Journal of Airport Engineering Technology (JAET)
https://e-journal.poltekbangplg.ac.id/index.php/jaet

Volume: 5, No. 1. December, 2024: pp. 26-34
E-ISSN; P-ISSN: 2774-9622; 2775-4871
DOI: 10.52989/jaet.v5i1.174
Submitted: 2024-09-24; Revised: 2024-10-28; Accepted: 2024-12-11

DESIGN OF POLTEKSMART TRASH BIN: SOLUTION FOR WASTE MANAGEMENT IN AVIATION TRAINING COLLEGE

M. Ichsan Ramadhani[1], Fadly Febriansyah[2], M. Indra Martadinata[3], Betha Agus Primadewi[4]

[1,2,3] Airport Engineering Technology Study Program, Politeknik Penerbangan Palembang, Indonesia
[4] Faculty of Engineering and Physical Sciences, University of Southampton, United Kingdom
* Correspondence e-mail: ichsan@poltekbangplg.ac.id

Abstract

Waste management issues are a significant challenge in many major environments, including dormitory life in aviation vocational colleges. This study aims to design a prototype of a Polteksmart trash bin equipped with sensors and a Telegram Bot to manage waste in the dormitory building at Politeknik Penerbangan Palembang. This research and development (R&D) method using a 4D model started with data collection from literature review and observation. The research result is a smart design technology of a robot trash bin equipped with infrared sensors, proximity sensors, RTC sensors, EM4, and a Telegram Bot that sends notifications to mobile phones whenever trash capacity reaches 90%. The final design has been validated by a material expert and IT expert, and the analysis becomes quantitative data with assessment results both 90% means it very innovative and can be implemented. By implementing it, we hope to increase the effectiveness and efficiency of the waste sorting and management system. This implementation not only helps in reducing operational costs but also supports efforts to recycle and reuse organic waste that in line with goal to create a cleaner and healthier environment in the Politeknik Penerbangan Palembang. This research emphasizes the importance of technology integration in providing real-time waste management by making it easier for users to monitor the condition of the bins. As such, this research provides a strong foundation for future research to improve waste management's efficiency and effectiveness in educational settings.

Keywords: *internet of thing, prototype, trash bin, waste management*

Introduction

Waste management is one of the major challenges in many major cities around the world (Firdous et al., 2020). According to data by Badan Pusat Statistik in 2020, the amount of solid waste generated reaches 65 million tons per year, and this figure is projected to continue to increase along with population growth and urbanization. Ineffective waste management can cause various negative impacts, such as environmental pollution, health problems, and decreased quality of life. Some of the efforts that the government and the community have made to overcome waste constraints include recycling programs, reducing the use of plastics, and education about waste sorting, supported by active community participation and education (Astuti et al., 2019; dan Ariefahnoor et al.,2020), provides a solid foundation for effective waste management. Community engagement and education are crucial in fostering an effective system. Waste management itself until now has not been touched by technology even though technology plays an important role in developing innovative solutions, and waste management is no exception. Paper shredders, composting machines, and Internet of Things (IoT)-based waste management systems are some of the technologies utilized.

The waste recycling system is the process of collecting and processing materials that were previously considered waste to be converted into new products (Astuti et al., 2019). One indicator of a sound waste recycling system is the existence of an organized system through a waste bank, where each individual has a role in collecting, sorting, and processing waste. The waste bank functions as an efficient management center, ensuring that waste, especially plastic waste, can be processed properly so that it can be reused or recycled. Complementing this view (Ariefahnoor et al., 2020), stated that an effective waste recycling system also includes waste bank management at the village level. This system collects, sorts, and processes waste to be sold or converted into new products. The success of this system is highly dependent on the active participation of all levels of society, especially at the village level. In addition, this system requires strong management, from waste collection to processing, which is supported by ongoing education to the community about the importance of recycling practices.

