

# **Mobile Application Implementation as Agriculture 4.0 Strategy for Sugarcane Yield Prediction**

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## **Abstract**

Information engineering strategies play a vital role in agriculture 4.0 to increase the product value, one of which is sugarcane commodities. Sugarcane production estimation has traditionally been practiced by recording data on a paper note. The recorded data were subsequently transferred to a computer by a sugar factory plantation assistant. Errors in calculating or inputting data into a computer can occur, storage space for paper documents is also limited, and farmers cannot independently calculate their production potential. Therefore, our study aims to create an android-based sugarcane production application as an information engineering strategy to predict sugarcane yields by farmers and plantation assistants. This study used the waterfall method with the SDLC (Software Development Life Cycle) model. Observations were performed by collecting data. Interviews were conducted with plantation assistants to produce related information on how to calculate sugarcane estimation. The analysis was carried out by examining the relationship between observation and interview data as a tool for developing an application interface and algorithm system design. The application makes it easier for farmers to estimate production potential, allowing them to get data on sugarcane productivity during harvest. Hence, the sugar factory could guarantee the quantity and quality of sugarcane raw materials.

## **Keywords**

Agriculture 4.0, Productivity, Estimation, Android Applications and Sugarcane.

## **1. Introduction**

Information on increasing commodity production is significant in the current era to be accessible to various elements of the agricultural community. An information engineering strategy is crucial in industrial revolution 4.0. countries (Davenport & Short, 1990). Indonesia has started implementing an industry 4.0 strategy and applying it to various development sectors, for example, agriculture 4.0 in the agroindustry. By putting it in a mobile application, all members of society, particularly smallholders in agriculture and plantations, will have simple access to an information system and management. Mobile application as an implementation strategy of information engineering can increase the big commodities production in Indonesia, especially sugarcane.

Today, Sugarcane is one of the leading commodities in Indonesia. The area of sugarcane still has an impact on the increment of sugarcane productivity in Indonesia. The development of sugar production from 2015 to 2019 tends to decline. Sugar production has decreased due to a decrease in area. According to its cultivation till 2019, community-owned plantations represent 57% of Indonesian sugar production, followed by private plantations at 29% and state-owned plantations at 14% (Perkebunan, 2018; Badan Pusat Statistik Indonesia, 2019). Sugarcane agriculture began to transition from paddy/wetland to dry/dry land, resulting in lower crop productivity. Land conversion for the production of other crops, such as soybeans, tobacco, watermelon, corn, and chili pepper, is triggered by improved income and profit gains with a shorter planting age (about four months) (Hermawan, 2012). One of the reasons for the decline in sugarcane productivity in Indonesia is the use of dry land that is less fertile (Mulyono, 2018).

Sugarcane productivity can be improved by increasing the number of populations per hectare, the number of stems per meter line, and the line factor (total line length per hectare) (Manimaran et al., 2009; Khuluq & Mulyaningsih, 2016). The increase in the population of sugarcane plants must be followed by the use of fertilizer doses so that the weight of the sugar cane does not decrease (Nurhidayati et al., 2013). The calculation of the total population per hectare and weight per plant becomes a reference in the sugarcane yield estimation at harvest. Estimated production counts can also be referred to as production estimates. When the sugarcane plantation was cut down, the estimated value represents the potential for sugarcane output (cane weight) (Fajri & Arifin, 2018). Production estimation on sugarcane can be done three times, namely in August, December and March. Estimating sugarcane production is usually handled manually, with a calculator and paper note as the recording medium.

