have a hand in determining the coffee price until it reaches the market.

3.4 The Importance of Information Flow in the Supply Chain

Case Diagrams are used to design e-commerce information systems to illustrate the system's goal. Use Case Diagrams to describe the system's external view and interactions with the outside world. Use Case Diagrams will be quite useful for studying a company's business operations (Handayani, 2018).

With the Business Process Model and Notation, a detailed business process in an organization can be modeled with the flow of information in the form of messages between linked parties (BPMN).

3.5 The Action Research Process

This study focuses on the information transfer between collectors and farmers in the supply chain for Arabica coffee. This study collected primary data, including coffee pricing and the flow of factual information along the coffee supply chain, from three subdistricts: Berastagi, Kaban Jahe, and Tigapanah. The Central Statistical Agency was contacted for secondary statistics on total coffee production. The major data-gathering mode involved direct observations and conversations with collectors and farmers. Literature studies, technical reports from linked agencies, and research institutions provided secondary data.

A model of the information flow system between collectors and farmers was created to process data. It was undertaken considering user requirements, including coffee quality criteria, coffee costs, and the quantity required by each collector. The system was modeled using Use Case Diagrams, the Business Process Model, and Notation to conceptualize the model (BPMN). The process was then proceeded by validating Use Case Diagrams and BPMN and defining the visualization of the system model design by developing system mock-ups. Figure 2 demonstrates the conceptual research framework.

Vol: 14 **No:** 04 **Year:** 2022 **ISSN**: 2146-0744 (Online) (**pp.** 151-173) **Doi:** 10.34109/ijefs. 202214207

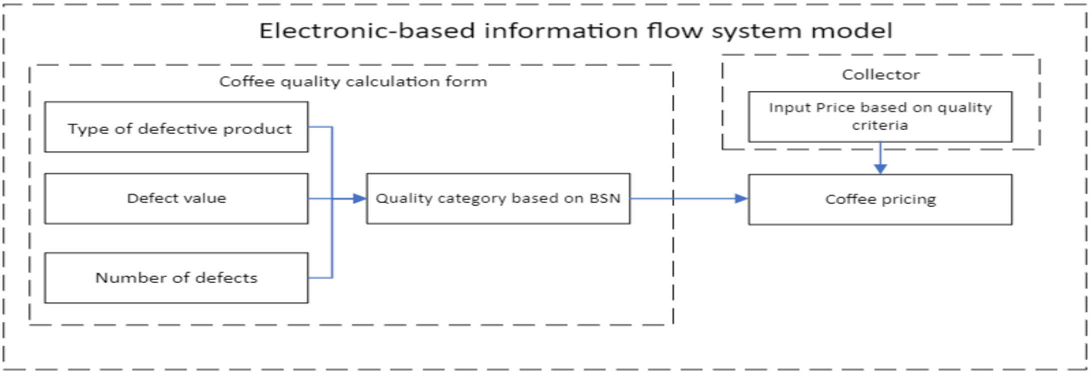


Figure 2. Research Conceptual Framework

4. RESULTS AND DISCUSSION

4.1 Variable Descriptive Analysis

Price variations resulted from disparities in coffee quality sold by farmers and collectors' market-winning methods. During the observation, the researcher saw that each collector lacked specific criteria for deciding pricing and quality. The sampling method was still conducted descriptively, without adherence to SNI's quality criteria. The farmer-level model of the coffee selling and purchase system in Tanah Karo is depicted in Figure 3.

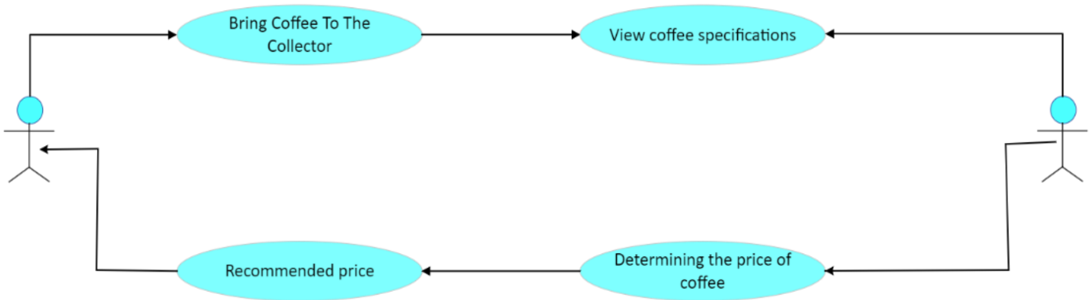


Figure 3. The Use Case Diagram of Coffee Sale and Purchase Model in Tanah Karo

At the collector level, the norm for determining the quality and price of coffee beans was descriptive sampling. Thus, producers were unable to determine the quality of their coffee. In addition, collectors failed to notify farmers about the stages involved in establishing the coffee's quality and price. Thus far, collectors have recommended that farmers increase their income by segregating imperfect coffee beans from the pile of coffee that will be sold. This practice occurred without explaining to farmers the categorization of coffee quality based on the extent of the flaw. Thus, it is vital to increase coffee quality standards following the 2017 National Standardization Body (BSN) requirements. Table 1. displays the quality standardization of coffee beans according to the Indonesian National Standard (SNI).

Vol: 14 **No:** 04 **Year:** 2022 **ISSN**: 2146-0744 (Online) (**pp.** 151-173) **Doi:** 10.34109/ijefs. 202214207

Table 1. Form of Determination of Coffee Beans Defect Value

Type of Defects	Value of Defects (A)	Number of Defects (B)	Number of Defects Values (C)
1 (one) black seed	1 (one)		
1 (one) partial black seed	(half)		
1 (one) broken black seed	(half)		
1 (one) coffee	1 (one)		
1 (one) cocoa	(quarter)		
1 (one) large-sized coffee	1 (one)		
1 (one) medium-sized coffee	(half)		
1 (one) black seed	1 (one)		
1 (one) partial black seed	(half)		
1 (one) broken black seed	(half)		
1 (one) coffee	1 (one)		
1 (one) small horn skin	1/10 (one-tenth)		
1 (one) broken seed	1/5 (one-fifth)		
1 (one) young seed	1/5 (one-fifth)		
1 (one) seed with one hole	1/10 (one-tenth)		
1 (one) seed with more than one hole	1/5 (one-fifth)		
1 (one) spotted seed	1/10(one tenth)		
1 (one) twig, soil, or large stone	5 (five)		
1 (one) medium-sized twig, soil, or stone	2 (two)		
1 (one) twig, soil, or small stone	1 (one)		
Information: The total defect value is calculated from a test sample weighing 300 g. If one coffee bean has more than one defect value, the defect value is determined based on the weight of the most prominent defect value.			