Aisha (2023) highlighted the importance of involving the younger generation in recycling practices, especially food waste management, the indicators of a sound recycling system include intensive education for the younger generation to increase awareness and skills in managing waste. Programs that support the younger generation's involvement in recycling activities are key to ensuring the sustainability and effectiveness of the waste recycling system. This waste recycling system has been widely studied by previous researchers, including (Meyrena & Amelia, 2020), (Diana et al., 2021), and (Andini et al., 2023). These studies have significantly strengthened the concept and implementation of an efficient, modern, and sustainable waste recycling system.

The embedding of IoT technology also positively impacts robot development, such as waste management systems. Recently, we saw an automatic garbage box robot controlled by IoT technology. This garbage box robot can also send information or data in real time. The robot has been equipped with communication technologies such as Blynk and Telegram. Telegram Bot is a free instant messaging application that can execute automated commands and interact with users through chatbots. The use of the Telegram Bot in waste management offers several advantages, such as providing adequate features for various sensors, ease of access, real-time notifications, and the ability to automate various tasks. Thus, integrating IoT technology and Telegram Bot in the waste box robot improves efficiency and provides innovative solutions for waste management.

In Indonesia, the issue of waste management is also a serious concern. The dormitory building at Politeknik Penerbangan Palembang is one of the educational facilities that generates a significant volume of waste. Currently, the building is only equipped with five waste boxes that are used to accommodate all types of organic and inorganic waste. This condition causes frequent accumulation of

overloaded waste, which causes various waste management problems. As a result of the lack of initial separation between organic and inorganic waste, the waste sorting process is very difficult. This situation is exacerbated by the cadets' low level of concern for waste separation. As a result, waste is often mixed and not managed properly. As a result, a pungent odor arises from the piles of garbage, which disrupts the activities and comfort of the academic community. In addition, improperly segregated waste cannot be effectively recycled in landfills, adding to the burden on the environment.

To face this challenge, one of the applications is the use of IoT-based trash cans. IoT-based trash cans are trash cans equipped with various sensors and information technology to optimize the waste collection and recycling process. One of the studies that utilized IoT-based trash boxes in waste management was conducted (Suryaningrat et al., 2020). This research uses the Global System for Mobile Communication (GSM) on the garbage box system to send message notifications to the officer's smartphone. This notification contains indicator information that the waste box is full, enabling a quick response in waste management. Apart from using GSM, various other studies have also developed smart trash bin models with different technological approaches. For example, ultrasonic sensor technology is used to detect the volume of hazardous waste, demonstrating the application of sensor technology in hazardous waste detection and management (Aji et al., 2021).

Further development of this system by (Ramadhan et al., 2023) involves the utilization of the Blynk application in its operation. This research developed an IoT-based trash can using the Blynk application for monitoring and control, utilizing ultrasonic sensors, NodeMCU 8266, servo motors, MQ-2 sensors, LEDs, and LCDs. This trash can detect whether the trash is full or not and the presence of smoke in real-time, provide notifications to smartphones, and display information on the LCD. Furthermore, the technology used includes Arduino Uno and IR sensors to detect smoke, adding safety features to the trash can (Sari et al., 2022). With the help of Arduino as a microcontroller, and also PING, people who want to throw garbage and then close the garbage bin execute a servo motor, and PING sensor measure the height of the garbage, then sensor and motor controller reading trash height (Hafsah et al., 2023). Besides that, this trash can use Raspberry-Pi technology and the IoT which is website-based (Ismail et al., 2021). Implementation of Remote Monitoring on Virtual Private Server Based on Telegram Bot API (Case Study of Bandung Polytechnic (Syani & Saputro, 2021). Design of a smart trash bin system with Arduino UNO R3-based HCRSF04 sensor (Wuryanto et al., 2019).

Based on this background, this research aims to design a Prototype Polteksmart Trash Bin equipped with sensors and a Telegram Bot to recycle waste in the dormitory Building. This system is expected to increase efficiency, effectiveness, and environmental friendliness in waste management in the building environment.

