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Internet of Things (IoT) System for Plastic-Sorting Sensory Device

Sistem *Internet of Things (IoT)* untuk Alat Sensorik Pemilah Plastik

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ABSTRAK

Timbunan sampah yang dihasilkan dari kegiatan manusia menghasilkan berbagai jenis sampah plastik yang membutuhkan waktu untuk pengelolaannya. Saat ini belum ada teknologi yang dapat mempermudah proses pemilahan sampah plastik. Oleh karena itu, perlu dibuat sebuah aplikasi yang dapat digunakan untuk mempermudah pemilahan dan pengolahan limbah plastik secara otomatis. Sistem *Internet of Things* (IoT) merupakan salah satu alternatif yang dapat digunakan untuk mempermudah pengelola bank sampah, pengepul sampah, atau pengelola plastik bekas dalam mengelola limbah plastik. Penelitian ini bertujuan membuat prototype berbasis IoT berupa aplikasi yang mampu memonitoring, mengirim, mendata sampah yang masuk, serta menyimpan informasi terkait jumlah sampah plastik. Penelitian ini menggunakan metode eksperimental dan perancangan di Bengkel Kerja Politeknik Kesehatan (Poltekkes) Tanjung Karang, Jurusan Kesehatan Lingkungan pada Januari 2023. Sampel dalam penelitian ini adalah limbah plastik yang dideteksi jumlah, jenis, warna, dan keunikannya oleh sistem IoT. Hasilnya menunjukkan bahwa sistem IoT yang dirancang mampu mengirimkan hasil berupa data jumlah, jenis, warna, serta grafik kenaikan jumlah sampah plastik dari alat sensorik (hardware) ke aplikasi smartphone (software) sehingga dapat terbaca secara *real time* dengan tingkat akurasi sebesar 98%, yang dibuktikan dengan hasil pengujian di tiga titik kampus Poltekkes yang berbeda dan enam jenis sampah plastik.

Kata kunci: Limbah plastik, Aplikasi, IoT, alat sensorik.

ABSTRACT

The piles of waste generated from human activities produce various types of plastic waste that require time to manage. Currently, there is no technology that can simplify the sorting process of plastic waste. Therefore, it is necessary to create an application that can facilitate the sorting and processing of the waste automatically. The IoT system is an alternative that can be used to facilitate waste bank managers, waste collectors, or used plastic managers in managing plastic waste. This study aims to create an IoT-based prototype in the form of an application that is able to monitor, send, record the waste data input, and store information related to the amount of plastic waste. This study applied experimental and design methods in the workshop of Tanjung Karang Health Polytechnic, Department of Environmental Health in January 2023. The sample used was plastic waste that was detected in terms of number, type, color, and uniqueness using the IoT system. The results show that the designed IoT system was able to send results in the form of data regarding the amount, type, color, and graph of the increase in the amount of plastic waste from the sensory device (hardware) to the smartphone application (software) so that it was readable in real time with an accuracy rate of 98%, as evidenced by the testing results at three different points in Health Polytechnic campus and six types of plastic waste.

Keywords: *Plastic waste, Application, IoT, Sensoric device.*

INTRODUCTION

Waste is one of the complex problems faced by both developing and developed countries. Waste is a common problem and has become a universal phenomenon in many countries globally. (Astuty, 2022). The application of the 3R (reduse, reuse, recycle) as a form of waste management is still an environmental health problem that has not yet been managed properly in Indonesia. Waste generation in Indonesia reached 67.8 million tons in 2020, with plastic waste estimated to reach 9.52 million tons per year. Waste production continues to increase every year with an average increase of 1 million tons per year. Every day, 270 million of people produce about 185,753 tons of waste or about 0.68 kg of waste per person (Yusuf, 2021).

Indonesia is the second largest producer of plastic waste in the world with a total of 3.2 million tons of plastic waste per year, meaning on average, each person produces 17.2 kg of plastic waste per year that can pollute marine ecosystems (Conservancy, 2018). Based on data from the Ministry of Environment and Forestry (KLHK), the amount of plastic waste in 2019 was estimated to reach 9.52 million tons. The Environmental Agency (DLH) of Lampung Province noted that around 24.7% of plastic waste generally still has economic value.