The formula for calculating the total number of defects is as follows.

C= A X B

After increasing coffee standardization by referencing the Indonesian National Standard, a Use Case Diagram, Business Process Model and Notation, and System Mock-Up were created. Using Power designer software, a Use Case Diagram was developed.

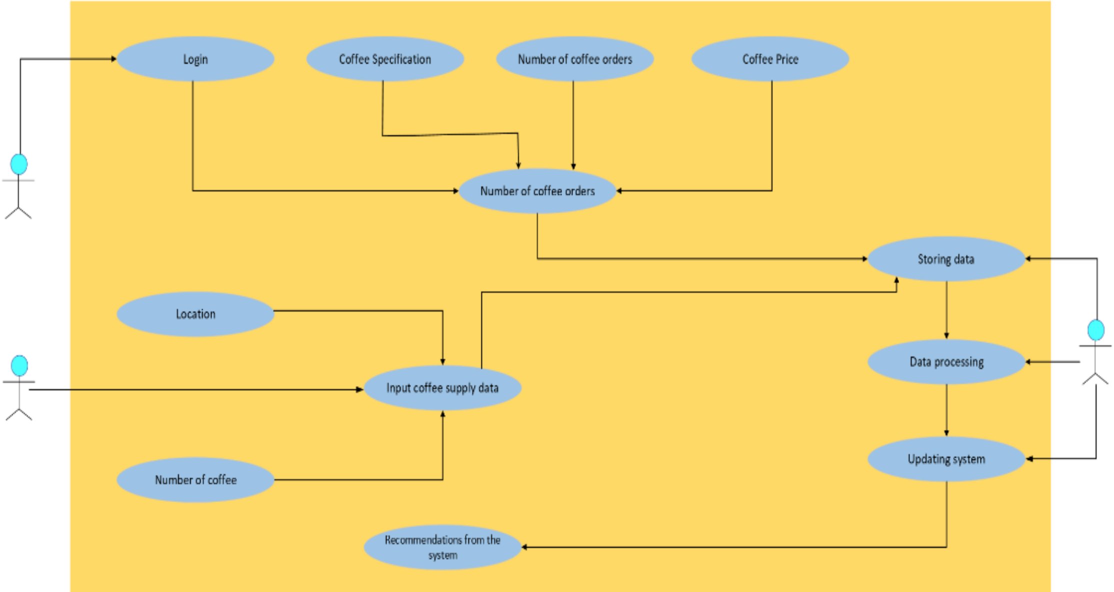


Figure 4. System Model of Use Case Diagram

The results of the model verification are shown in Figure 5 below:

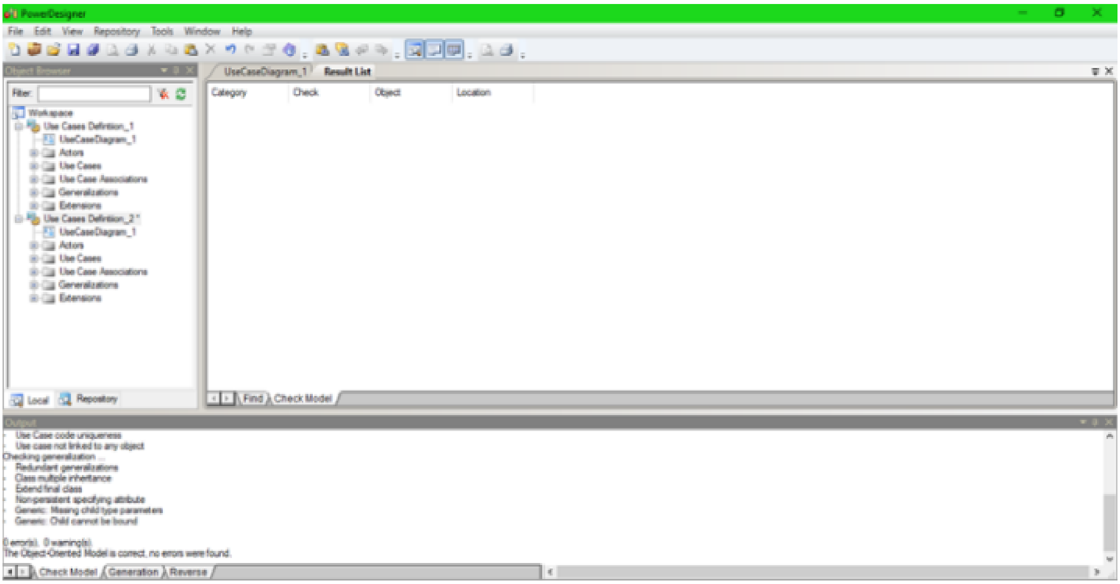


Figure 5. Verification of Use Case Diagram System Model

From the picture above, verification results show that the model form is correct.

Business Process Model and Notation (BPMN) is a graphical representation of business processes within the business process model. The primary purpose of BPMN is to offer a standard notation that all business stakeholders easily understand. This includes

Vol: 14 **No:** 04 **Year:** 2022 **ISSN**: 2146-0744 (Online) (**pp.** 151-173) **Doi:** 10.34109/ijefs. 202214207

business analysts who establish and improve procedures, technical developers responsible for their implementation, and business managers who oversee and manage them. As a result, BPMN serves as a common language that bridges the frequent communication gap between business process design and execution. The Business Process Model and Notation were created using Power designer software. This system's Business Process Model and Notation are depicted in Figure 6.

