Application of Vegetable Composting Method Takakura with Temperature and pH Control Based on Internet of Things

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Abstract— **Compost is organic material that is decomposed in a place that is protected from the sun and rain. Factors that affect the success of composting are temperature, pH and light intensity in raw materials, types and sizes of raw materials. Waste processing carried out by the community is still conventional with a long time of 60 days so that by reprocessing waste simply by making Takakura basket compost which is done naturally for 30 days. The purpose of this research is to create a monitoring system for composting types of vegetables and fruits based on the internet of things using temperature sensors, pH sensors and light intensity sensors. The measurement results taken will be sent to firebase and displayed on the WEBSITE. The ESP32 microcontroller will process the value taken by the sensor and displayed on the LCD and WEBSITE in real time. Based on the test results, the temperature sensor is used to detect the basket temperature with an average value of 27-39°C. The temperature is more than 35°C then the fan will turn on. The pH sensor is used to detect acidity levels in vegetable and fruit compost. The light intensity sensor is used to detect sunlight received for photosynthesis when the afternoon light intensity value is below 1800 lux, the light will turn on to help photosynthesis in composting. WEBSITE display can be accessed well from 0.002307s delay and 93.3% packet loss.**

Keywords— ***Compost, Internet of Things, pH sensor, Takakura, Temperature sensor***

I. INTRODUCTION

The environment is very important in the survival of living things, especially humans. One of the environmental problems that is still a serious concern is waste. Garbage is something that is discarded and unused that comes from activities produced by humans every day continuously and in solid form. Waste by type is divided into two, namely organic waste and inorganic waste. Organic waste is waste that is easily decomposed from food scraps, leaves, fruits, kitchen waste and vegetable residues. Meanwhile, inorganic waste is waste that is not easily decomposed from plastic, paper, and metal.

Waste processing carried out by the community is still conventional which takes a long time for 60 days so that an innovation can be needed by reprocessing waste simply by reusing waste into compost [1-3]. Compost is an organic material that is decomposed in a place that is protected from the sun and rain, the humidity is regulated by pouring water when it is too dry. Factors that influence the success of composting are temperature, pH and light intensity on raw materials, type and size of raw materials, aeration, humidity, microorganisms and activator. Determination of the optimum water content and size of raw materials is needed to determine the optimum conditions that can accelerate the composting process [4-8].

One method of composting is the Takakura basket method. This method has advantages compared to other methods, namely 1) Practical, does not require a large location. 2) Easy, because the garbage is simply put and buried in the composter without the addition of liquids or special substances. 3) No smell because the process is through fermentation not decay. The process of making compost using a Takakura basket is done naturally and takes 30 days. This can be done by making a balanced mixture of ingredients, Takakura compost seeds can be made at home using husks, and microorganisms that have been made previously.

Provision of sufficient water also regulates aeration and adds activator. Temperature and pH are factors that affect the process of making fertilizer [9-12]. By utilizing current technological developments, several sensors can map and monitor temperature, pH and light intensity, whether they meet the standards or not. Several sensors that can be used to determine the quality of good compost are temperature, pH and light intensity in the compost.

Based on the description above, this study aims to determine the comparison of physical parameters such as temperature, pH and light intensity in the Takakura method of composting with vegetable and fruit waste raw materials with SNI 16-7030-2004 guidelines regarding compost specifications from organic waste [13-15].

II. METHOD

A. Research Design

Stages of the research to be carried out are stated by the flowchart shown in Fig. 1. The explanation of the research design flowchart is as follows:

1. The first stage, literature study is about the theory of the ESP32 microcontroller, DHT11 sensor, pH sensor, BH1750, C programming language, Firebase. At this stage

we are studying the use and characteristics of the sensor and programming for the manufacture of the system.

2. The second stage is system planning regarding the test parameters to be obtained by the sensor.
3. The third stage, the design of the tool design, namely the device used, at this stage planning is carried out regarding sensors and relays connected to the microcontroller and connectivity from the microcontroller to the database (firebase).
4. The fourth stage, planning script used to program all the tools used.
5. The fifth stage, system testing, is the testing process that has been made in stages three and four. This test is carried out to determine the results of the planned system testing.
6. The sixth stage, the process of checking the existing system whether it is running or not, if the system is running but not in accordance with the system design that has been made, it will return to the system design stage to re-ensure. If the system is in accordance with the system design, it can proceed to the next stage.
7. The seventh stage, work system analysis, is the stage that analyzes the work system regarding the program running as planned. If the system is in accordance with the plan, the system is complete.

