Optimization of Forest Plant Seeding Based On the Internet of Things

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Abstract. The research objective is to compare the seeding of forest plants using manual methods with the Internet of things-based seeding. The research method used a prototyping model. In this research, the application of the Internet of Things is supported by solar panels that are used as alternatives energy if at some time conventional energy has decreased power or disconnected. Thus, the use of tools connected to each other can continue to run without worrying about losing power. Some of the parameters measured in this seeding include room temperature, soil pH, and soil humidity. Sensor equipment used includes temperature sensors, Soil Moisture Sensor, and soil pH sensors. The temperature sensor is used as a trigger to turn on the blower that serves to remove heat from the room. Besides, the moisture sensor is used as a trigger to turn on the water pump used as an automatic sprinkler of crop seeds. Then, soil pH sensors are used to measure soil acidity levels that affect the growth of forest plant seeds. As for the seeding process is done using Mangium type plant seed or in Latin "Acacia Mangium" by using 400 seed samples. The results of this study showed that there was an increase in seed growing during seeding supported by the Internet of Things method of 24% compared to manual methods.

1. Introduction
Plant seed is a living body that functions as a means for plant reproduction, the seed is the result of security, which is also the beginning of the life that will determine the continuity of the next generation [1]. The problem that arises during the Germination (seeding) process is the difficulty of regulating the temperature of the hot test room during the day and also the irregular watering process of plants. Every test data is not well recorded, such as what is the right room temperature for a seeding forest plant seed and the type of soil used at the time of the seeding test. Furthermore, when it is time to go home from work or holidays, the testing room is not taken care of so that the watering process is no longer carried out causing the test to be obsolete. Besides, from the 1000 seeds that grow only about 45% of the total and also access to electricity to the testing room frequent blackouts and Electric voltage is fluctuating or unstable so that alternative energy is needed to be the main electric power in the testing room. The problems that have been outlined for the management of forest plant seeds is to create a device, which acts as a medium room monitoring and testing.

Internet of Things (IoT) consists of two main pillars namely "internet" and "Things". Therefore, every object that can connect to the internet will fall into the "Things" category as it includes a set of more general entities such as smartphones, sensors, humans, and other objects. The context can communicate with other entities, making it accessible anytime and anywhere. Broadly speaking with the Internet of Things (IoT) objects must be accessible without limitation of time or place [2]. Currently, the application of the Internet of Things technology is already used in all fields, one of which is used as a monitoring system used in agriculture [3].
Raspberry Pi as one of the tools that are often used in the application of the Internet of things technology is considered effective in processing and producing information according to the needs [4]. It is expected that with the use of this tool, the seeding of a forest plant monitoring system can run well and produce accurate information during the seeding process. The research objective is to compare the seeding of forest plants using manual methods with the Internet of things-based seeding. The research method used a prototyping model.

2. Method
The research method used a prototyping model, it is because in making this system the user involvement is very high so the system meets the user needs better [5,6]. The prototyping model can be seen in Figure 1 below.

![Figure 1. Prototyping models](image)

Explanation of the prototype model point is as follows:

1. Communication
   We analyse the system requirements by collecting data, namely by conducting interviews with examiners of Forest Plant Seed Centres and collecting additional data both in journals and in books.

2. Quick Plan
   At this stage, we continue the process of communication. This step will send the generated data related to the user's wishes in the building has a system. A system that can monitor and manage the germination of forest plants can reduce the plant seed germination failure.

3. Modelling Quick Design
   We began to do a system design according to the needs of the Forest Plant Seed Centre (BPTH) testers who could be estimated before the coding process. The quick design modeling process is carried out by designing data structures, software architecture, and unified modeling language.

4. Construction of Prototype
   We began coding, which is to build the system in accordance with the planning at the quick design modeling stage. Coding the Raspberry Pi is to set the DHT 22 sensor function, Soil Moisture, voltage and amperes to retrieve and display sensor data on the website. Activate the relay to turn on the exhaust fan when the temperature of the test room exceeds the specified limit and turns on the water jet pump when soil moisture starts to dry and saves seed as well as testing data that has been done in Raspberry Pi [7]. After the coding is complete then testing is done on the system that has been built, the goal is to find errors in the system and then it can be repaired.
5. Development Delivery & Feedback

This step can be said to be final in making a system. After conducting analysis, design, and coding, the finished system will be used by the user, then the system that has been built is carried out maintenance or maintenance on a regular basis.