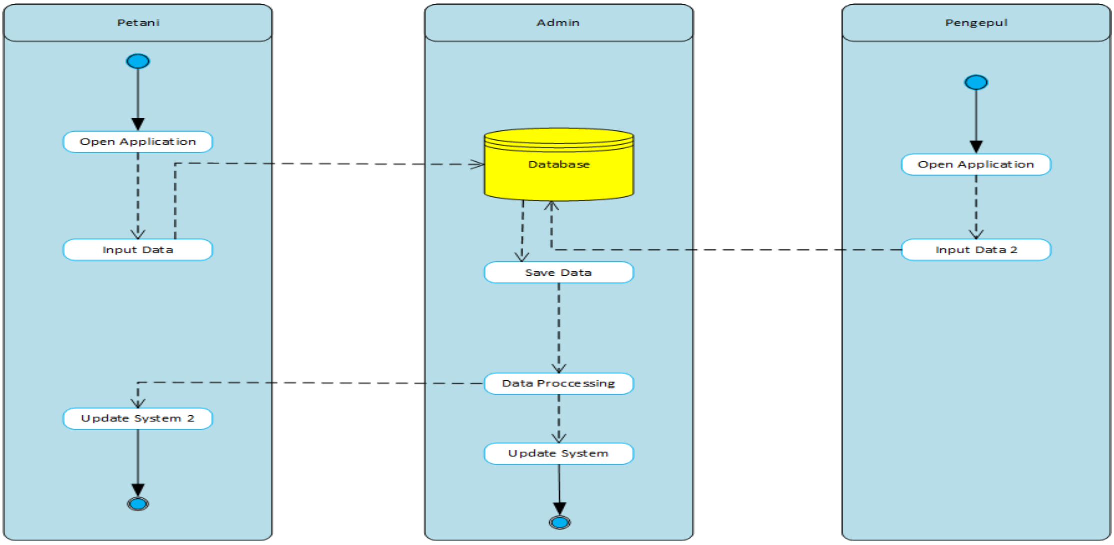


Figure 6. BPMN System

Using the power designer application, a model verification was conducted to determine the constructed system's conceptual validity. Figure 7 depicts the model verification results.

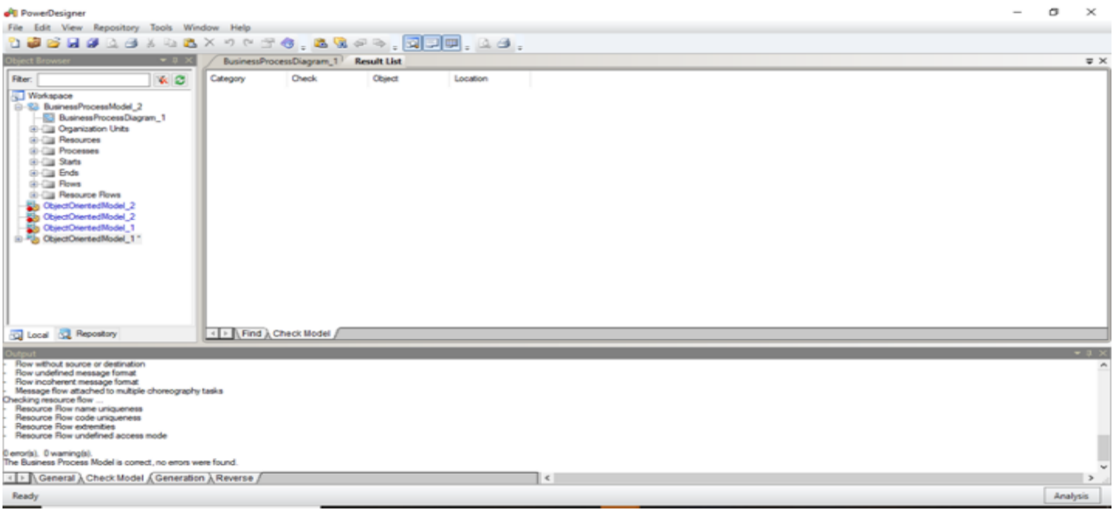


Figure 7. System BPMN Verification

Vol: 14 **No:** 04 **Year:** 2022 **ISSN**: 2146-0744 (Online) **(pp.** 151-173) **Doi:** 10.34109/ijefs. 202214207

From the verification results obtained, it is found that the model formed is correct.

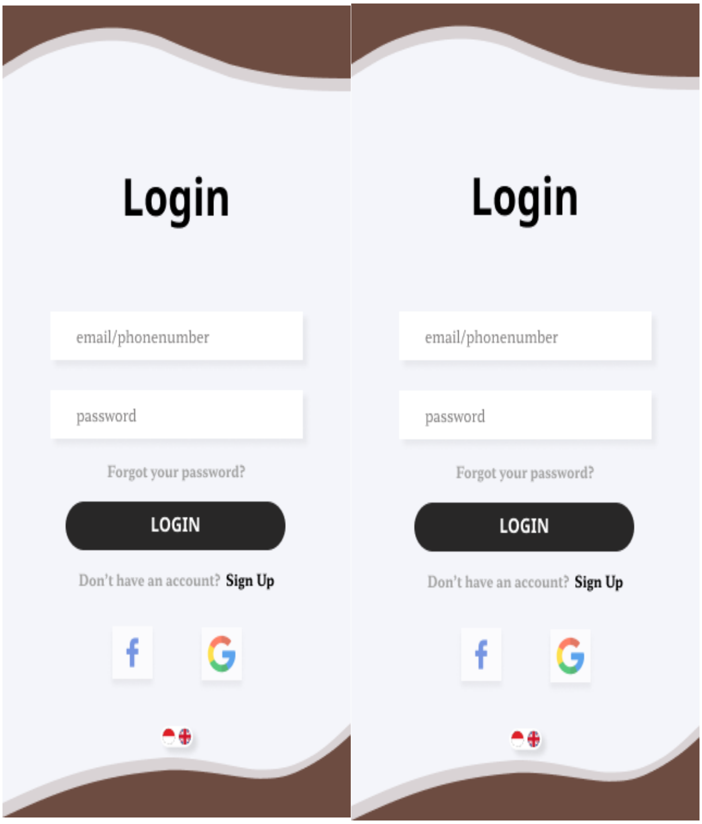
The system model is constructed using mock-up software and serves as an interface between collectors and farmers. Using internet-based media, this concept is utilized to optimize information flow. The outcomes of the constructed model are as follows.

5. QUANTITATIVE ANALYSIS

5.1 Collector Interface

a. Initial View

The initial view of the collector interface is shown in Figure 8 below.



