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Development of Smart Environment Systems Model for The Optimization of Agriculture Products

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Abstract. The purpose of this study is to developing smart environment systems model for optimization in agriculture is to monitor soil, water, pollution levels, and weather conditions in farming. The monitoring process is carried out to increase the level of agricultural productivity. The model can be used to assist farmers in the decision-making process to cultivate the land and determine the types of commodities to be planted. The method used to develop the model is a descriptive qualitative. The result of the research is a model. Poor pollution levels and relatively erratic weather can worsen the productivity of agricultural land. These conditions make it difficult for farmers to determine the right seeds and fertilizers to use, as well as the right time to start the planting period. Thus the model is expected to support farmers in increasing the quantity and quality of their agricultural products. The model is developed as a part of the implementation of the smart city and internet of things (IoT) concepts which specialize in creating smart environments in agriculture.

1. Introduction

Indonesia is strategically located on the equator [1]. This caused Indonesia to only know two seasons [2]. The advantage of this strategic location is that Indonesia has fertile land [3]. Thus the Indonesian agricultural sector can support the economic income of its citizens [4]. Indonesia still imports foodstuffs from abroad until today [5]. This shows that agricultural potential in Indonesia is still not optimized. As one example, in the last ten years there has been a decline in the average productivity of wetland in West Java Province [6]. The most important problem in the agricultural sector is the degradation of agricultural land as a result of increasingly rapid urban development [7-8]. This is directly related to the decreasing number of farmers in Indonesia [9]. Decreasing land and farming professions can cause production problems related to farmers' capacity and productivity, even in some areas water sources for agricultural areas have been contaminated with industrial waste [10]. Erratic weather conditions due to damage to the ozone layer can also worsen the productivity of agricultural land [11]. Some of these conditions cause farmers not to know what types of plants are suitable for planting in an area. Farmers also find it difficult to determine the right seeds and fertilizers to use.

We propose a model of smart systems for the optimization of agricultural products in this research. The model developed can monitor the conditions of soil fertility, water, pollution levels and weather. The monitoring process is carried out to increase the level of agricultural productivity. In fact, there have been several studies related to smart systems, as conducted by Finandhita et al. [12], Sajid et al. [13], and Ghayvat et al. [14]. There are also several studies of smart systems that are specific to agriculture, as conducted by Higgs et al. [15], Takacs et al. [16], and Ayyanagowadar et al. [17]. However, there has been no specific implementation of integrated monitoring process that includes conditions of soil fertility, water, pollution levels and weather. In addition, in previous works, there is



no explanation of the process of retrieving information on the results of monitoring that can be used to assist the decision-making process using big data analytics.

Smart Environment is part of the implementation of smart cities and the Internet of Things that specialize in how to create smart environments [18]. The criteria for intelligent environmental assessment include a process of sustainability and better management of resources [19]. Effective integration of information technology in agriculture can provide timely and relevant agricultural information. This information can be used as a source for farmers in the process of making land management decisions and determining the types of commodities to be planted. Based on the problems described earlier, an integrated system is needed that can read soil, water, pollution, and weather conditions. This system is expected to create an intelligent environment that can support farmers in improving the quality and quantity of their agricultural products. The purpose of this study is to develop smart environment systems. in farming. The method used to develop the model is a descriptive qualitative.

2. Method

Figure 1 shows the descriptive qualitative method used to develop the model [20-21].

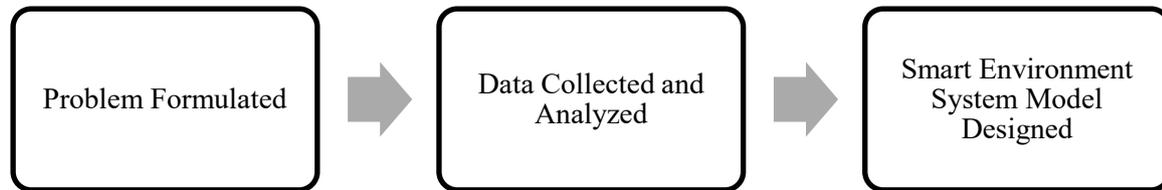


Figure 1. Descriptive Qualitative Method

3. Results and Discussion

To make the agricultural environment smarter, some sensors are needed to be able to read agricultural environmental conditions based on the parameters used by farmers in managing agriculture [22]. Table 1 shows information on agricultural parameters and sensors that can be used.

Table 1. Agricultural Parameters and Sensors

No	Agricultural Parameters	Sensors
1	Soil pH	Soil Moisture Sensor
2	Water pH	Ph Sensor
3	Humidity	DHT1 Humidity Module
4	Soil Moisture	Soil Moisture Sensor
5	Rainfall	Rain Sensor
6	Light Intensity	BH 1750FVI Digital Ligth Intensity Sensor
7	Air Temperature	MAX6675 K-type Thermocouple Temperature Sensor Temperature 0-800 Degrees Module
8	Air Pressure	MPX53DP Air Pressure Sensor
9	Land Nutrients	DT-SENSE TCS3200DB

After all agricultural parameter data are known, the next step is to determine how the monitoring process is carried out to obtain accurate data on environmental conditions and the conditions of the land to be used in agriculture. The flowchart diagram in figure 2 is an overview of the monitoring process that starts from taking sensor data to be stored in the database [23].