KLHK's data in 2021 showed that there were 11,556 waste bank units spread across 363 regencies/cities in 34 provinces in Indonesia (KLHK, 2021). The implementation process of waste banks in Indonesia needs to be improved through significant innovations. Industry 4.0, which proceeds towards Industry 5.0, encourages improvements in overcoming the waste problem. The industrial revolution 4.0 encourages the use of IT (Information Technology) in the form of the internet and CPS (Creative Problem Solving), IoT (Internet of Things), and IoS (Internet of System) to generate new innovations or other optimizations that are more effective and efficient to solve certain problems (Nabilah et al., 2021). One of the efforts that can be applied is to create a sensory device for sorting plastic waste by utilizing IoT (Internet of Things) as an application of 3R (reduce, reuse, recycle).

The use of software is a means to achieve government targets related to waste reduction by 30% and waste management by 70% until 2025. The innovation used is a plastic-sorting sensory device that is able to sort types of plastic waste using RGB (red, green, blue) sensors and can sort types of plastic based on colors taken from examples of each type of plastic. Sensory device is designed to automatically sort waste in six garbage boxes that have been arranged according to the type of plastic so as to minimize manual plastic waste management activities. Wafi et al. (2020) have developed a waste can automation system using an ESP 32 microcontroller, but this system can only distinguish between organic and inorganic waste. Juwariyah et al. (2020) developed an automation system, but only provides results in the form of data about the condition of empty or full garbage, where this data can be sent to waste management. Thus, it is necessary to develop a sensory device that capable of sorting six types of plastic waste. This study aims to create an IoT-based prototype in the form of an application that is able to monitor, send, record the waste data input, and store information related to the amount of plastic waste. In addition, this study aims to measure the accuracy of software (application) and hardware (plastic-sorting sensory device) and provide information about the amount of waste in a certain period of time to determine the trend of waste accumulation.

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METHODS

This study was conducted in January 2023 at the workshop of Tanjung Karang Health Polytechnic, Department of Environmental Health, Environmental Sanitation Study Program, Applied Undergraduate Program. The method used in this research was the experimental and design method. The selection of this method was based on the fact that in practice, researchers conducted designing, then proceeded to testing to obtain the desired results. Overall, the method comprised of collecting information, planning, developing the forms of initial product, preparing materials and evaluation equipment, testing, then disseminating and implementing the product. Figure 1 presents the research flow conducted in this study.

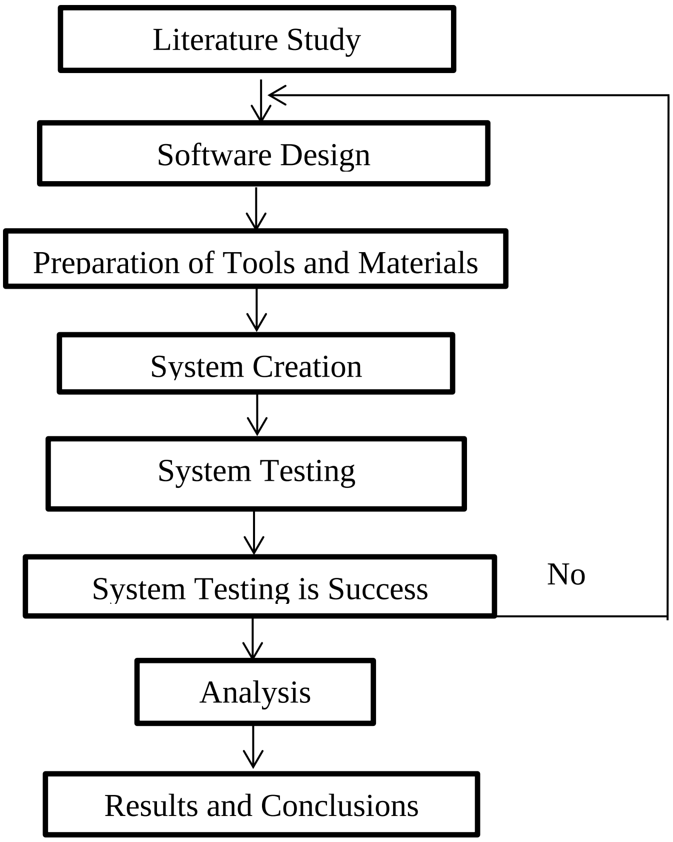

Figure 1. Research flow.