By implementing the Polteksmart Trash Bin not only helps in reducing operational costs but also supports efforts to recycle and reuse organic waste that in line with goal to create a cleaner and healthier environment in the Politeknik Penerbangan Palembang. This research emphasizes the importance of technology integration in providing real-time waste management by making it easier for users to monitor the condition of the bins. As such, this research provides a strong foundation for future research to improve waste management's efficiency and effectiveness in educational settings.

Method

This research using the 4D Research and Development (R&D) model methodology. The 4D model is a research methodology designed to create, refine, and optimize a specific product or model that is both effective, validated for reliability, and capable of implementation through a structured series of stages (Guslinda et al., 2024). This research limited to the second stage, namely the design stage, with a focus on prototype design that is in accordance with the purpose of manufacture.

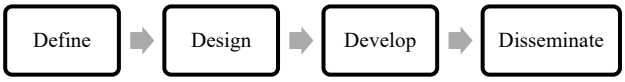

Figure 1. 4D Development Steps

This research is located in Politeknik Penerbangan Palembang dormitory for one semester or 6 months. This research begins with the define stage, which is conducting a literature study to collect relevant theories and concepts from various sources, such as books and journals. This stage aims to identify problems regarding waste management in the dormitory, determine research objectives to answer these problems with the Polteksmart Trash Bin innovation and formulate an appropriate smart trash bin design based on theoretical analysis that is the basis for the concept formulation.

The next stage is the Design stage, where the initial design of the product or prototype is developed. This involves creating a flowchart or framework that serves as a guide for product development and product design. The design stage focuses on aligning the product with the identified research problems and objectives to ensure its relevance and feasibility for further development.

Assessment of expert validation analysis with the quantitative method using table assessment as below:

$$P = \frac{N}{f}\ x\ 100\% \quad \text{(figure 1)}$$

Description :
P = Percentage
N = Score obtained
F = Maximum score

Table 1. Validation Criteria

Score (%)	Eligibility Category
<21 %	Very Unworthy
21 – 40 %	Unworthy
41 – 60 %	Quite Worthy
61 – 80 %	Worthy
81 – 100 %	Very Worthy

Results And Discussions

The Polteksmart Trash Bin is one of the innovations in waste management that is designed to detect waste volume independently and provide a warning when the capacity is full. This technology aims to increase efficiency in waste management (Chandra & Tawami, 2020). This prototype has three key indicator categories: smart trash bin model design, waste recycling system, and application-based monitoring. For the smart bin design, indicators include fullness detection, energy efficiency, data storage, IoT integration, ease of use, and system reliability. The waste recycling system focuses on reducing emptying frequency and improving cleanliness and waste management regularity. Application-based monitoring emphasizes data delivery and real-time notifications to inform users about the bin's fullness status.

This prototype emphasizes indicators such as fullness detection, energy efficiency, IoT reliability, system integration, and sensor accuracy for the smart bin design. For waste recycling, it focuses on reducing emptying frequency, while application monitoring highlights automatic notifications and real-time updates on bin status (Ismail et al., 2021)**.** This innovation adds a safety feature to smart trash cans through the ability to detect potential fires early. The sensors and devices used in this study include IR Sensor, Arduino, and Micro Servo. The design of smart trash can models continues to be the focus of many previous researchers, such as those conducted by (Widodo et al., 2019), (Ramadhan et al., 2023), and (Fikri et al., 2022). These studies significantly contribute to developing smart trash bin technology that is efficient and adaptive to various needs.