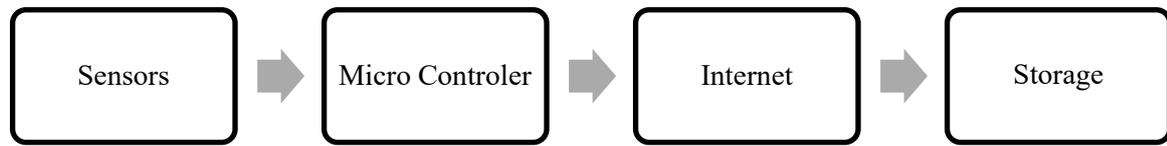


Figure 2. Sensor Data Collection Process

The data taken from the sensor is then stored to be managed as the basis of the Decision Making System [24-25]. The output of this decision-making system is handling instructions or it can also be a recommendation for the selection of commodities to be planted. Figure 3 shows the scheme of decision-making system.

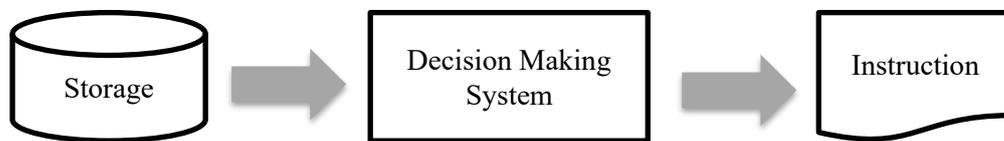


Figure 3. The Scheme of Decision Making System

Figure 4 shows the system architecture used for Smart Environment Systems for The Optimization of Agriculture Products.

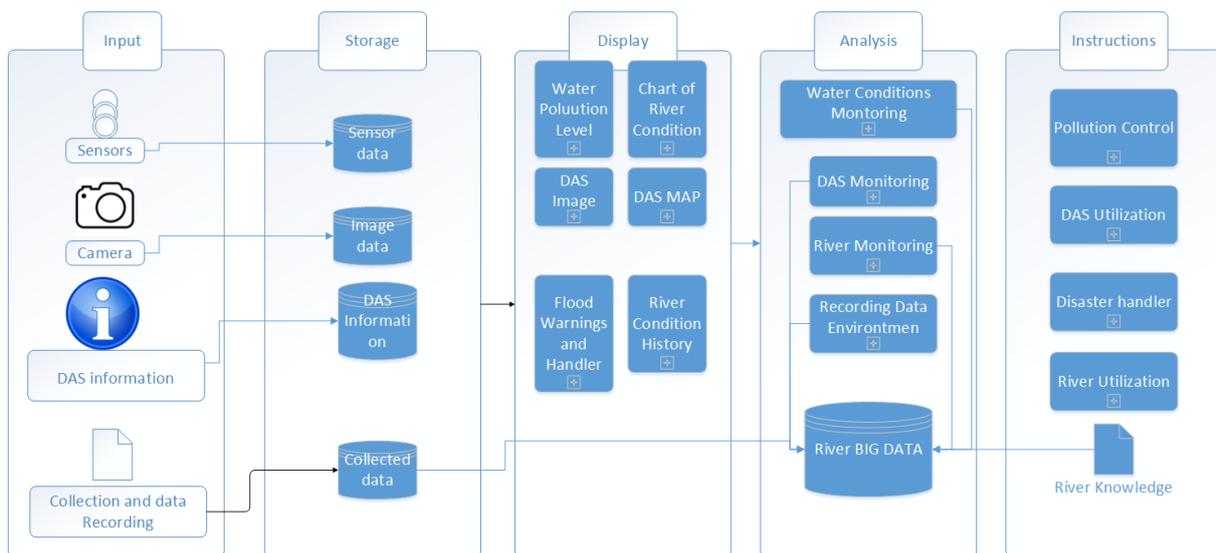


Figure 4. Smart Environment Systems for The Optimization of Agriculture Products Architecture

The system has five main parts consisting of input, storage, display, analysis, and instruction [26]. Input is used for data collection both from sensors, images, work information and documents on agricultural activities. Storage is used as a storage medium for data taken from sensors, cameras, and information added by farmers. Display is used to display information in the form of graphics, and everything related to changes in agricultural parameters. Analysis contains artificial intelligence, used to analyse data obtained from the environment to be used as recommendations for handling or selecting

agricultural commodities. Instruction contains suggestions that are produced as outputs of Artificial Intelligence systems that can be used by farmers in conducting agricultural activities [27].

Software is designed as an intermediary between farmers and smart systems according to their needs. To meet user needs, software requirements specifications (SRS) need to be state. The software requirements specifications are divided into two parts, F-SRS (Functional Software Requirements Specifications) and NF-SRS (Non-Functional Software Requirements Specifications) [28]. The software requirements specifications can be seen in Table 2 and 3.