Data collection was carried out through observation, namely (a) observation of a plastic-sorting sensory device that capable of sorting plastic types, (b) literature study by collecting data related to plastic type management and related technology, and (c) testing process to determine the level of validity and reliability of the application. Data obtained from observations, literature studies, and the testing were then presented in the form of application prototypes and narratives. Data analysis was intended to determine the level of accuracy of the sensor reading results. It was conducted by comparing the data results in the plastic-sorting sensory device (hardware) with the results of data input in the application (software). If there is a similarity between the results of the

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amount and type of plastic in the device and the data results in the application, then this IoT system can be declared have functioned properly.

Table 1. Plastics code and examples of their uses.

Code Number	Plastic Type	Description
	PET, PETE (Polyethylene terephthalate)	- Clear and transparent, strong, solvent resistant, gas and waterproof, softens at 80°C - Usually used for beverage bottles, cooking oil, soysauce, chili sauce, and medicine - Not for containing warm water, even hot water - This type is recommended for one-time use only and not for containing food with a temperature of more than 60°C
	HDPE (High density polyethylene)	- Hard to semi-flexible to chemicals and moisture - Gas permeable - Waxy or opaque surface - Easy to be colored, processed, and shaped - Softens at 75°C - Usually used for liquid milk, juices, and beverages bottle; ice cream containers; shopping bags; medicine containers; and plastic lids - Recommended for one-time use only because if used repeatedly, there is concern that the material's ingredients will easily enter the foodstuffs
	PVC (Polyvinyl chloride)	- This type is difficult to recycle - More resistant to chemical compounds - Usually used for soy sauce bottles, chili sauce bottles, trays, and plastic wrappers - Should not be used to contain food in hot conditions, food containing fat/oil, and alcohol

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	LDPE (Low density polyethlene)	- Materials are easy to process, strong, flexible, impermeable, not clear but translucent, softens at 70°C - Usually used for honey bottles, yogurt containers,crackle bags, and thin plastics - Should not be used for direct contact with the foodstuffs
	PP (Polypropylene)	- Usually transparent, but not clear or cloudy - Hard but flexible and strong - Waxy surface; resistant to chemicals, heat, and oil - Softens at 140°C - A good choice for food packaging, medicine container, milk bottles, and straws
	PS (Polystyrene)	- There are two kinds of PS, namely rigid and soft/foam-shaped. - Rigid PS is usually clear like glass, brittle, easily affected by fats and solvents (such as alcohol), easy to mold, softens at 95°C. Example: box-shaped clear plastic food containers. - Soft PS is foam-like, usually white in color, soft, brittle, easily affected by fats and other solvents (such as alcohol). It can release styrene compound when in contact with foodstuffs. A well-known example is styrofoam.

	Other (Used for types of plastic other than number 1–6, including polycarbonates, bio-based plastics, co-polyesters, acrylics, polyamide, and plastic blends)	- Hard, clear, and thermally very stable - The polycarbonate materials can release Bisphenol-A (BPA) into foodstuffs, which can damage the hormone system. - Usually used for gallons of drinking water, milk bottles, and baby tableware - To sterilize milk bottles, it should only be soaked in boiling water, not poaching it. - Cracked bottles should not be used again. - Choose clear gallons of drinking water, and avoidthose that are dark or green in color.

The preparation of tools and materials used began with data collection using the plastic-sorting sensory device. The data then were transferred to the software using sensors to facilitate observation in real time. The system was tested by running the platform that has been made to find out whether the system can function properly or not. The system data generated from this test were then analyzed to find out whether things have gone according to purpose or not, then drawed conclusions from the research results and provide suggestions for further related studies (Simanjuntak et al., 2017).

Table 2. Operational definition of research variables.

No.	Research Variables	Operational Definition	Measurement Devices	How to Measure
1.	Plastics-Sorting Sensory Device	This is a prototype design of a device for sorting plastic waste based on its type automatically using RGB (red, green, blue) sensors as a solution in the field of plastic waste management, which in the process, plastic waste can be sorted based on its type. This breakthrough in terms of sorting waste is expected to be able to facilitate all sectors in terms of collecting data on the amount of waste and as an effort to innovate in the field of science and technology.	RGB Sensor (Red, Green, Blue)	- Plastic waste detection. - Plastic waste that has been read by the sensory system then enters the separation aisle. - The plastic waste separation aisle consistsof seven doors according to the type ofplastic waste. - The door that has been connected to the sensory system opens automatically according to the type of plastic waste, indicated by the ‘on’ mode of the LED lights on the garbage