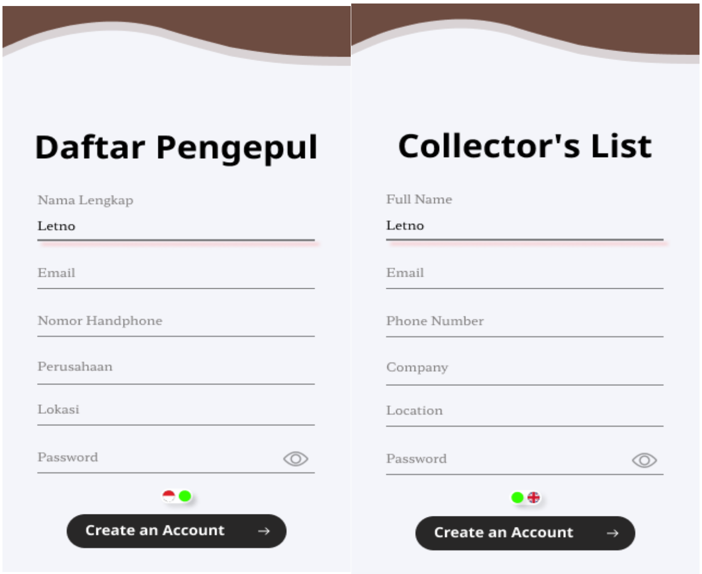
(a) (b)

Figure 8. (a) Collector Interface Initial View Indonesian Version (b) Collector Interface Initial View English Version

b. List view to signing up as a Collector.

The display as a collector is shown in Figure 9 below.

Vol: 14 **No:** 04 **Year:** 2022 **ISSN**: 2146-0744 (Online) (**pp.** 151-173) **Doi:** 10.34109/ijefs. 202214207

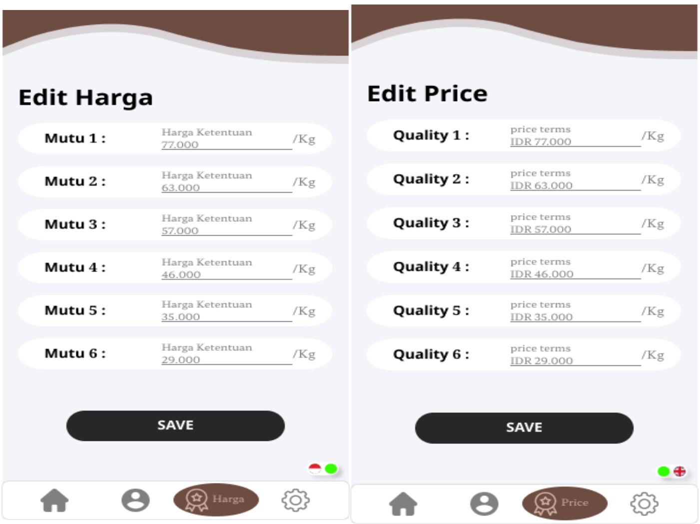


(a) (b)

Figure 9. (a) Collector Sign up View Indonesian Version (b) Collector Sign up View Indonesian Version English Version

c. Input Coffee Price

The coffee price input is shown in Figure 10 below.



(a) (b)

Figure 10. (a) Coffee Price Input Display Indonesian Version (b) Coffee Price Input Display English Version

Vol: 14 **No:** 04 **Year:** 2022 **ISSN**: 2146-0744 (Online) (**pp.** 151-173) **Doi:** 10.34109/ijefs. 202214207

5.2 Farmer Interface

a. Initial View

The initial view of the farmer interface is shown in Figure 11 below.