Table 2. Functional Software Requirements Specifications

No	Code	Requirement
1	F-SRS-01	Retrieve data from sensors
2	F-SRS-02	Use the database as data storage
3	F-SRS-03	Requires data analysis function
4	F-SRS-04	Shows the development of environmental conditions
5	F-SRS-05	Provide recommendations for handling environmental problems
6	F-SRS-06	Providing advice on commodity selection

Table 3. Non-Functional Software Requirements Specifications

No	Code	Requirement
1	NF-SRS-01	A web-based system
2	NF-SRS-02	Farmers are system users
3	NF-SRS-03	Using a Microcontroller

Analysis of non-functional software requirements specifications related to the elements or components needed by the system. The analysis includes analysis of hardware requirements, software requirements, and users. Hardware is needed to support the smart system that will be developed [28]. Table 4 describes the results of hardware requirements analysis.

Table 4. Hardware Requirements Analysis

No	Hardware	Spesification
1	Processor	Quad Core Processor
2	Memory	Min. 2 GB
3	Storage	Min. 2 GB Free Space
4	Micro Controller	Raspberry Pi
5	Sensors	Soil Moisture Sensor, Ph Sensor, DHT1 Humidity Module, Rain Sensor, BH 1750FVI Digital Ligth Intensity Sensor, MAX6675 K-type Thermocouple Temperature Sensor Temperature 0-800 Degrees Module, MPX53DP Air Pressure Sensor, DT-SENSE TCS3200DB

Software becomes one of the components used in the process of developing a smart environment system. Software is used to build interfaces as intermediaries between hardware and users [28]. Software is also used for data management [29]. Table 5 explains the results of software requirements analysis.

Table 5. Software Requirements Analysis

No	Software	Function
1	Firebase Realtime Database	Database Management System
2	Sublime Text	Source Code Editor

Smart system users that will be developed are farmers. Table 6 describes the user specifications needed by the system.

Table 6. System User Analysis

No	Spesification	Requirement
1	User	Farmers
2	Privilege	Users can use the Smart Environment System
3	User Experience	Users understand the use of the website
4	User Jobs and Tasks	Users can understand commands or instructions given
5	User Physical Characteristic	Users can use the application properly Users have good vision Users have no physical barriers
6	The Type of Training	Users follow training about how to use the website

Figure 5 shows the use case diagram as part of the process view in the Smart Environment System software design [28].

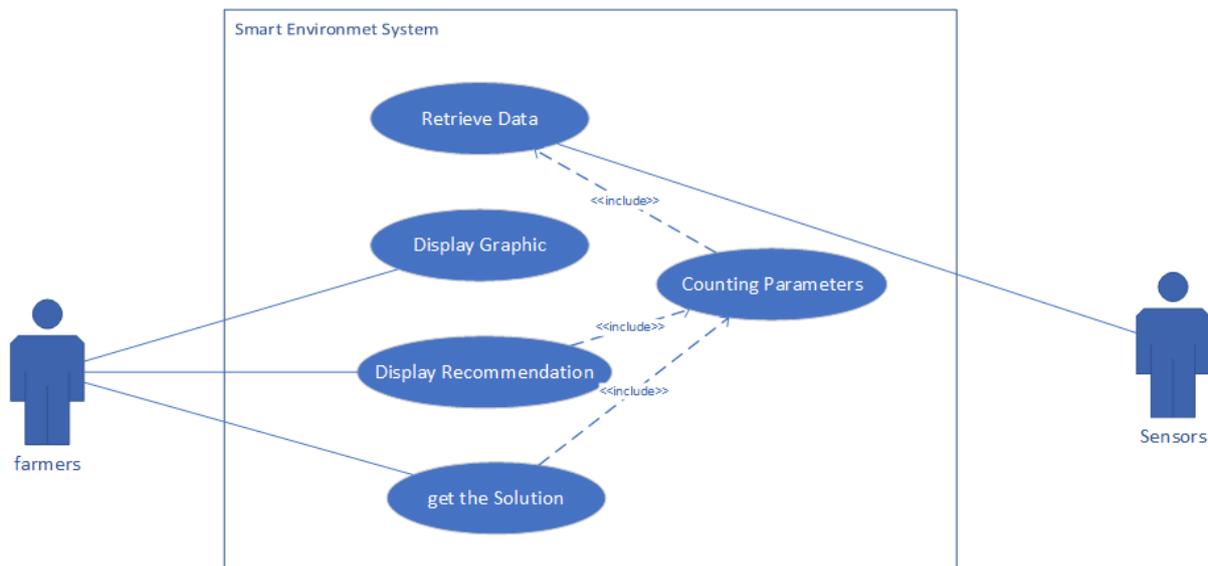


Figure 5. Smart Environment Systems Process View

4. Conclusion

The present study has given an overview of Smart Environment Systems Model for The Optimization of Agriculture Products. The developed model has a functional system that allows farmers to display a description of environmental conditions in the form of a graph, see the results of recommendations on the types of commodities that can be planted in an area, be able to know the development of land and the agricultural environment, and get solutions to problems related to agriculture. The development of the smart environment system model raises a study of Smart Environment Architecture which can be directed to the next stage, the implementation stage.

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