				box of the related type of plastic waste. There is a barcode on the front side of the garbage box according to its type to make it easier for the public to find out information related to the type of waste and its characteristics. - After the sorting valve opens, the plastic waste will automatically enter the catch basin, then the door will automatically close again.
2.	Aplication	An application is a software program for a specific purpose. This not only include programs contained in mobile phones, but also programs contained in computers. The system used functions to manage data so as to generate useful informations for certain users to meet their various needs.	Plastics-Sorting Sensory Device	The application is able to remotely record, read, and display plastic waste data.
3.	Calibration	Calibration is the process of checking and adjusting the accuracy of a measuring instrument by comparing it with a standard/benchmark. Calibration serves to ensure that the results of measurements taken are accurate and consistent with other instruments. In this	Plastics-Sorting Sensory Device	Accuracy between the plastic-sorting sensory device and the application using ESP32 standardization

		case, the calibration carried out is between the sensory device (hardware) and the application (software) to see the suitability of the results on the hardware with the data displayed in the software.		
6.	Detecting	Detect, locate, or determine the presence of the input amount or type of plastic on the plastic-sorting sensory device.	ESP 32	The input of plastic waste is able to be located and detected using the microcontroller, namely ESP 32.
7.	Mentransfer	Transferring is the process of moving (transmitting) something from one place to another, in this case transferring the results from the plastic-sorting sensory device into data.	Internet of Things (IoT)	Transferring, transmitting, and switching the information from the plastic-sorting sensory device into data
8.	Recording	Recording is a process of compiling several observation results and facts to generate certain informations.	Software	Able to compile several pieces of informations to generate certain results or interpretation.
9.	Displaying	Displaying is a process of showing or presenting data that has been collected, along with the description.	Application	The application is able to display data related to the amount and type of plastic waste input
10.	Software	A program in a computer that will perform the work function according to certain commands form the user. From this definition, it can be seen that software has a function to give a command to the	Arduino IDE	Controlling the work system based on the expected goals so as to regulate the performance of input and output media.

	computer, so that the computer operates optimally, according to the certain commands from the user.	

Overview of the Plastic-Sorting Sensory Device

The hardware design includes the design of inputs that are connected to the ESP32 microcontroller. The input circuit includes a color sensor (red, green, blue), servo motor, arduino uno, power supply adapter, and power plug. The hardware design is presented in Figure 2.

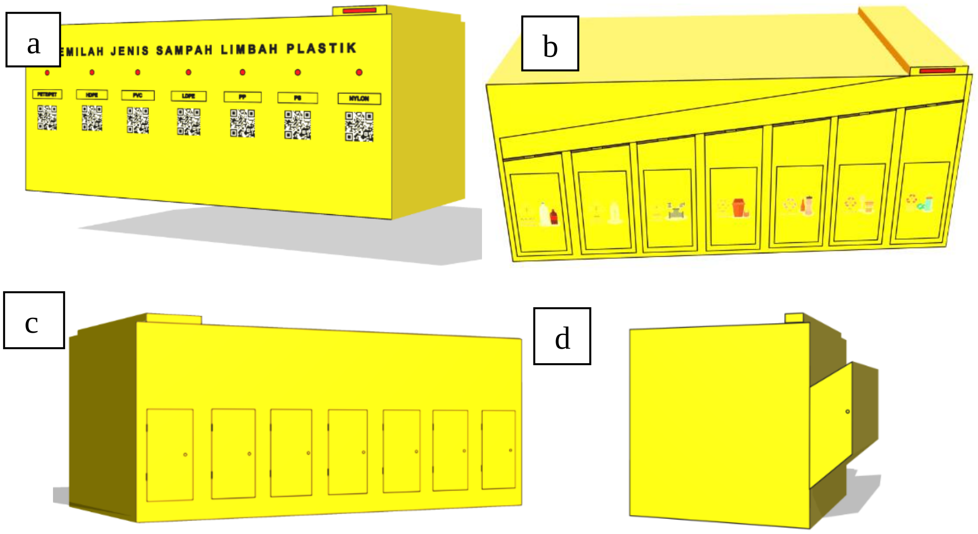


Figure 2. Design of the plastic-sorting sensory device: a) front view, b) top view, c) back view, d) side view.