An infrared sensor and a proximity sensor are installed inside the Polteksmart Trash Bin to scan the type of garbage. If the waste is confirmed as inorganic, the lid of the Polteksmart Trash Bin for inorganic waste will open, allowing the user to dispose of the waste. If the waste is confirmed as organic, the lid for organic waste will open, with the addition of an RTC sensor that sprays EM4 every 8 hours to speed up composting. Additionally, the filling level of the Polteksmart Trash Bin can be monitored via an ultrasonic sensor. When it reaches 90%, Polteksmart Trash Bin will send a notification via Telegram Bot to the user's smartphone in real time, enabling immediate action for emptying and further management.

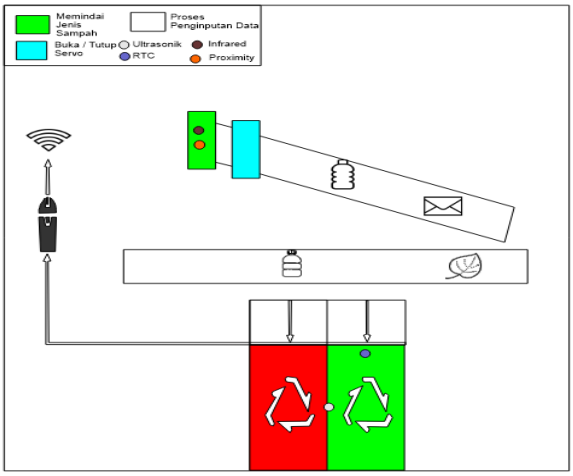

Figure 2. Illustration of Polteksmart Trash Bin Work

The operation of the Polteksmart Trash Bin starts when the user brings the trash closer to the sensors, which consist of infrared and proximity sensors, to scan the type of trash. If the waste is identified as organic, the servo will open at an angle of 105°, and the user puts the waste into the appropriate bin, then servo 1 will close again. If the waste is identified as inorganic, servo 2 opens at an angle of 105°, the user inserts the waste, and servo 2 closes again.

Ultrasonic sensors monitor the filling level of the bin. When the filling level reaches or exceeds 90%, the system will notify via Telegram Bot that the bin is almost full. The system uses Arduino Uno to integrate the process with various sensors and actuators. Figure 3 shows the flow chart of the Polteksmart Trash Bin operation process.

Figures 2 and 3 display our proposed Polteksmart Trash Bin design model. We reviewed the adequacy of our method for sorting organic and inorganic waste at the dormitory building. Based on this review, we plan to implement a waste identification technique using infrared and proximity sensors. This processing technique uses an infrared sensor connected to a smartphone to identify waste into organic or inorganic types.