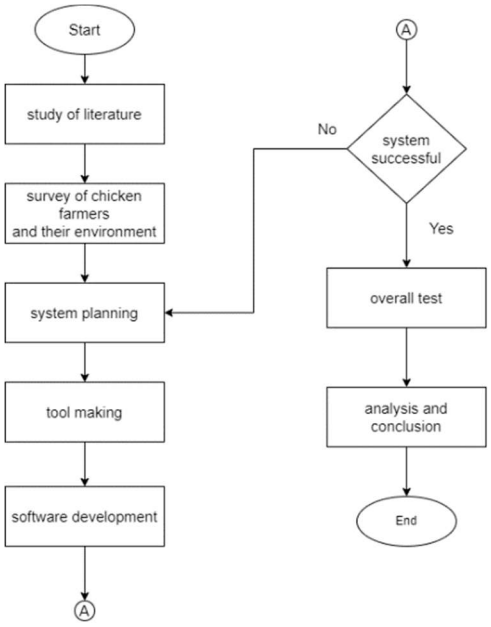

Figure 1. Flowchart of Research Stages

B. *System*

The research design to be carried out is stated by the block diagram shown in Fig. 2. It can be explained in Fig. 2 regarding the composting process, there is a Takakura basket with a DHT11 sensor to measure the air temperature in the basket, a soil pH sensor to measure acid levels, and a BH1750 sensor to measure light intensity. The monitoring system uses an ESP32 microcontroller as the control center and then uses a 16x2 LCD to display the values that have been obtained from all. The sensors used work alternately. To store data as database of all sensors use firebase from google. A website application that is used to display values during the composting process as well as a graph of changes in values taken from the database (firebase).