Figure 2 shows a rectangular design, formed from zinc gutters with a length of two meters, a height of one meter, and a width of one meter, with seven doors at the back, and the front lists seven types of waste and barcodes containing information about the explanation of the type of plastic waste. On the inside, there is a sloping hallway by utilizing the force of gravity to make it easier for waste to enter each of catch basin. The hallway has an automatic valve that is driven by a servo motor as a link between the hallway and the catch basin with a capacity range of 5–10 kg.

RESULTS AND DISCUSSION

Plastic-Sorting Sensory Software Program

The software design was carried out using the Blynk application contained in android. Blynk application functions to create interfaces with various components, both input and output, which support the process of sending and receiving data and representing data according to the selected components. Data can be displayed in the form of visual numbers or graphs (Ardyanto, 2018). To create a Blynk account, firstly the user must download the Blynk application, then register in it. Blynk is not associated with any particular module or board. By using Blynk, the user can perform any function they want remotely, as long as it is connected to the internet. This is what reffered to as IoT.

Transfer of Waste Data Input from the Plastic-Sorting Sensory Device into the Application

After the application account was created, the user need to connect the application with a microcontroller in the form of an ESP32 that was connected to a sensory device (hardware). The use of the widget box in Blynk was conducted to display graphs related to the input amount of waste in daily, monthly, weekly, and annual periods.

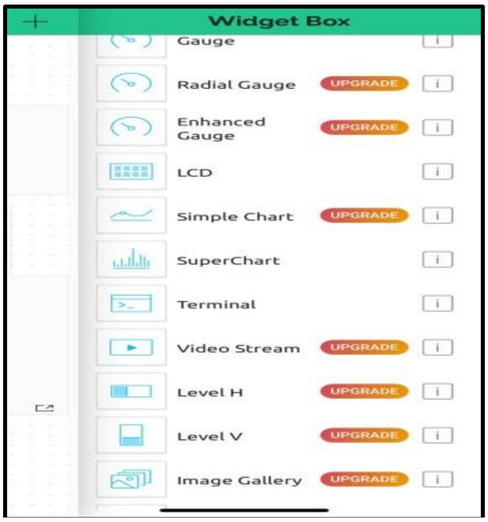


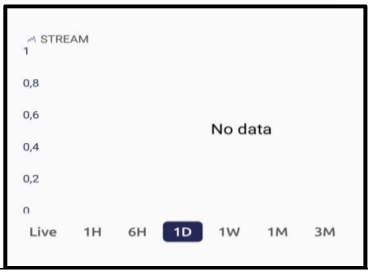
Figure 3. Display to add graphic icon.

Display of Plastic Waste Data into the Application to Facilitate Plastic Waste Management

Plastic waste data to facilitate plastic waste management is displayed on the application as presented in Table 3.

Table 3. Display of plastic waste data on the application.

No.	Displayed data	Display	Description
1.	Amount of plastic waste		Display of the amount of plastic waste being monitored on the device (hardware) and displayed on the app (software)

2.	Color of plastic waste		Display of the color of plastic type being monitored
3.	Type of plastic waste		Display of the type of plastic being monitored
4.	Graph of the amount of plastic waste		A graphical display of the amount of waste being monitored, where the user can observe the dynamics of the graph in real time, be it in hourly, daily, weekly, monthly, and yearly periods.

Information about the Amount of Waste in a Certain Period of Time to Determine the Accumulation of Waste

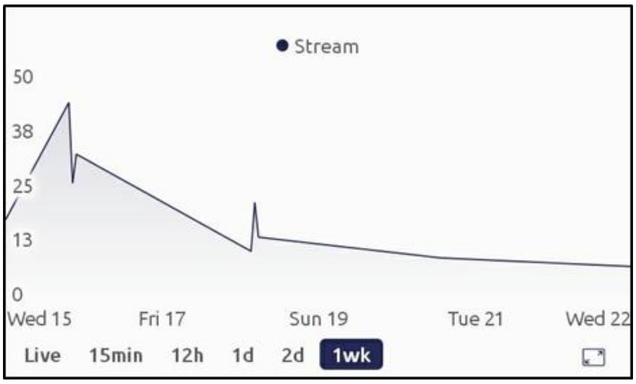


Figure 4. Graphical display of data collection of the amount of waste.

The information component about the amount of waste in the form of a graph was intended to make it easier for the user to read the data of waste pile at a certain period of time, because the application display was created in real time at time intervals of 15 minutes, 12 hours, 1 day, 2 days, and 1 week.