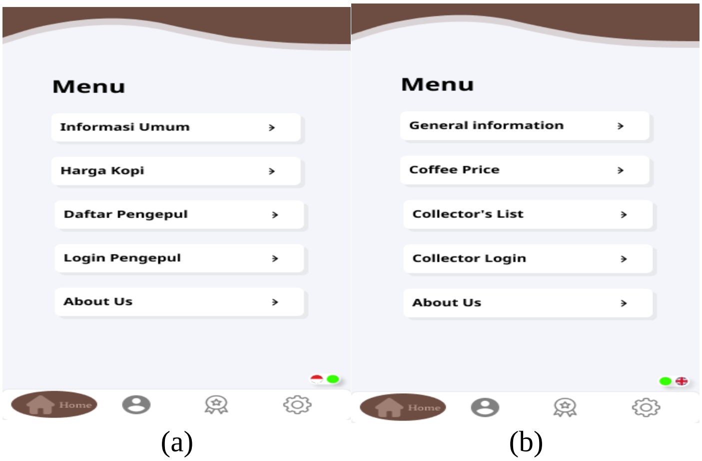
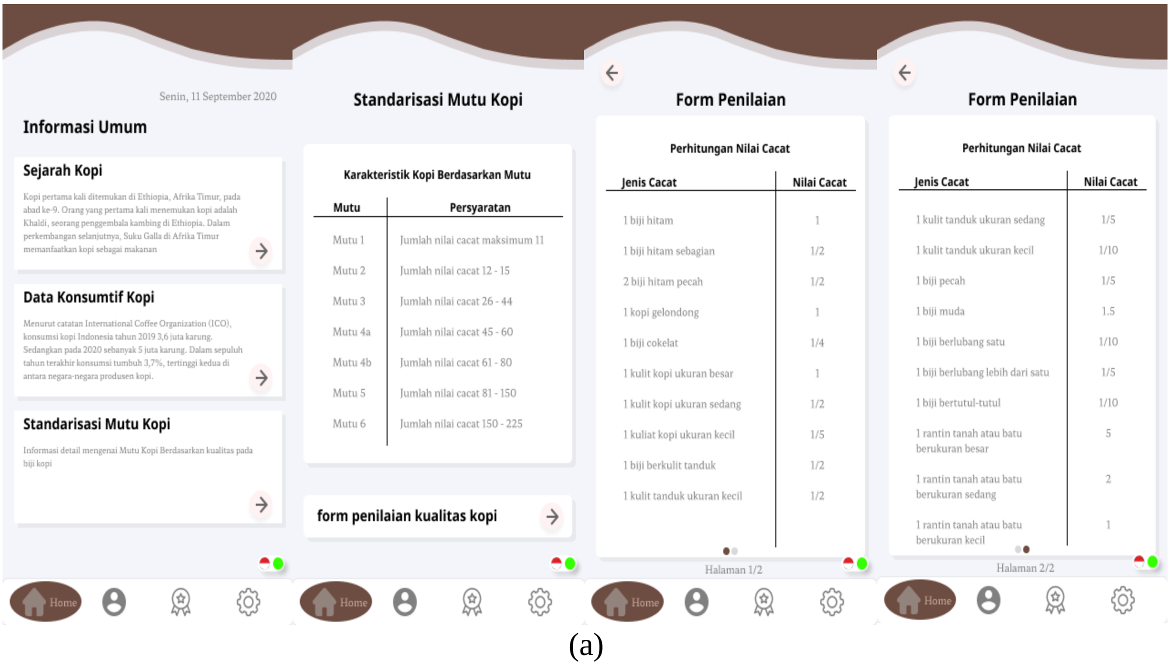
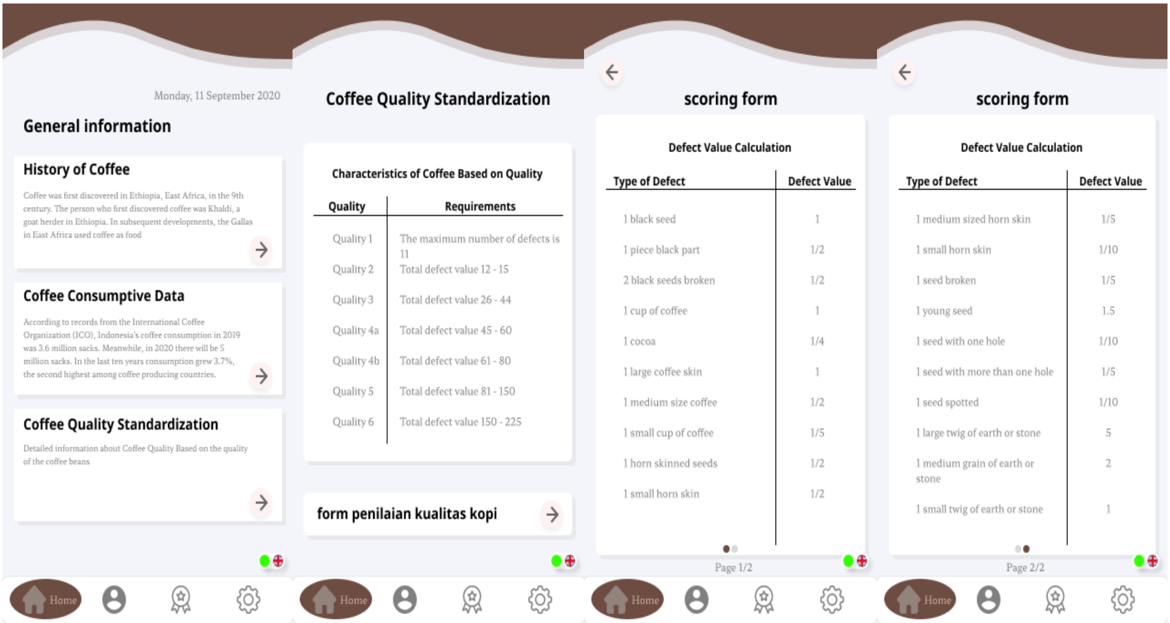


Figure 11. (a) Farmer Interface Initial View Indonesian Version (b) Farmer Interface Initial View English Version

b. General Information Display

General Information Display is shown in Figure 12 below.



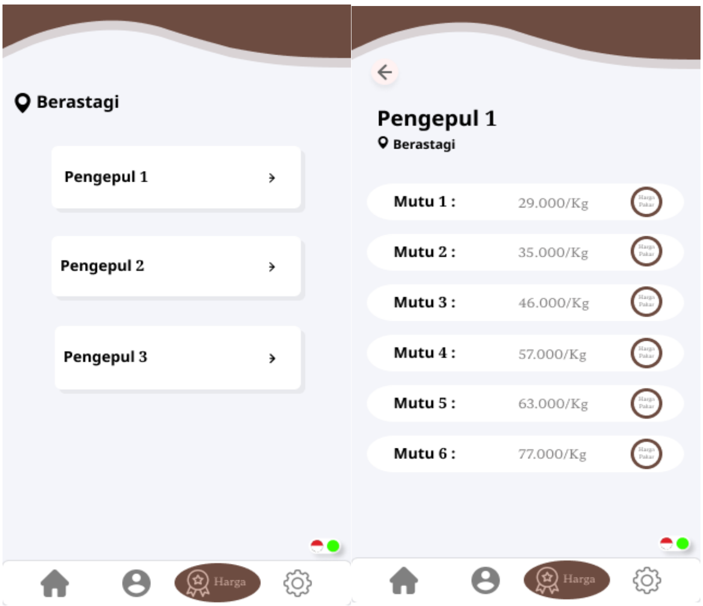


(b)

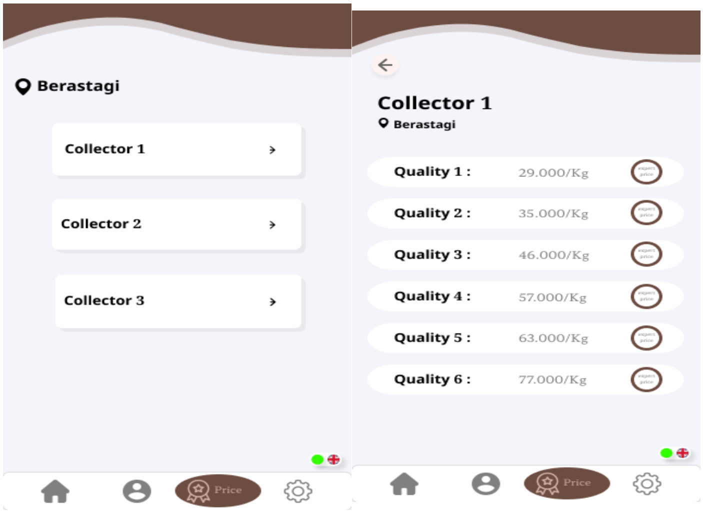
Figure 12. (a) General Information Display Indonesian Version (b) General Information Display English Version

c. Coffee Price Display

The coffee price display is shown in Figure 13 below.