The problem in manual estimation is the discrepancy between the values on the calculator and the recording media due to illegible or unreadable values. In addition, note storage with paper is not durable, easily damaged by rain and paper age, nor is it easy to disseminate. Human error also occurs during estimation, such as the wrong calculation formula, resulting in inaccurate estimation data. All of these problems can be overcome by using technology to assist in sugarcane production prediction. Because of its compact size, which allows it to be carried in the palm of your hand, everyone has a device that can be implemented to handle information and communication in today's modern technological era. We had developed technologies such as hybrid support regression (Caraka et al., 2017), crowdsourcing annotation systems (Cenggoro et al., 2018a), texture-based foreground segmentation (Muchtart et al., 2018), artificial intelligence (AI) (Prabowo et al., 2018; Lumbanraja et al., 2019), management information system (Gunawan & Pardamean, 2013; Pardamean et al., 2013; Pardamean et al., 2019), embedding model design (Rahutomo et al., 2019b), and Decision Support System (DSS) application (Atmojo et al., 2014) to organized data to reduce human error in processing analyze data.

We had also applied these technologies to the management of information systems such as databases (Baurley et al., 2013), knowledge system models (Soeparno et al. 2018), as well as application of bioinformatics toolkits (Baurley et al., 2019) to solve agricultural problems. Recently, several android-based application developments and implementation information systems had begun to be used by several farmers in Indonesia for estimation (Cenggoro et al., 2018b; Rahutomo et al., 2019a; Harsawardana et al., 2020) and simulation (Putra & Firmansyah, 2019; Putra et al., 2020) to increase crop yields or price value product (Caraka et al. 2018b) and also predict environment plantation factors (Caraka et al. 2018c; Caraka et al. 2018a).

Therefore, this research was conducted to develop an android-based sugarcane estimation mobile application as an information engineering strategy that can predict sugarcane yields for sugarcane farmers and sugar factories quickly and accurately. Sugarcane farmers and sugar factories can plan for production demands immediately with accurate sugarcane yield predictions, ensuring maximum results.

## **2. Methodology**

The study used secondary data obtained from the work area of PT. Perkebunan Nusantara. Figure 1 depicts the research flow, which used the SDLC (Software Development Life Cycle) model with the Waterfall method (Royce, 1987; Shylesh, 2017; Gahara et al., 2021).

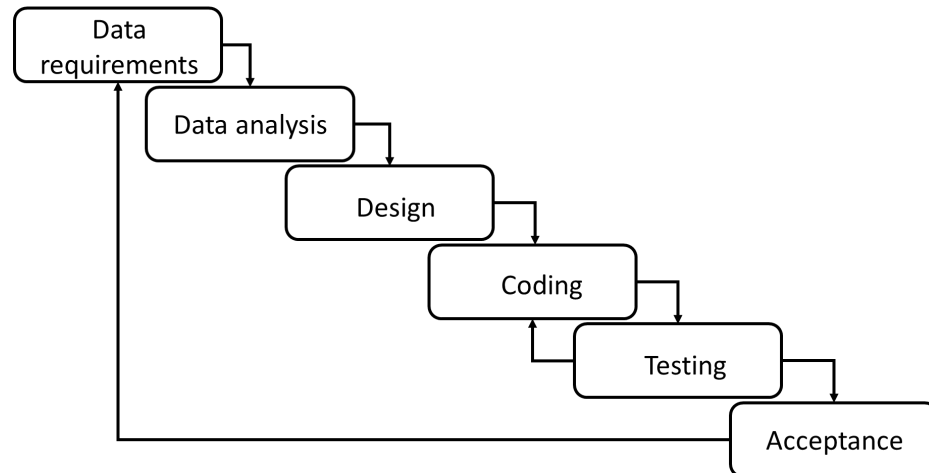


Figure 1. Android system development using Waterfall Method (Shylesh, 2017; Caraka et al., 2018a)

The research method used for secondary data collection is observation and interviews, while the application development method is the analysis stage, design stage, coding stage, and testing stage. The description is as follows:

- A. **Data Analysis**  
Observations of the land and interviews with practitioners, such as plantation assistants and plant heads, were conducted during the data requirements and analysis stage. The data collected is related to activities carried out by practitioners to increase sugarcane productivity. Data was collected on the number of rows and plants per hectare as parameters that affect plant height and sugar cane stalk weight per meter as sugarcane growth.
- B. **Design**  
After collecting data to support the growth of sugarcane and increasing sugarcane productivity, an application development plan was then drawn up. Interface design, flow charts, and data flow diagrams were produced at this phase.
- C. **Coding**  
The results design was produced using Javascript, a programming language, so that the compiled formulas could be functioned as required, with the sublime editor supporting them.
- D. **Testing**  
Users are the ones who perform the system testing. The purpose of this process is to find out the results of the system that has been created. If the testing process occurs an error or lack of requirements in the application, then repairs are made.

### **3. Results and Discussion**

#### **3.1 System Analysis**

In this study, the data collected in the initial analysis were obtained manually from each plantation. The data obtained by each plantation consisted of data on the area of the plantation, the number of rows, the distance between the rows, the length of the row, the number of plants per row, stem diameter, stem weight, and plant height. From these data, analysis was performed to determine the estimated production value.

In general, production estimating operations in farmers' plantations were conducted by community plantation assistants. Then the estimate was reported to the head of the plant area of the Sugar Factory. Data from observations in the field such as land area, number of rows, length of rows, number of plants, plant height, and weight per meter of plant stems were recorded in a book and then calculated manually using a calculator. The estimated value obtained was reported to the plant administrator and compiled in the table printed in the form of 1 bundle of report documents. The report became a reference for regional plant heads to estimate the amount of sugarcane raw materials to be processed. Figure 2 depicts the flow of the estimating process when conducted manually.

Production estimation errors made by the community plantation assistant resulted in a mismatch in the amount of sugarcane raw materials available with the processing capacity of the sugar factory. This problem led to a decrease in sugar yield. Because of this error, the plantation assistant must repeat the estimation task, which took additional time and effort.

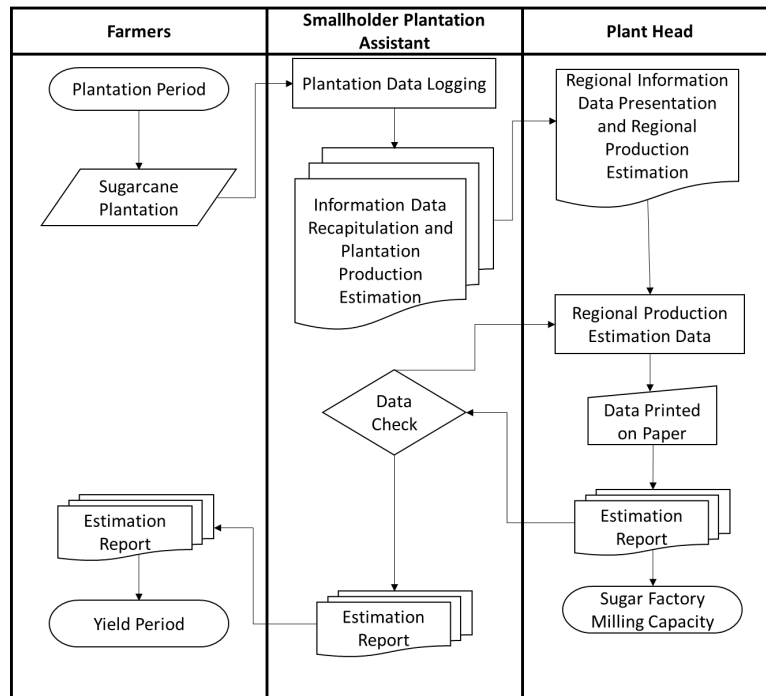


Figure 2. Manual production estimation flowchart

The benefits of production estimation would help sugar factories in obtaining optimal yields. The optimal yield estimation showed the milling capacity of the mill in accordance with the amount of raw material harvested for sugar cane. Farmers, on the other hand, did not have a good understanding of the production estimation technique. Limited knowledge in calculating production estimation raises the attitude of farmers who were less concerned about the refinement of cultivated sugarcane plants. Ignorance of the potential for crop production managed by farmers affects low yield because there was no improvement in cultivation activities to support the optimal result. The number of documents and the time used to estimate are so many. Therefore in this study, the sugarcane farming application made the workflow of estimation activities shorter and more accurate, as shown in Figure 3.