Testing

The testing was carried out with several steps to get the desired results. The initial testing was the calibration process between the plastic-sorting sensor device and the Blynk application. The testing stage of each component was conducted to find out whether the component can work properly or not. Testing started from the Arduino uno, which was conducted through calibration, namely entering the Blynk application account code that will be connected to the device so that all data in the device would be readable by the application. ESP32 was tested by uploading the plastic waste type program to the microcontroller, with an indicator showing whether it was readable or not, and connecting the USB jack to the laptop to check whether the microcontroller was readable by the computer (PC/laptop) or not. Testing using android and Blynk was conducted by reading the plastic waste data input in the plastic-sorting sensory device.

The next stage was to conduct the main testing (data input process in the application). The testing method was carried out by entering as many as six samples of plastic types and was tested 10 times. The testing process was intended to check the accuracy between the monitoring application readings and the sensory device readings, as well as to anticipate obstacles that might occur in the application. The testing was conducted to see the accuracy of the reading of the type of plastic being detected, the color of the plastic, the amount of waste, and the graphic display on the application.

Table 4. Testing results.

Types of Plastic Waste	Testing Results										Success Percentage
	1	2	3	4	5	6	7	8	9	10	
HDPE (Red)	√	√	√	√	√	√	√	√	√	√	98%
PP (Orange)	√	√	√	√	√	√	√	√	√	√	98%
HDPE (Green)	√	√	√	√	√	√	√	√	√	√	98%
LDPE (Blue)	√	√	√	√	√	√	√	√	√	√	98%
PS (White)	√	√	√	√	√	√	√	√	√	√	98%
Others	√	√	√	√	√	√	√	√	√	√	98%

Table 4 shows the experiments conducted on six samples of plastic types, namely 10 trials of HDPE (high density polyethylene) plastic waste types in red, 10 trials of PP (polypropylene) plastic waste types in orange, 10 trials of HDPE (high density polyethylene) plastic waste types in green, 10 trials of LDPE (low density polyethylene) plastic waste types in blue, 10 trials of PS (polystyrene) plastic waste types in white, and 10 trials of the other types of plastic waste (acrylic, polycarbonate, and others) in 15 minutes intervals. The results reveal that the success percentage of input data recorded in the application was in accordance with that of in the plastic-sorting sensory device, with an accuracy rate of 98%. This means that this application was able to read, record, and display the input amount of plastic waste in real time remotely.

The final stage was the on-site implementation of monitoring application on plastic-sorting sensory device, namely the application of hardware in the Environmental Health Department, which was connected to the application at the Golden Waste Bank, Tanjungkarang Health Polytechnic. This testing was carried out together with Golden Waste Bank officers through socialization related to application that are able to monitor data on the amount and type of waste, especially plastic, then by conducting on-site application testing to apply the reading of waste data input in the form of the amount, type, and color of plastic waste. The tests carried out achieved a 98% success indicator in terms of the reading of plastic waste data displayed on the remote Blynk monitoring application between Health Polytechnic Building B, Department of Environmental Health and Health Polytechnic Building A.

Secondly, a remote testing was conducted at the point of Metro Midwifery Study Program. The plastic-sorting sensory device was placed in Health Polytechnic Building B, Department of Environmental Health with a monitoring application test conducted at Health Polytechnic Building C, Metro Midwifery Study Program. The testing conducted was reading the plastic waste data in the form of the amount and type of waste in the application. This second testing was declared successful with an indicator of 98% in terms of the success process of using the remote monitoring application and the success of all processes conducted using the application to monitor the plastic-sorting sensory device.

Lastly, a remote testing was conducted at the point of the Kota Bumi Nursing Study Program. The plastic-sorting sensory device was placed in Health Polytechnic Building B, Department of Environmental Health with a monitoring application testing conducted at Health Polytechnic Building D, Kota Bumi Nursing Study Program. The testing was intended to ensure that the device was connected to electricity and the network and monitoring application was connected to the internet network. The testing conducted was reading the plastic waste data in the form of the amount and type of waste in the application. This third testing was declared successful with an indicator of 98% in terms of the success process of using the remote monitoring application and the success of all processes conducted using the application to monitor the plastic-sorting sensory device.

Usefulness and Development

The plastic-sorting sensory device equipped with IoT system is managed and will be implemented by Tanjungkarang Health Polytechnic, Health Ministry, Department of Environmental Health as a new innovative idea in the field of science and technology that facilitates plastic waste management activities, especially for the academic community at Tanjungkarang Health Polytechnic. As a follow-up, the use of this product is expected to be beneficial for the wider community, such as to academicians, environmental practicioners, also to provide economic benefits to the public through the utilization of plastic products that have been managed.