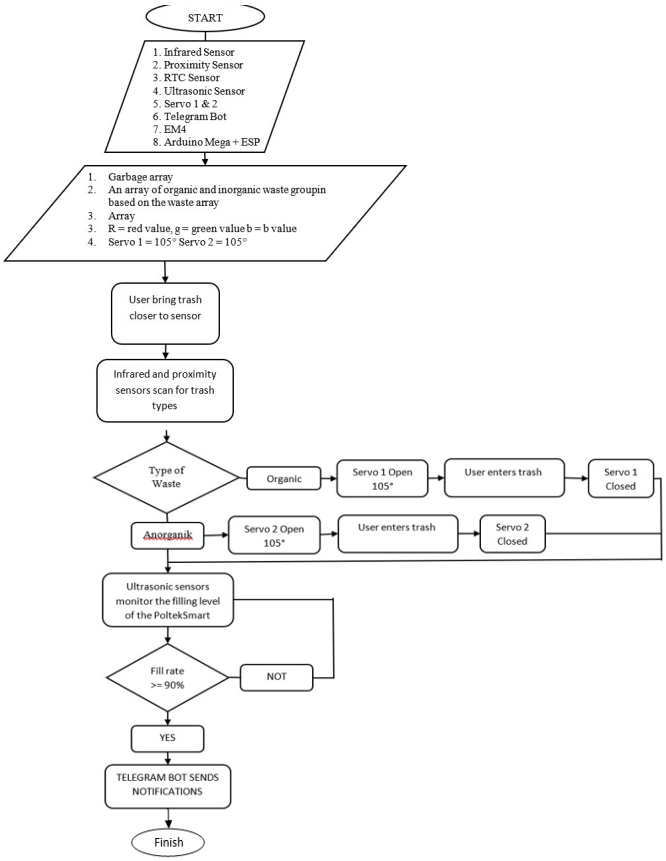

Figure 3. Operation Flowchart of Polteksmart Trash Bin

The advantage of this technique is the use of low-cost sensors, which provides an economic advantage. These sensors will be used to determine the type of waste with relatively high accuracy and efficiency. In addition, if the RTC sensor is combined with EM4 and Telegram Bot, we can manage organic waste into compost. This technology also allows us to monitor the waste fullness level in real-time through the Telegram Bot, providing a comprehensive and efficient solution for waste management in the building.

By combining the technology of infrared sensors, proximity sensors, RTC sensors, EM4, and Telegram Bot, we hope to increase the effectiveness and efficiency of the waste sorting and management system. This implementation helps reduce operational costs and supports efforts to recycle and reuse organic waste. This aligns with our goal to create a cleaner and healthier environment in the dormitory building.

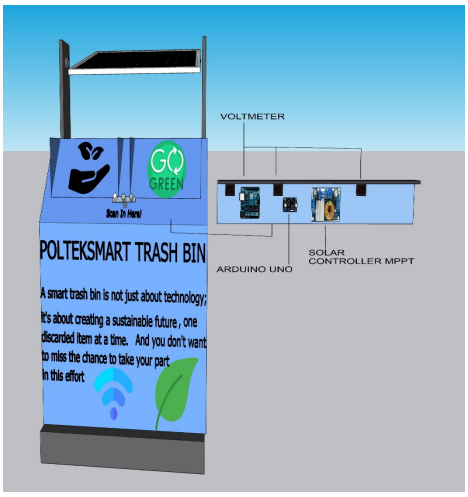

Figure 4. Front View

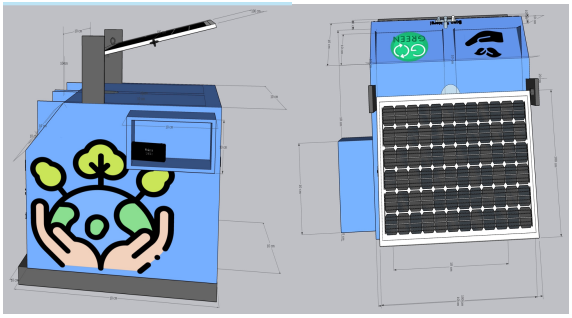

Figure 5. Side View and Top View

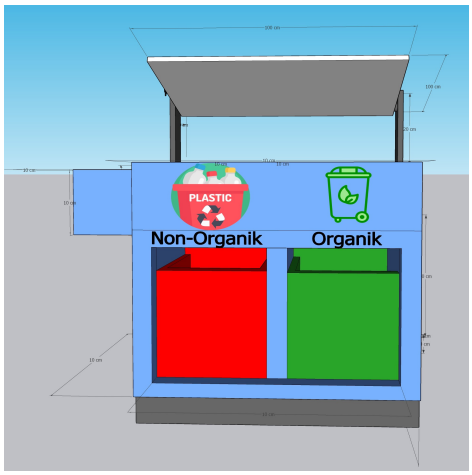

Figure 6. Back View

Each component in the design of the Polteksmart Trash Bin model has a vital role in supporting the system's functionality. For example, the infrared and proximity sensors identify the type of trash and ensure accuracy and efficiency in processing received data. In addition, other components, such as the communication module, assist in real-time data transmission to the central server, enabling more effective monitoring and management. The interconnection between these components creates a well-integrated system, where each part works synergistically to achieve the ultimate goal: smarter and more efficient waste management.