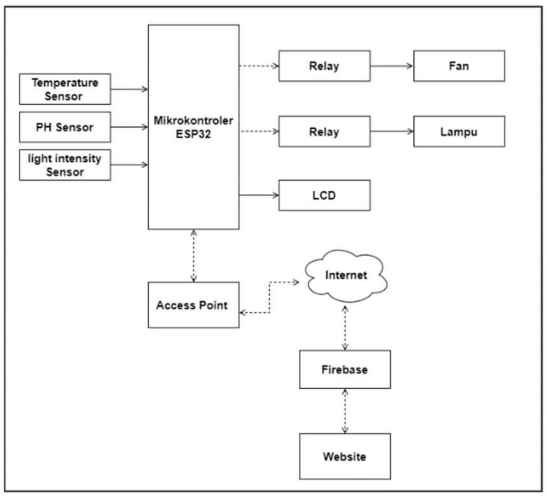

Figure 2. System Block Diagram

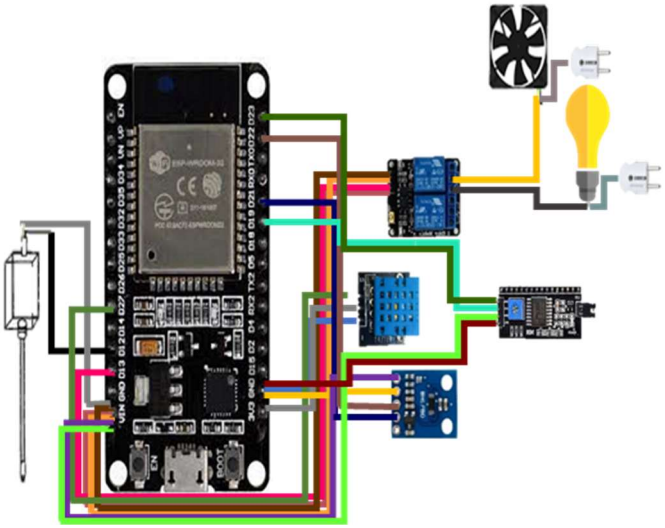

Figure 3 Diagram Hardware

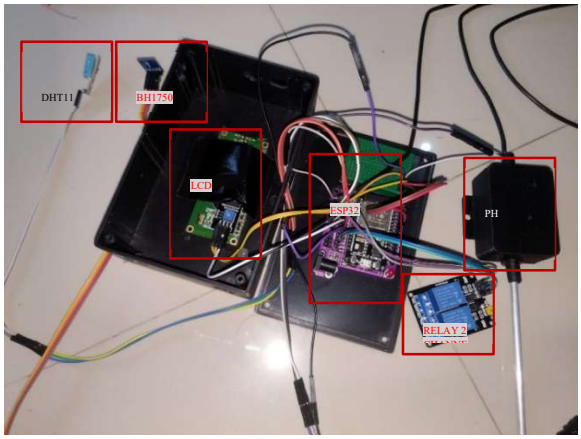

Figure 4. System Design Implementation

C. *Website Planning*

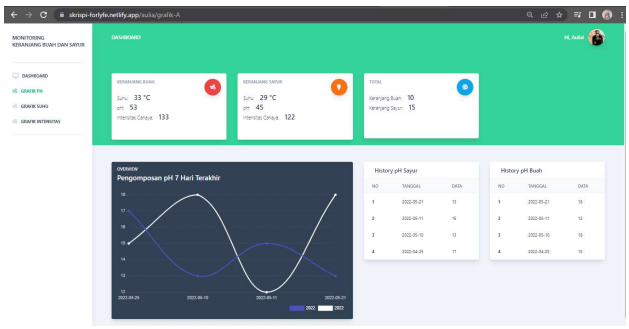

Figure 5. Website Planning

In Fig. 5 is a website design for monitoring temperature, acid levels, and pH in compost that can be monitored by users. To find out the data information on the value of temperature, pH, and light intensity. The picture above shows a real-time display of numbers and graphs of the measurement data performed by the system. There are 3 menus above, namely temperature, pH, and light intensity.

III. RESULTS AND DISCUSSION

A. *DHT11 Sensor Temperature Analysis*

Temperature sensor is used to determine the room temperature in the Takakura basket with natural vegetable and fruit compost. The following is a figure of the results of temperature measurements at 07.15 - 08.00 WIB and 16.15-17.00 WIB.