CONCLUSIONS

Based on this study's results, it can be concluded that the designed application was able to send (transfer) the data results regarding the amount and type of plastic waste from the plastic-sorting sensory device (hardware) to the smartphone application (software), and was readable in real time. The Blynk application that has been connected to the ESP32 microcontroller was able to detect plastic waste data in the plastic-sorting sensory device with an accuracy rate of 98%, proven through the testing results at three different points in Health Polytechnic campus and six types of waste with a percentage error of 2%, namely when the sensory device and the application were not connected to the internet network. The IoT system was able to determine the amount, type, and color of plastic waste, as well as graphical display of the increase in the amount of waste in a certain period of time.

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REFERENCES

Ardyanto, A. A. (2018). *Rancang bangun kotak sampah beroda otomatis berbasis arduino dan aplikasi Blynk*. [Disertasi]. Universitas Bangka Belitung.

Astuty, H. K. (2022). Pemberdayaan ekonomi kreatif melalui daur ulang sampah plastik (Studi kasus bank sampah Kelurahan Paju, Ponorogo). *OSF* Preprints, 1–12.

Conservancy, O. (2018). *Building a clean swell: 2018 report*. https://ocean conservancy.org

Juwariyah, T., Krisnawati, L., & Sulasminingsih, S. (2020). Perancangan sistem monitoring terpadu Smart Bins berbasis IoT menggunakan aplikasi Blynk. *Jurnal Informatika dan Rekayasa Elektronik*, *3*(2), 91–99.

KLHK (Ministry of Environment and Forestry). (2021). *Laporan Direktorat Jenderal Pengelolaan Sampah, Limbah, dan B3 (PSLB3)*. Jakarta.

Nabilah, P., Mhd, Y., & Nurbaiti. (2021). Revolusi industri 4.0: Peran teknologi dalam eksistensi penguasaan bisnis dan implementasinya. *Jpsb*, *9*(2), 91–98.

Simanjuntak, T. B. O., Magindaan, G. M. C., & Pakiding, M. (2017). Rancang bangun sistem kontrol otomatis dan pengamatan kondisi baterai pada sistem pembangkit listrik berbasis microcontroller. *E-Jurnal Teknik Elektro dan Komputer*, *6*(2), 63–68.

Wafi, A., Setyawan, H., & Ariyani, S. (2020). Prototipe sistem *smart trash* berbasis IoT (Internet of Things) dengan aplikasi android. *Jurnal Teknik Elektro dan Komputasi (ELKOM)*, *2*(1), 20–29.

Yusuf, F. (2021). *Membenahi tata kelola sampah nasional*. https://indonesia.go.id. COMSERVA.

APPENDICES

Calibration Process to Check the Accuracy Level of Application (Software) and Plastic-Sorting Sensory Device (Hardware)

Connecting ESP32 to Wi-Fi using Arduino IDE

1) Connecting ESP32 toWi-Fi:
   To connect ESP32 to Wi-Fi, few things need to be prepared in advance:
   a) ESP32
   b) Wi-Fi network
   c) Arduino IDE
2) Steps to connect ESP32 to Wi-Fi:
   a) Make sure the Wi-Fi network is available, as well as the SSID name and the password if there is one.
   b) Connect ESP32 to a laptop, and open the Arduino IDE.
   c) Fill in the required Library, namely "WiFi.h".

```

#include <WiFi.h>
```
konek_esp32_lib hosted with ❤ by GitHub view raw

Figure 5. Connecting ESP32 toWi-Fi.

d) Create a Variabel, fill in with SSID name and the password of the Wi-Fi network to be used.

```
char auth[] = BLYNK_AUTH_TOKEN;
char ssid[] = "Tselhome-03F0";
char pass[] = "71314517";
```

Figure 6. Fill in the SSID name and password.

e) Initiate to connect ESP32 Module to Wi-Fi network.

```
} else {
  Serial.println("No TCS34725 found ... check your connections");
  while (1);
}
```

Figure 7. Connecting ESP32 module to Wi-Fi.

f) Upload the program and see the results. If the device can connect to the Wi-Fi and SSID that has been set in the programming process, then the application can operate directly.