Table 2. Polteksmart Trash Bin Components

Component	Function
Arduino Uno	Sensor and motor controller
Battery	Source of electrical energy
EM4	Accelerates the Composting Process
Inorganic Waste Box	Accommodates inorganic waste
Organic Waste Box	Accommodates organic waste
Inverter	Converts DC current into AC current
Infrared Sensor	Responds to signals in the form of sound
Proximity Sensor	Identifies the type of waste
Ultrasonic Sensor	Measures the height of the waste box
RTC Sensor	EM4 spraying timer
Servo	Drives the lid of the trash can
Solar cell	Converts sunlight into electrical energy through the photovoltaic effect.
Stainless Steel 304	As a material for making smart trash bin
Telegram Bot	Trash box monitoring application

Table 2 shows what components are used in the design of the Polteksmart Trash Bin model and the function of each component. For example, infrared and proximity sensors are used to identify the organic or inorganic waste. This sensor works by utilizing the fact that absorption in the infrared region has different energy when each object receives energy in the form of light, so the trash can be analyzed for identification.

At the validation test stage, the validators assess several aspects to ensure that the Polteksmart Trash Bin is suitable for use. This assessment includes various indicators designed to evaluate the quality and feasibility of the product from a technical and functional perspective (Ulfa, 2021). This testing process involves validators who are experts in IT and Materials. Each validator provides an assessment based on their respective competencies and expertise, ensuring that the application meets the expected quality standards.

Table 3. Design Validation Results by Design Expert Validator

Number	Assessment Aspect	Percentage	Criteria
1	Appearance	87%	Very Worthy
2	Ease	95%	Very Worthy
3	Flexibility	88%	Very Worthy
Average		90%	Very Worthy

Table 4. Design Validation Results by Material Experts

Number	Assessment Aspect	Percentage	Criteria
1	Quality	87 %	Very Worthy
2	Purpose	93 %	Very Worthy
Average		90 %	Very Worthy

The IT test results showed that the application scored 90% from the IT Expert validator. Likewise, the material test results got the same score, namely 90%, from the Material Expert validator. So that an average score of 90% is obtained. Based on these results, the Polteksmart Trash Bin is included in the "Very Worthy" category for use.

Research by (Hafsah et al., 2023) developed a smart trash bin prototype based on ultrasonic sensors to detect fullness levels and send data to the monitoring system. This smart trash bin prototype for waste management has been the object of research by various parties, such as (Wuryanto et al., 2019), (Nusyirwan, 2020) and (Amin et al., 2023). Each study significantly contributes to developing a more efficient, modern, integrated waste management system. Telegram Bot's adaptability is considered superior compared to platforms such as Blynk, which often require additional configuration or face device compatibility limitations (Amertha et al., 2022).

Conclusion

In this research, a Polteksmart Trash Bin prototype was successfully developed, specifically designed to overcome waste management problems at the Politeknik Penerbangan Palembang. This development uses the 4D model R&D method but is limited to the design stage. The design process is based on the analysis of theoretical results, related articles, and discussions that identify the need for a more efficient waste sorting and composting system.

Polteksmart Trash Bin integrates advanced technology, such as infrared and proximity sensors, to detect and separate various types of waste automatically. In addition, an RTC sensor is used to spray EM4 solution, accelerating the composting process of organic waste. An ultrasonic sensor is also implemented to monitor the filling level of the trash can and send real-time notifications via Telegram Bot when its capacity is almost full.