(a)



(b)

Figure 13. (a) Coffee Price Display Indonesian Version (b) Coffee Price Display English Version

d. Collector List View

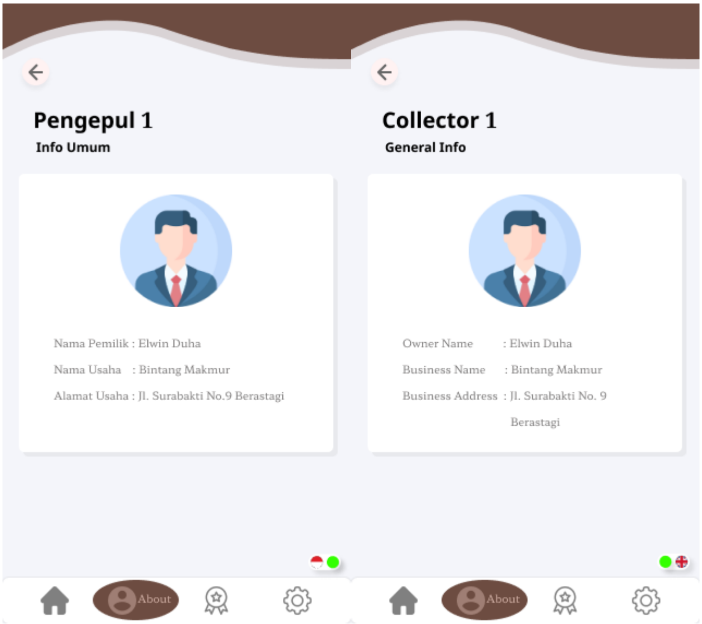
The view of the Collectors List is shown in Figure 14 below:

(a) (b)

Figure 14. (a) Collector List View Indonesian Version (b) Collector List View English Version

e. About Us display

The About Us display is shown in Figure 15 below.



(a) (b)

Figure 15. (a) About Us Display Indonesian Version (b) About Us Display View English Version

6. DISCUSSION AND IMPLICATIONS

The quality of the coffee produced by farmers determines the pricing of coffee. The issue in the industry until recently has been the lack of clarity in judging the quality of coffee by collectors, resulting in variable coffee pricing (Madhyamapurush, 2023). With the planned improvement of coffee standardization that refers to the 2017 Indonesian National Standardization (SNI) released by the Indonesian National Agency (BSN), it is envisaged that the pricing issue will become more clear (Handayani et al., 2023). In addition, with the planned standardization of SNI, which is then entered into an electronic-based information flow system, farmers can view the purchase price entered by collectors. This increases the health and transparency of market competition. Farmers can also have more discretion over who collectors they do sales and purchases with.

The electronic-based information flow model's design for assessing coffee beans' cost in Tanah Karo has a number of theoretical consequences. For example, the study of an electronic-based information flow model design for determining the price of coffee beans in Tanah Karo advances the information flow theory. This theory highlights the significance of information sharing and dissemination for decision-making processes. The study employs electronic-based information flow models to demonstrate how information can be communicated rapidly and precisely, facilitating more effective decision-making. Concurrently, the model is predicated on the notion that knowledge is essential for establishing the price of coffee beans. The model aims to facilitate the flow of information between buyers and sellers via an electronic system. This strategy adheres to the tenets of information economics, which assert that information is an economic resource that influences market outcomes.

In addition, the model has ramifications for studying behavioral economics, which investigates how people make decisions in real-world contexts. The model presupposes that buyers and sellers are rational agents that respond to alterations in market conditions, but this may not always be the case. By examining individuals' market behavior, we may better understand how prices are determined and how they might be changed. The approach has implications for supply chain management, which focuses on coordinating the production and delivery of goods and services. By enhancing the flow of information between buyers and sellers, the model aims to increase the supply chain's efficiency. The model can assist us in comprehending how to optimize supply chain performance in the coffee industry and other sectors.

Moreover, by building a dependable model of electronic information flow, buyers and sellers of coffee beans in Tanah Karo can make more educated pricing selections. This can assist in ensuring that the price of coffee beans appropriately reflects market demand and supply, resulting in increased profitability for coffee farmers and reasonable pricing for customers. In addition to enhancing market efficacy, the electronic-based information flow paradigm can help to reduce information asymmetry. The model can provide real-time updates on coffee bean pricing and market conditions, enabling buyers and sellers to make better-informed decisions and prevent market inefficiencies.

The establishment of an electronic model of information flow can help boost the market's transparency in Tanah Karo. Ensuring all participants have access to accurate and up-to-date information on the coffee bean market can help decrease corruption and encourage fair trade practices. The data acquired by the model of electronic information flow can be utilized for analysis and decision-making. This can help buyers and sellers of coffee beans recognize market trends and patterns, enabling them to make more educated decisions about whether to purchase or sell coffee beans. Hence, by giving more precise pricing information, the model can assist in ensuring that Tanah Karo coffee beans are priced competitively and attractively on the worldwide market.

7. CONCLUSION AND SUGGESTION

7.1 Conclusion

After conducting the action study, it can be stated that the 2017 Indonesian National Standardization (SNI) published by the National Standardization Agency (BSN) can assist collectors in assessing the quality and price of coffee. In addition, an electronic information-based information flow model is designed by constructing Use Case Diagrams, business process models, and notations, followed by system mock-ups to visualize the model. Pricing is calculated based on six qualities defined by SNI. Each collector can enter a fair price, making the price competition more transparent as each collector is aware of the purchase price of its competitors.

7.2 Suggestions

The study entitled "Electronic-Based Information Flow Model Design as a Foundation for Calculating the Pricing of Coffee Beans in Tanah Karo" may have several shortcomings and possible future research directions:

The research is limited to Tanah Karo coffee beans, and its conclusions may not apply to other regions or varieties of coffee beans. To confirm these findings, future research could expand its reach to cover additional areas and varieties of coffee beans. In addition, the study's sample size may not be typical of the Tanah Karo coffee bean market. Further research could enhance the sample size to increase the results' dependability.