Reading and Transferring the Waste Data Input from the Sensory Device into the Application

Select the *New Project* menu, then select *Add New Device*. Select *Quickstart*. For the microcontroller module hardware section, select "ESP 32" according to the microcontroller used. In *Connection Type*, select "Wi-Fi". Select *Continue* to proceed. After all parts are filled in, the display in the application will automatically become "online" when the device is operated and "offline" when the device is not operated.

Furthermore, there are two ways to display the icon on the Blynk application that has been connected to the plastic-sorting sensory device, namely by entering the coding program, or by utilizing the existing features in the Blynk application. The following is the first step to display the icon on the Blynk application, namely entering the coding program that displays the amount of waste and the color of the type of plastic.

```
void myTimerEvent()
{
  Blynk.virtualWrite(V2, millis() / 1000);
  Blynk.virtualWrite(V4, warna_plastik);
  Blynk.virtualWrite(V5, jumlah_sampah);
  Blynk.virtualWrite(V6, jenis_plastik);
```

Figure 8. Coding to display the icon on Blynk.

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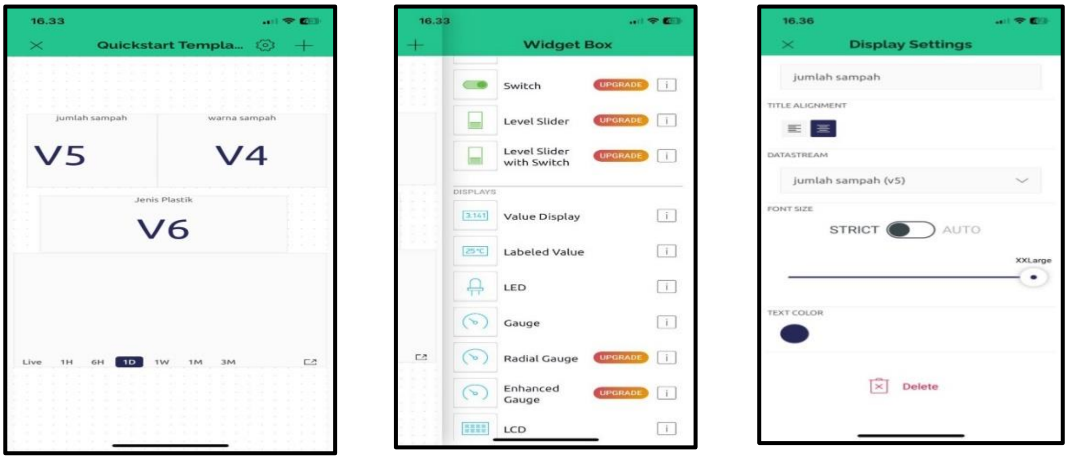
Figure 8 shows the coding to display the icon of plastic color, waste amount, and plastic type. After entering the coding, the user must enter the widget box in the Blynk application to display the icon. In the widget box, select the *value display* icon.



a b c

Figure 9. a) Display for customizing and renaming the icon. b) The process of renaming the icon. c) Display for adjusting the font size, right and left alignment, and renaming the icon that will appear.

The testing results of the use of the IoT system in displaying waste type data are presented in Figure 10.

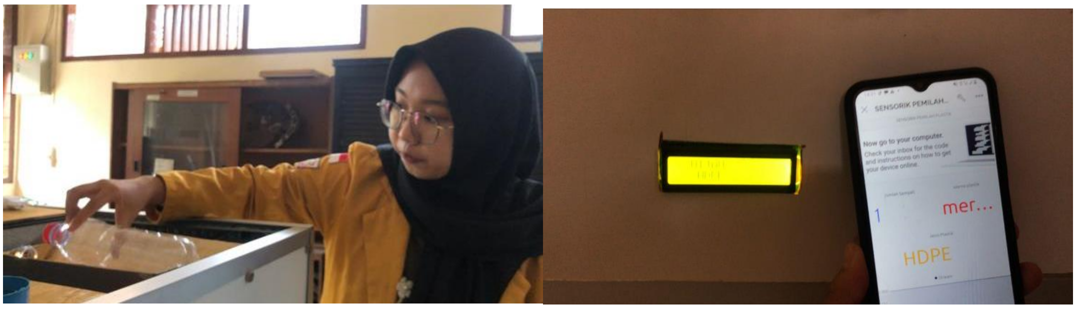


Figure 10. Waste type detection process.