The results of this design show that the Polteksmart Trash Bin has great potential to increase the efficiency and effectiveness of waste management in the building environment. By utilizing automation technology such as smart sensors, waste type recognition, and real-time monitoring systems, this prototype is expected to facilitate the waste sorting process, accelerate composting, and optimize overall waste management

References

Aisha, N. W. (2023). Pengaruh Bank Sampah Terhadap Jumlah Sampah Plastik di Indonesia. *Jurnal Alternatif - Jurnal Ilmu Hubungan Internasional*, *14*(1). https://doi.org/10.31479/jualter.v14i1.57

Aji, F. P., Solehudin, A., & Rozikin, C. (2021). Implementasi Sensor Ultrasonik Dalam Mendeteksi Volume Limbah B3 Pada Tempat Sampah Berbasis Internet of Things. *Jurnal Ilmiah Informatika*, *6*(2), 117–126. https://doi.org/10.35316/JIMI.V6I2.1306

Amertha, L. B., Hartati, R. S., & Sudarma, M. (2022). Sistem Monitoring dan Kontrol Tangki Air Menggunakan Raspberry Pi Berbasis Bot Telegram. *Majalah Ilmiah Teknologi Elektro*, *21*(2). https://doi.org/10.24843/mite.2022.v21i02.p02

Amin, M., Ananda, R., Nofriadi, N., Muflih, H., & Arif, M. (2023). Pengenalan Teknologi Microcontroller dengan Kompetensi Pembuatan Tong Sampah Pintar Pada Siswa Kelas XI SMKN 2 TanjungBalai. *Jurnal Pemberdayaan Sosial Dan Teknologi Masyarakat*, *2*(2). https://doi.org/10.54314/jpstm.v2i2.1089

Andini, D. R., Olivia, D., & Ratnasari, A. (2023). Penerapan Konsep Arsitektur Berbasis Komunitas Pada Pusat Edukasi Daur Ulang Sampah. *IKRA-ITH Teknologi Jurnal Sains Dan Teknologi*, *7*(3), 1–12. https://doi.org/10.37817/IKRAITH-TEKNOLOGI.V7I3.3228

Ariefahnoor, D., Hasanah, N., & Surya, A. (2020). PENGELOLAAN SAMPAH DESA GUDANG TENGAH MELALUI MANAJEMEN BANK SAMPAH. *Jurnal Kacapuri : Jurnal Keilmuan Teknik Sipil*, *3*(1). https://doi.org/10.31602/jk.v3i1.3594

Astuti, S. P., Purnasari, N., Purwono, P., Ristiawan, A., & Ulya, A. U. (2019). MENDEKATKAN PEMUDA KE DAUR ULANG SAMPAH MAKANAN. *J-Dinamika : Jurnal Pengabdian Masyarakat*, *4*(2). https://doi.org/10.25047/j-dinamika.v4i2.1081

Chandra, R. P., & Tawami, T. (2020). Design of Smart Trash Bin. *IOP Conference Series: Materials Science and Engineering*, *879*(1). https://doi.org/10.1088/1757-899X/879/1/012155

Diana, A. I., & Fansuri, S. (2021). Optimalisasi Daur Ulang Sampah Organik dan Anorganik untuk Meningkatkan Jiwa Enterpreneur Mahasiswa Teknik Sipil. *Jurnal ABDIRAJA*, *4*(2). https://doi.org/10.24929/adr.v4i2.1533

Fikri, M. A., Hartama, D., Kirana, I. O., Gunawan, I., & Nasution, Z. M. (2022). Kotak Sampah Pintar Menggunakan Sensor Ultrasonik Berbasis Mikrokontroller Arduino Uno pada Kantor Seketariat DPRD Kota Pematangsiantar. *Jurnal Ilmu Komputer Dan Informatika*, *2*(2). https://doi.org/10.54082/jiki.24

Firdous, S., Altaf, Z., Nabi, G., & Khan, R. A. (2020). Smart Bin for Waste Managemen Using CPaaS Clouds & IoT. *International Journal of Education and Management Engineering*, *10*(2), 38. https://doi.org/10.5815/IJEME.2020.02.05

Guslinda, G., Kurniaman, O., Firdaus, L. N., & Hadriana, H. (2024). Developing Local Wisdom-Based Teaching Materials on “Family Addressing Terms" for Elementary School Students: Validation Analysis Using the 4D Model. *Multidisciplinary Journal of School Education*, *13*(1 (25)), 295–315. https://doi.org/10.35765/MJSE.2024.1325.15