The study mainly relies on models of electronic information flow, which may not be available or practical in all coffee bean markets. Future research may investigate other pricing structures that do not rely on technology. The study does not account for external factors, such as weather, global coffee pricing, and political instability, which may influence the price of coffee beans. Further research could study how these characteristics affect the pricing model. Similarly, this study does not include input from all market participants, such as coffee producers and wholesalers. Future research could incorporate their viewpoints to develop a more inclusive pricing strategy.

This study does not examine the sustainability of coffee production and its effect on pricing. Future research could investigate incorporating sustainability principles into the pricing model to foster an environmentally and socially responsible coffee sector. The electrical model can be evaluated using game theory, a field of mathematics that investigates interactions involving strategic decision-making. Many parties, including coffee growers, traders, and purchasers, each with their interests and methods, are involved in the model. The theory of games can help us comprehend how these market participants interact and make decisions in a dynamic context.

REFERENCES

Augusto, A., Conforti, R., Dumas, M., La Rosa, M., & Polyvyanyy, A. (2019). Split miner: automated discovery of accurate and simple business process models from event logs. *Knowledge and Information Systems*, *59*, 251-284. doi: https://doi.org/10.1007/s10115-018-1214-x

Azis, A. M., Irjayanti, M., & Rusyandi, D. (2022). Visibility and Information Accuracy of Coffee Supply Chain in West Java Indonesia. In *Modeling Economic Growth in Contemporary Indonesia*, 225-236. Emerald Publishing Limited. https://doi.org/10.1108/978-1-80262-431-120221014

Bager, S. L., Singh, C., & Persson, U. M. (2022). Blockchain is not a silver bullet for agro-food supply chain sustainability: Insights from a coffee case study. *Current Research in Environmental Sustainability*, *4*, 100163. https://doi.org/10.1016/j.crsust.2022.100163

BPS. (2020). *Karo Regency in Figures 2020. Sumatra: Central Agency for Statistics of Karo Regency*. Retrieved from https://karokab.bps.go.id/publication/2020/05/14/20d25edf8b2b6a2c7d4402c9/kabupaten-karo-dalam-angka-2020.html

Central Agency on Statistics. (2020). *Indonesian Coffee Statistics 2020*. Sumatera: Pusat Statistik Kabupaten Karo. Retrieved from https://www.bps.go.id/publication/2021/11/30/b1b6cf2a6aad1ee2d8a4c656/statistik-kopi-indonesia-2020.html

Chopra, S. (2019). *Supply Chain Management Strategy, Planning, and Operation (7th ed.)*. London: Pearson Education Limited. Retrieved from https://base-logistique-services.com/storage/app/media/Chopra_Meindl_SCM.pdf

Darwis, V., Saputra, Y. H., & Muslim, C. (2020). Performance and Development of Robusta Coffee Agribusiness in Lampung Province (Case Study: Tanggamus District). *Journal of Food System and Agribusiness*, 83–91. doi: https://doi.org/10.25181/jofsa.v4i2.1649

Dossou, P. E. (2018). Impact of Sustainability on the supply chain 4.0 performance. *Procedia Manufacturing*, *17*, 452-459. doi: https://doi.org/10.1016/j.promfg.2018.10.069

Ferrantino, M. J., & Koten, E. E. (2019). Understanding Supply Chain 4.0 and its potential impact on global value chains. *Technological Innovation, Supply Chain Trade, and Workers in A Globalized World*, 103-119. Retrieved from https://www.wto.org/english/rese/bookspe/gvcdevreport2019ech5.pdf

Frederico, G. F. (2021). From supply chain 4.0 to supply chain 5.0: Findings from a systematic literature review and research directions. *Logistics*, *5*(3), 49. doi: https://doi.org/10.3390/logistics5030049

Frederico, G. F., Garza-Reyes, J. A., Anosike, A., & Kumar, V. (2020). Supply Chain 4.0: concepts, maturity, and research agenda. *Supply Chain Management: An International Journal*, *25*(2), 262-282. doi: https://doi.org/10.1108/SCM-09-2018-0339

Hanaysha, J. R., & Alzoubi, H. M. (2022). The effect of the digital supply chain on organizational performance: An empirical study in Malaysia manufacturing industry. *Uncertain Supply Chain Management*, *10*(2), 495-510. https://doi.org/10.5267/j.uscm.2021.12.002

Handayani, M. N., Ramadhan, M. O., Maharani, S., Cakrawati, D., & Mukhidin, M. (2023). E-Module Development of Sustainable Coffee Processing to Improve Vocational Students' Green Skills. *Jurnal Kependidikan: Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran*, *9*(1), 66-79. https://doi.org/10.33394/jk.v9i1.7194

Handayani, S. (2018). E-Commerce Based Sales Information System Design Case Study of Toko Kun Jakarta. *ILKOM, Jurnal Ilmiah*, *10*(2), 182-189. doi: https://doi.org/10.33096/ilkom.v10i2.310.182-189

International Coffee Organization. (2019). *Exports of all forms of coffee by all exporting countries*. Retrieved from https://www.ico.org/

Javidroozi, V., Shah, H., & Feldman, G. (2020). A framework for addressing the challenges of business process change during enterprise systems integration. *Business Process Management Journal*, *26*(2), 463-488. doi: https://doi.org/10.1108/BPMJ-03-2019-0128

Jesisca, M., & Hafid, S. (2020). Ecotourism potential development of Bukit Barisan forest park in Karo Regency. *Advances in Management*, *13*(2), 17-23. Retrieved from https://www.proquest.com/openview/90c6e62230aa8f939335d4f47e0f94ab/1?pq-origsite=gscholar&cbl=2030322

Kocbek, M., Jošt, G., Heričko, M., & Polančič, G. (2015). Business process model and notation: The current state of affairs. *Computer Science and Information Systems*, *12*(2), 509-539. Retrieved from https://www.doiserbia.nb.rs/Article.aspx?id=1820-02141500006K

López-Pintado, O., García-Bañuelos, L., Dumas, M., Weber, I., & Ponomarev, A. (2019). Caterpillar: a business process execution engine on the Ethereum blockchain. *Software: Practice and Experience*, *49*(7), 1162-1193. doi: https://doi.org/10.1002/spe.2702

Madhyamapurush, W. (2023). Analysis of factors affecting tourist involvement in coffee tourism after the COVID-19 pandemic in Thailand. *F1000Research*, *11*(1269), 1269. https://doi.org/10.12688/f1000research.123759.2

Makris, D., Hansen, Z. N. L., & Khan, O. (2019). Adapting to supply chain 4.0: an explorative study of multinational companies. In *Supply Chain Forum: An International Journal*, *20*(2), 116-131). Taylor & Francis. doi: https://doi.org/10.1080/16258312.2019.1577114

Min, H. (2022). Examining the impact of energy price volatility on commodity prices from energy supply chain perspectives. *Energies*, *15*(21), 7957. https://doi.org/10.3390/en15217957

Ministry of Agriculture. (2020). *Coffee Outlook 2020*. Jakarta: Department of Agriculture.