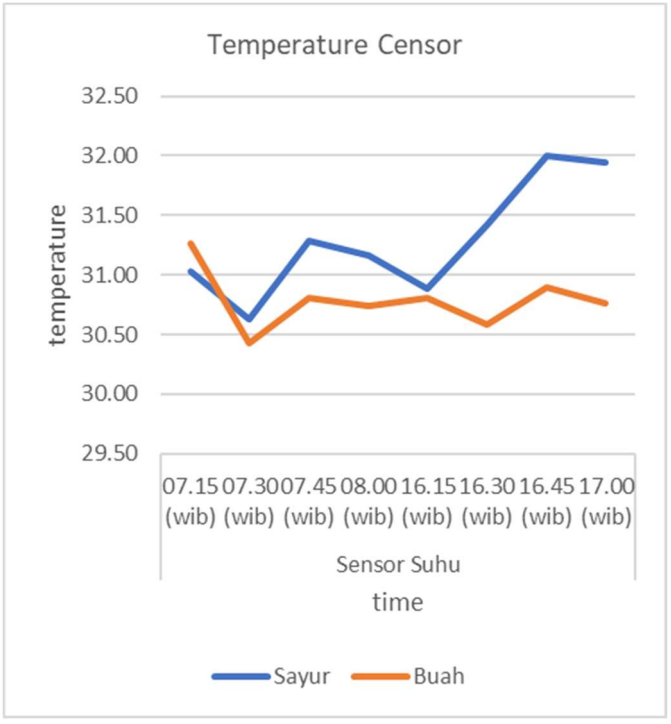

Figure 6. DHT11 sensor test graph

Based on Fig. 6, observations of changes in temperature readings on the DHT11 temperature sensor were carried out at 07.15 WIB to 08.00 WIB and 16.15 WIB to 17.00 WIB. Temperature data is taken every 15 minutes in 1 hour. On day 1 to day 30. The temperature of making Suyur compost on day 1 was 30.24°C then the temperature increased by 39.21°C. This condition indicates that the decomposition process has started because a number of bacteria convert organic waste into simpler materials that are easily absorbed. Furthermore, on the next measurement on the 20th day the temperature decreased to 28°C because the organic matter described in the compost began to decrease and shrink. The temperature in the compost works well. While the manufacture of fruit type compost on day 1 is 30.22°C and there is an erratic change because the microbes in the compost material begin to multiply. On the 17th day the temperature decreased to 28°C. Decreased microbial activity in decomposing the available material indicates that the compost has entered the maturity phase.

B. *pH Sensor Acidity Analysis*

Sensor is used to determine the level of acidity contained in vegetable and fruit compost. The following is a figure of the results of temperature measurements at 07.15 - 08.00 WIB and 16.15-17.00 WIB.

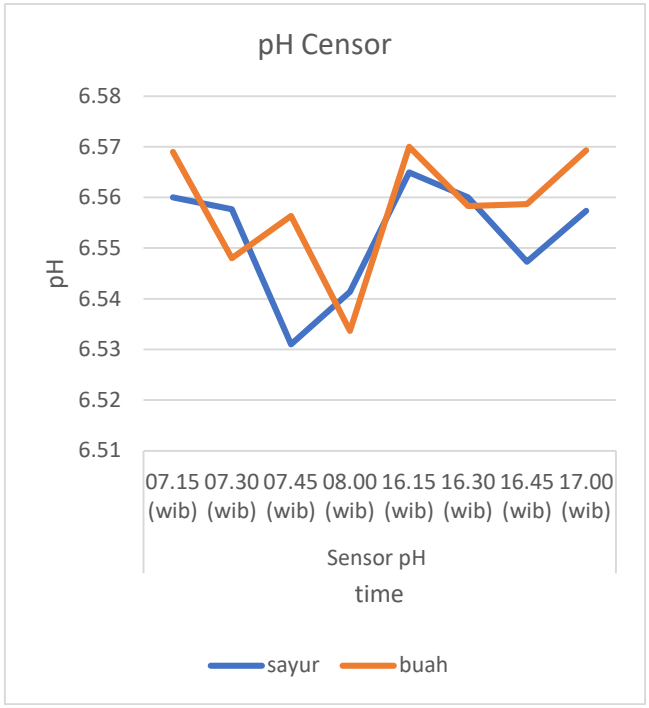

Figure 7. pH sensor test graph

Based on Fig. 7, observations of changes in pH readings on the pH sensor were carried out at 07.15 WIB to 08.00 WIB and 16.15 WIB to 17.00 WIB. The pH data is taken every 15 minutes in 1 hour. On day 1 to day 30. The pH of making Suyur compost on the 1st day is 6 which is acidic due to the number of bacteria converting organic matter into organic acids then the pH value decreases until it returns to neutral due to

unfavourable weather conditions. On the 20th day the pH value reached 7.4 while the compost type of fruit waste on day 1 was 5.4 then the pH value increased due to the activity of microorganisms.

C. *BH1750 Sensor Light Intensity Analysis*

The light intensity sensor BH1750 is used to determine the light intensity to help photosynthesis in vegetable and fruit compost. The following is a figure of the results of temperature measurements at 07.15 - 08.00 WIB and 16.15-17.00 WIB.