Hafsah, H., Rifai, H. M., Mulyati, R., & Putri, F. E. (2023). Rancang Bangun Pembuatan Smart Trash Bin Berbasis Arduino Uno: (AMIK) Tri Dharma. *Journal Intra Tech*, *7*(1), 25–35. https://doi.org/10.37030/JIT.V7I1.135

Ismail, M., Abdullah, R. K., & Abdussamad, S. (2021). Tempat Sampah Pintar Berbasis Internet of Things (IoT) Dengan Sistem Teknologi Informasi. *Jambura Journal of Electrical and Electronics Engineering*, *3*(1). https://doi.org/10.37905/jjeee.v3i1.8099

Meyrena, S. D., & Amelia, R. (2020). Analisis Pendayagunaan Limbah Plastik Menjadi Ecopaving Sebagai Upaya Pengurangan Sampah. *Indonesian Journal of Conservation*, *9*(2). https://doi.org/10.15294/ijc.v9i2.27549

Nusyirwan, D. (2020). TONG SAMPAH PINTAR DENGAN PERINTAH SUARA GUNA MENGHILANGKAN PERILAKU SISWA MEMBUANG SAMPAH SEMBARANGAN DI

SEKOLAH. *Jurnal Teknoinfo*, *14*(1). https://doi.org/10.33365/jti.v14i1.336

Ramadhan, R. A., Kakke, G. R., Fajar, I. N., & 4∗, S. P. (2023). Smart Trash Bin Berbasis Internet Of Things Menggunakan Suplai dari Panel Surya. *G-Tech: Jurnal Teknologi Terapan*, *7*(3), 1149–1158. https://doi.org/10.33379/GTECH.V7I3.2777

Sari, V. R., Suhada, S., Wanto, A., Hartama, D., & Irawan, I. (2022). PEMANFAATAN ARDUINO UNO DALAM TONG SAMPAH PINTAR DAN PENDETEKSI ASAP BERBASIS IR SENSOR. *Device*, *12*(1). https://doi.org/10.32699/device.v12i1.2569

Suryaningrat, A., Kurnianto, D., & Syifa, F. T. (2020). Pemanfaatan Google Firebase Pada Sistem Tempat Sampah Pintar Berbasis Internet of Things. *Dinamika Rekayasa*, *17*(1), 1. https://doi.org/10.20884/1.dr.2021.17.1.324

Syani, M., & Saputro, B. (2021). Implementasi Remote Monitoring Pada Virtual Private Server Berbasis Telegram Bot Api (Studi Kasus Politeknik Tedc Bandung. *Jurnal SISKOM-KB (Sistem Komputer Dan Kecerdasan Buatan)*, *4*(2). https://doi.org/10.47970/siskom-kb.v4i2.190

Ulfa, M. (2021). Pengembangan E-Learning Berbasis Moodle Pada Mata Pelajaran Fiqih Dalam Meningkatkan Efektifitas Dan Hasil Belajar Siswa. *AL-WIJDÃN Journal of Islamic Education Studies*, *6*(1), 29–40. https://doi.org/10.58788/ALWIJDN.V6I1.959

Widodo, Y. B., Sutabri, T., & Faturahman, L. (2019). Tempat Sampah Pintar Dengan Notifikasi Berbasis IOT. *Jurnal Teknologi Informatika Dan Komputer*, *5*(2). https://doi.org/10.37012/jtik.v5i2.175

Wuryanto, A., Hidayatun, N., Rosmiati, M., & Maysaroh, Y. (2019). Perancangan Sistem Tempat Sampah Pintar Dengan Sensor HCRSF04 Berbasis Arduino UNO R3. *Paradigma - Jurnal Komputer Dan Informatika*, *21*(1). https://doi.org/10.31294/p.v21i1.4998