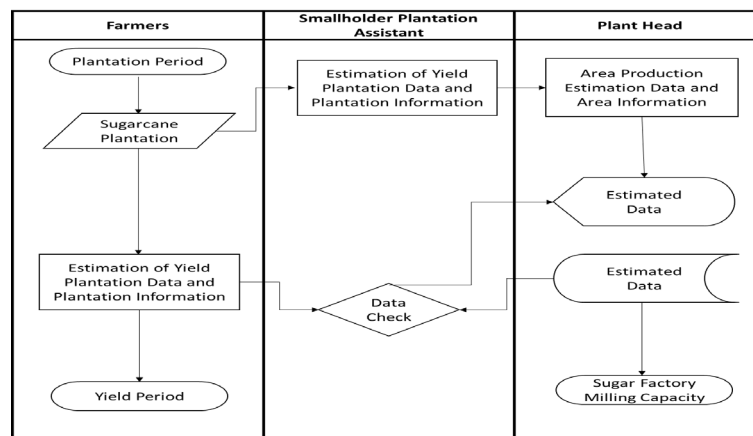


Figure 3. Production estimation flowchart using app

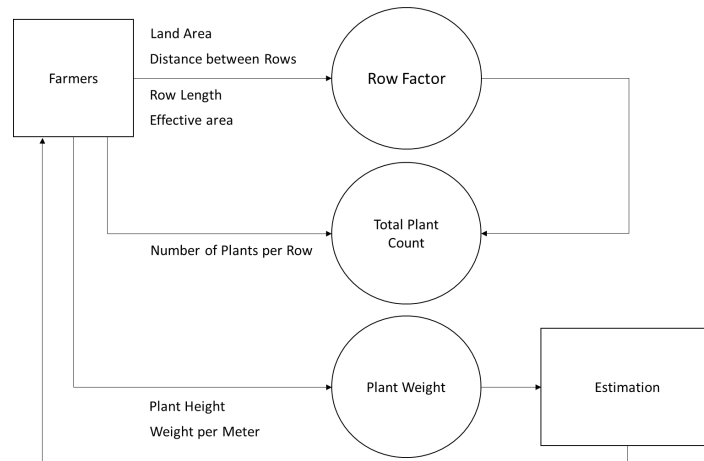


Figure 4. Production estimation flowchart using app

Because of its simplicity and accuracy, the sugarcane farming application would make it convenient for smallholder plantation assistants and farmers to compute sugarcane production estimation. As a result, it would be possible to optimize agricultural activities early and more effectively to achieve optimal actual production. Recognize the data flow that occurred in the system. The data flow diagram (DFD) in Figure 4 was used to simplify the design and development of mobile applications (Wulandari & Widiyanto, 2017).

### 3.2 System Design

The system design, including interface design, was developed once the data was analyzed for system requirements. The interface design was a crucial part of a system performing the analysis process in a mobile platform or application. Implementing the interface design in the estimating sugarcane yields process serves to minimize formula errors from the analysis process that had been determined by the admin. Otherwise, the predicted value of the final yields might be compared to the actual sugarcane production quickly and accurately.