3. Results and Discussion

3.1. Existing System Analysis

Existing System Analysis is a description of the problem based on the stages of the activity. The explanation of the evaluation of running procedures can be seen in Table 1.

| Problem | The Solution |
|---------|--------------|
| Ineffective watering methods for seeds that are random or depend on hourly counts. | Seeing the moisture condition of the soil conditions by using a soil moisture sensor, when the medium is dry the relay will trigger the water jet pump to pump water and do watering automatically to each basin. |
| The lack of attention to the temperature and humidity conditions in the test room can cause many factors that do not germinate seeds. | Seeing the state of the temperature and humidity of the room with a 22 DHT sensor, when the room temperature exceeds the specified limit, the relay will trigger the absorbing fan to suck the room temperature to return to normal conditions or below the specified temperature limit. |
| The choice of medium (soil or sand) for testing seeds which are not monitored, their pH conditions can cause the seed factor to be incompatible with the medium used. | Seeing the pH of the soil using a soil pH sensor, can get the pH data for each medium used and can help in the growth factor of forest plant seeds. |

3.2. System Architecture

System architecture analysis is a process to describe the physical system to be built and also its supporting components. The following is a view of the system architecture used in the research. It can be seen in Figure 2.

![Figure 2. System Architecture](image-url)
The following is an explanation of the architectural description of the development of a forest plant seed management system using the Internet of Things, as follows:

1) Testers will use web application and they can see the state of the room temperature, humidity of the room, soil moisture like the test tub, and soil pH of the test tub, the testers can do device control [8].

2) Web service is used as sending data between sensors and web pages.

3) Battery charging is controlled by the solar charge controller to avoid over-charge when getting power from the solar panel.

4) Regulator is used to step down the 12V DC current from the battery to the 5V DC so that it can provide power for the Raspberry Pi 3B.

5) Relay is used to activate the absorbing fan when the room temperature exceeds the limit set by the tester and activate the water jet pump when the soil moisture starts to dry from the soil moisture sensor data.

6) Temperature and humidity sensors use DHT 22, this sensor data is used to measure the temperature and humidity of the testing room air.

7) Soil humidity sensor, this sensor data is used to measure the level of soil moisture like a test.

8) Soil pH sensor data and the voltage sensor from analogue are converted to digital using PCF8591 then the data is used to measure the acidity of the soil like a test.

9) Solar panels as smart energy convert sunlight into electricity used as the main source of electricity [8].

3.3. Data Communication
The data communication is a very important thing in the development of an application. It is because, without data communication, an application that is built will not be able to run properly. The data communication used in forest plant seed management systems using the Internet of Things (IoT) is communication between Raspberry Pi with sensors and relay modules and Raspberry Pi with websites using JSON [8,9]. The flow of data communication can be seen in Figure 3.

![Data Communication Diagram](image-url)
3.4. Testing of Hardware Components

Hardware component testing aims to determine the characteristics of each component used and separately to find out whether each component is in good condition or not, to maximize the function of each component, it can then be used on a system that is made [10].

3.5. Seed Management Testing

Seed management testing is done by comparing test data before the system is installed with data after the system is installed, the comparison of data before and after the system is installed can be seen in Table 2 [11].

| Seed Name      | System State  | Test Start Date | Test End Date | Sown Seed (pcs) | Seeds That Grow (pcs) | Average Temperature | Medium Description | Growth Percentage (%) |
|----------------|----------------|-----------------|---------------|-----------------|-----------------------|---------------------|--------------------|-----------------------|
| Acacia Mangium (Mangium) | Not installed | 10-05-2019      | 24-05-2019    | 400              | 261                   | -                   | Kiara Payung Soil   | 65.75                 |
|                | Installed      | 11-07-2019      | 22-07-2019    | 400              | 359                   | 24.42                | Kiara Payung Soil   | 89.75                 |

Comparison Value of Difference in Percentage of Growing Seeds

From the test results, it can be concluded, before the system was installed the test lasted 14 days with the percentage of seeds germinating 65.75% and after the system was installed the test lasted 11 days with the percentage of seeds germinating 89.75%, comparing the percentage of seeds germinating before the system was installed and after being installed by 24%. After the system is installed the test is faster 3 days so that the system is installed the seeds germinate increases by 24% and the test is 3 days faster. This can be influenced by the temperature conditions that have been set based on the value of the 22 DHT sensor, the watering cycle of the seedlings based on the value of the soil moisture sensor and soil pH conditions in accordance with the needs of the seeds. Test photos can be seen in Figures 4,5,6.

![Figure 4. Display Tools](image-url)
4. Conclusion
The experiment results using the manual method gained a seed success percentage of 65.75% of the total 400 seeds or just 263 seeds that grow normally. Meanwhile, the results of the test-based Internet of things percentage the success of seeds 89.75% or 359 seeds that successfully grow. This means that in the seeding process there is an increase of 24% from the manual method.

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