Mutarraf, U., Barkaoui, K., Li, Z., Wu, N., & Qu, T. (2018). Transformation of Business Process Model and Notation models onto Petri nets and their analysis. *Advances in Mechanical Engineering*, *10*(12), 1687814018808170. doi: https://doi.org/10.1177/1687814018808170

Nabila, A. W., Mahendrawathi, E. R., Chen, J. C., & Chen, T. L. (2021). The impact analysis of information technology alignment for information sharing and supply chain integration on customer responsiveness. *Procedia Computer Science*, 197, 718–726. doi: https://doi.org/10.1016/j.procs.2021.12.193

Nasution, S. K. H., & Rahmanta, R. (2022). Analysis of Price Transmission and Price

Formation Factors at the Level of Arabica Coffee Marketing Institutions in North Tapanuli Regency, North Sumatra, Indonesia. *Agro Bali : Agricultural Journal*, *5*(1), 67–75. doi: https://doi.org/10.37637/ab.v5i1.869

Nurullah, S. A. (2022). Practice Services Between Sale and Purchase of Coffee Syari'ah Economic Perspective. *Nusantara Economy*, *1*(1), 14-28. https://juna.nusantarajournal.com/index.php/numy/article/view/22

Pangestuti, E., Sanawiri, B., Hanum, L., Robith, D. M., & Fahmi, A. (2020). The Effectiveness of the Coffee Supply Chain in the UB Forest Region, Malang Regency. *In Jurnal Sains Manajemen dan Bisnis Indonesia 10*(1), 18-23. doi: https://doi.org/10.32528/jsmbi.v10i1.3382

Prasetyo, E., Listiyaningsih, D., Setiadi, A., Mukson, M., Roessali, W., & Ekowati, T. (2022). Factors determining income and product type of Robusta coffee farming in Central Java, Indonesia. *International Social Science Journal*, *72*(245), 737-748. https://doi.org/10.1111/issj.12362

Rosiana, N. (2020). Dynamics of Coffee Marketing Patterns in Main Production Centers in Indonesia. *Jurnal Agrosains Dan Teknologi*, 5(1), 1-10. doi: https://doi.org/10.24853/jat5.1.1-10

Sari, P. A., Suryana, U., & Hedismarlina, M. (2018). Analysis of the Problems of Community Coffee Plantation Farmers in Pangalengan By Adapting Theory Of Change. *Jurnal Dharma Bhakti Ekuitas*, 02(02), 2528–2190. doi: https://doi.org/10.52250/p3m.v2i2.77

Sembiring, M. T., Pasaribu, F. M., Nu'man, A. H., & Gurusinga, L. N. (2022). Data on Area, Production and Productivity of People's Plantations From 2015 to 2019. *csv*. doi: https://doi.org/10.6084/m9.figshare.20507322.v1

Sembiring, M. T., Pasaribu, F. M., Nu'man, A. H., & Gurusinga, L. N. (2022). Farmer-level Coffee Prices From middleman: UD.Simpang Singa, UD. *Milala Kopi, UD Loken Coffee*. doi: https://doi.org/10.6084/m9.figshare.20507826.v1

Septarianes, S., Marimin, & Raharja, S. (2020). Performance Improvement Strategy and Supply Chain Sustainability of Robusta Coffee Agroindustry in Tanggamus Regency. *Jurnal Teknologi Industri Pertanian*, 207–220. doi: https://doi.org/10.24961/j.tek.ind.pert.2020.30.2.207

Siti Khadijah Hidayati Nasution, R. (2022). Benefits Of Arabica Coffee For Health And Causality Analysis Of Arabica Coffee Prices In North Tapanuli Regency, Indonesia. *Journal of Pharmaceutical Negative Results*, 6756-6762. https://doi.org/10.47750/pnr.2022.13.S09.805

Taib, G., & Hari, P. D. (2019). Supply Chain Analysis and Marketing of Coffee Beans in West Sumatra. *Jurnal Teknologi Pertanian Andalas*, *23*(1), 111-116. doi: https://doi.org/10.25077/jtpa.23.1.111-116.2019

Tamru, S., & Minten, B. (2023). Value addition and farmers: Evidence from coffee in Ethiopia. *Plos one*, *18*(1), e0273121. https://doi.org/10.1371/journal.pone.0273121

Tomaskova, H., & Kopecky, M. (2020). Specialization of business process model and notation applications in Medicine—A review. *Data*, *5*(4), 99. doi: https://doi.org/10.3390/data5040099

Tomaskova, H., Maresova, P., Penhaker, M., Augustynek, M., Klimova, B., Fadeyi, O., & Kuca, K. (2019). The business process model and notation of open innovation: The process of developing medical instrument. *Journal of Open Innovation: Technology, Market, and Complexity*, *5*(4), 101. doi: https://doi.org/10.3390/joitmc5040101

Vanpoucke, E., Vereecke, A., & Muylle, S. (2017). Leveraging the impact of supply chain integration through information technology. *International Journal of Operations and Production Management*, *37*(4), 510–530. doi: https://doi.org/10.1108/IJOPM-07-2015-0441

Viriyasitavat, W., Da Xu, L., Bi, Z., & Sapsomboon, A. (2020). Blockchain-based business process management (BPM) framework for service composition in industry 4.0. *Journal of Intelligent Manufacturing*, *31*(7), 1737-1748. doi: https://doi.org/10.1007/s10845-018-1422-y

Zadeh, A. V., Ramayah, T., Hanifah, H., Kurnia, S., & Mahmud, I. (2020). Supply chain information integration and its impact on the operational performance of manufacturing firms in Malaysia. *Information and Management*, *57*(8), 103386. doi: https://doi.org/10.1016/j.im.2020.103386