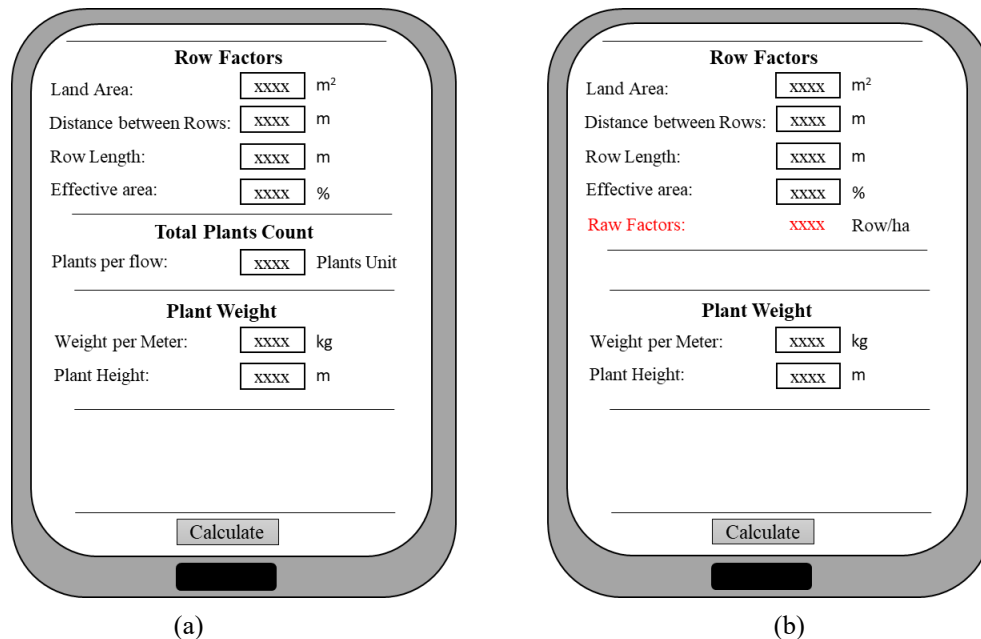


Figure 5. Design of Interface of Sugar Cane Farming app: (a) Input form; (b) Result of yield prediction on application.

The interface design of the sugarcane farming application consisted of a login, dashboard, data list, input data, and results. The system executes the analysis process and displays the results of the data assessment when the column had been filled in. Data entry into the application field was operated directly by the user (farmer or plantation assistant), thereby reducing the weakness of the manual system. Therefore, an algorithm formula was needed in the estimation process to perform automated calculations in the process. As illustrated in Figure 5, the interface was created simply as a field with several columns.

#### **4. Conclusion**

An application was developed to calculate sugarcane production estimation based on an android mobile system. The application development used the waterfall method with the SDLC (Software Development Life Cycle) model and interface design that supports the sublime editor program making it easier for users to access android-based applications. Observations, interviews, and literature studies were employed as a requirement gathering process. Interviews with plantation assistants were conducted to gather information on how to estimate sugarcane production. The application and interface were designed based on observation and interview data. Advancements in technology, particularly in the information sector, make it easier for everyone to have access to the same information. Farmers could be used the application to predict production potential and collect data on sugarcane productivity throughout harvest. Hence, the quantity and quality of sugarcane raw materials could be guaranteed by the sugar factory. The mobile application was convenient for plantation practitioners (farmers and plantation assistants) to carry out a fast and precise assessment process.

Future works, this application can be added with features that fulfill complete information about sugarcane plantation management. Artificial Intelligence (AI) and big data can be used to improve the performance and ability of this application.

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## **Biographies**

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**Bens Pardamean** has over thirty years of global experience in information technology, bioinformatics, and education. His professional experience includes being a practitioner, researcher, consultant, entrepreneur, and lecturer. He currently holds a dual appointment as Director of Bioinformatics & Data Science Research Center (BDSRC) | AI Research & Development Center (AIRDC) and Associate Professor of computer science at Bina Nusantara (BINUS) University in Jakarta, Indonesia. He earned a doctoral degree in informatics research from the University of Southern California (USC), as well as a master's degree in computer education and a bachelor's degree in computer science from California State University at Los Angeles (USA).