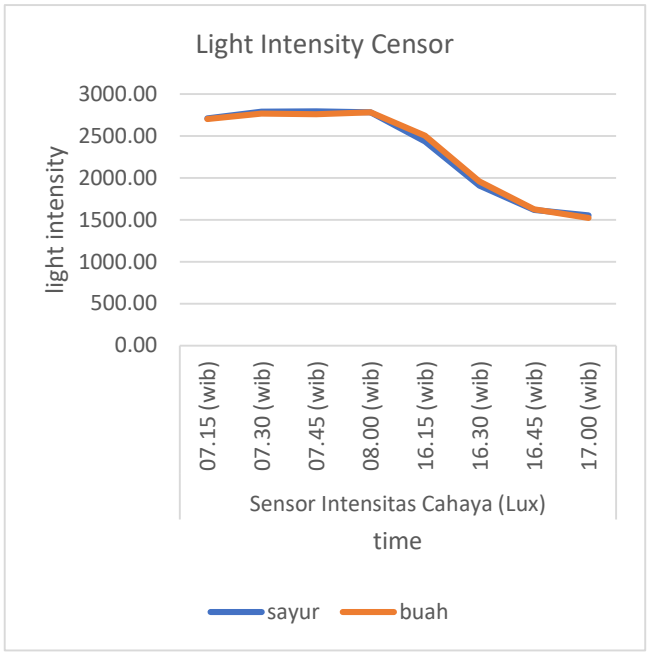

Figure 8. BH1750 sensor light intensity measurement graph

Based on Fig. 8, observations of changes in light intensity readings on the BH1750 sensor were carried out at 07.15 WIB to 08.00 WIB and 16.15 WIB to 17.00 WIB. Light intensity data is taken every 15 minutes in 1 hour. On day 1 to day 30. The production of vegetable compost and fruit type compost in the morning tends to be high above 2000-3000 lux due to sunlight right on the side of the research area. Meanwhile, in the afternoon, the intensity of sunlight decreases because sunlight is blocked so that lights are needed to help the photosynthesis process.

D. *Delay Test*

Testing is needed to see if the communication system in this final project is running well or not. Wireshark can display several packets when doing live streaming, because the protocol used is TCP and therefore must be filtered first. Do a filter according to the ip used. The IP used by ESP32 on the access point used is 192.168.43.72 and the website IP is 114.125.67.226. Table 1 is the result of the packet calculation with the average delay obtained is 0.002307s, it can be seen that the delay calculation result is very small. The smaller the delay, the better the quality of a call because there is no delay in information.

TABLE I
DELAY TEST

Package Delivery to Firebase	IP ESP 32 (src)	IP Website Monitoring (dst)	Delay (S)
1	192.168.43.72	114.125.67.226	0.0029
2	192.168.43.72	114.125.67.226	0.0024
3	192.168.43.72	114.125.67.226	0.0025
4	192.168.43.72	114.125.67.226	0.0028
5	192.168.43.72	114.125.67.226	0.0037
6	192.168.43.72	114.125.67.226	0.0016
7	192.168.43.72	114.125.67.226	0.0023
8	192.168.43.72	114.125.67.226	0.0025
9	192.168.43.72	114.125.67.226	0.0014
10	192.168.43.72	114.125.67.226	0.0029
		Average	0.002307

E. Packet Loss Test

Testing the success rate of data transmission can be done by calculating the packet loss sent from ESP32 to firebase. The packet loss can be calculated by:

$$\frac{amount\ of\ data\ sent - amount\ of\ data\ received}{amount\ of\ data\ sent}\ x\ 100\ \%$$

TABLE II
PACKET LOSS TEST

Package Delivery to Firebase	Data Firebase
1	updated
2	updated
3	updated
4	updated
5	updated
6	permanent
7	updated
8	updated
9	updated
10	updated

Based on Table 2 of the 10 packets sent, there was 1 failed packet and 9 succeeded with a success percentage of 93.3% with packet loss 6.7% where the quality of package delivery is good.

IV. CONCLUSION

Based on the design, observations and tests that have been carried out, the following conclusions can be drawn:

1. The system is designed using an ESP32 microcontroller in the control section. The data obtained is saved to the firebase to be sent to the website so that it can be monitored in landfills as wide as possible by utilizing internet technology.
2. The temperature sensor used can detect the basket temperature with an average value of 27-39°C when the

temperature is more than 35°C then the fan will turn on. The pH sensor used can detect acidity levels in vegetable and fruit compost. The light intensity sensor used can detect sunlight received for photosynthesis when the afternoon light intensity value is below 1800 lux, the light will turn on to help photosynthesis in composting.

3. The display of the website that provides information can be accessed properly with a value resulting from a delay of 0.003207s and a packet loss of 93.3% and can be opened using any type of laptop or smartphone that has a website. On the website, you can see the temperature, pH levels and light intensity in vegetable and fruit compost.

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