Smart Trash Can: Innovation of Automatic Trash Can with Arduino Uno-Based as an Effort to Support Global Sustainable Development Goals (SDGs) Action

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ABSTRACT
Garbage is an item that we encounter every day and often causes problems. Based on statistical data from the 2020 National Waste Management Information System, in the City of Yogyakarta the highest percentage of waste by type is organic waste consisting of food waste with a percentage of 50.21%. One of the problems that must be addressed is the presence of waste mixed with other types of waste, this is due to the lack of public awareness and knowledge in sorting waste. Therefore, appropriate treatment is needed to overcome these problems. Smart Trash Can is a smart trash can that detects types of waste consisting of organic, inorganic, and metal waste. One of the containers can be opened and pushed by the drive according to the information received from the sensor. This trash can product will also display the type of waste detected through the LCD, so that it can educate users regarding the type of waste. This product is made using strong iron material and can accommodate 5 kg of waste in each container. To open the container used an actuator. Another feature is a hand sanitizer box that also uses sensors, so when the user's hand is detected by a sensor, the box will issue a hand sanitizer. The method used is PDCA (Plan, Do, Check, Action). This trash can is expected not only to encourage innovation in industry and technology, but also to increase public awareness and knowledge about environmentally waste management as an effort to support the global action plan for Sustainable Development Goals (SDGs).

Keywords: *Hand Sanitizer Feature, Sensor, Smart Trash Can, Sustainable Development Goals, Types of Waste*.

1. INTRODUCTION

Garbage is an item that often causes problems, especially cleanliness, tidiness, and aroma that is released. Insufficient capacity of trash bins is the reason people don't throw garbage in its place. Public knowledge is also still lacking in sorting waste by type. Based on statistical data from the 2020 National Waste Management Information System, in the City of Yogyakarta on Figure 1. The highest percentage of waste by type is organic waste consisting of food waste with a percentage of 50.21%.

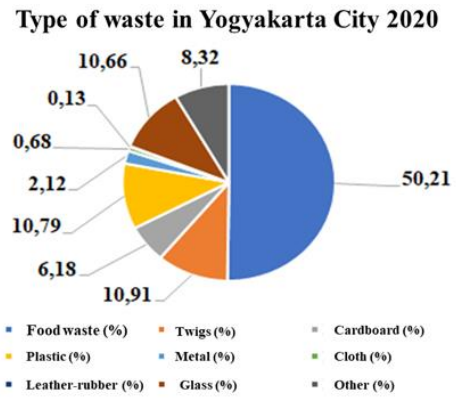

Figure 1 Comparison Graph of Waste Types in Yogyakarta City.

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Waste separation can support the global action plan Sustainable Development Goals (SDGs) number 13 by 2030. Good waste separation and environmentally sound waste management can reduce negative impacts on public health and the environment [1].

Another problem is the lack of awareness of washing hands after throwing garbage in the community even though there is a *hand sanitizer* as a substitute for water. According to the reference number, as in [2], the comparison of the number of bacteria between washing hands with soap and *hand sanitizers* for students majoring in Health Analysts at the Health Polytechnic of the Ministry of Health Kendari, it was found that *hand sanitizers were* more effective in reducing the number of bacteria compared to liquid soap, which was 1%.

Similar innovations that exist, there are still limitations such as the type of waste that can be detected only metal or non-metallic waste, then there is no feature for washing hands [3]. Therefore, innovation improvements were made with Smart Trash Can, a smart trash can detect types of organic, inorganic, and metal waste equipped with a feature *hand sanitizer*. This product aims to increase public awareness and knowledge about environmentally sound waste management as an effort to support the global action plan *Sustainable Development Goals* (SDGs).

2. THEORETICAL BASIS

2.1. Garbage in Indonesia

Data from the Ministry of Environment and Forestry (KLHK) in February 2019, released that currently Indonesia produces at least 64 million tons of waste piles every year. Based on these data, about 60% of the waste is transported and dumped to the landfill, 10% of the waste is recycled, while the other 30% is not managed and pollutes the environment [4]. According to the Yogyakarta Environment Service in 2017, the highest amount of waste in the city of Yogyakarta by type is organic waste with a percentage of 61.12%, then inorganic waste with a percentage of 30.55%.

2.2. Arduino

Arduino is an electronic device based on a flexible and open source microcontroller so that the software and hardware are easy to use [5]. Arduino has several types that are often used to be controllers in an electronic circuit. One type of Arduino that is often used is Arduino Uno. Arduino Uno is an ATMega 328 type microcontroller which has a function as a controlling brain that can process all formations and commands on the designed tool [6].

2.3. Proximity Sensor

Proximity sensors are sensors that can detect the presence of objects or targets without physical contact or proximity switches [7]. There are two types of proximity sensors, namely capacitive proximity sensors and inductive proximity sensors. The induced proximity sensor can detect metal targets that are approaching the sensor without any physical touch. When the target approaches the magnetic field, an induced current or eddy current flows in the target due to electromagnetic induction. The capacitive proximity sensor works and is active to detect the presence or absence of an object by looking at changes in the capacitance value when brought near a certain object. This sensor will generate an electric field and will later detect the capacitance value when this electric field cuts an object [8].

2.4. Infrared Sensor

Infrared is electromagnetic radiation which is invisible light, located in the red color spectrum. Invisible rays include: Ultraviolet Rays, X-Rays, Gamma Rays, Cosmic Rays, Microwaves, Electric Waves and Infrared Rays. Electromagnetic waves between visible light and microwave light are called infrared rays with characteristics that are invisible or invisible, linear or diffuse, reactive or can be reflected and can be absorbed by several objects. So, the infrared sensor is a voltage change detector using an infrared signal. The infrared sensor or photo transistor has 2 parts, namely the transmitter and the receiver [9].

2.5. Microcontroller

Microcontroller is a microprocessor system in which there is already a CPU, ROM, RAM, I / O, Clock and other internal equipment that are interconnected and well organized (observed) by the manufacturer and packaged in a ready-to-use chip. So that the implementation team only needs to program the contents of the ROM according to the usage rules by the manufacturer that made it [10].

2.6. Linear Actuator

Electric linear actuator is a device that converts rotational motion from an electric motor to linear motion (push and pull motion). Electric linear actuators can be used anywhere whether the machine is pushing or pulling loads, raising or lowering loads, roughly positioning loads, or rotating loads [11]. Linear actuators are widely used in various applications and are useful in many areas, especially in

industrial fields such as transportation, manufacturing, and robotics [12].

2.7. Quality Function Development

The purpose of the QFD Principle is to ensure that: Customer needs and desires can be satisfied in the process of reducing product quality. That is why QFD is said to start with the voice of the customer (VOC = voice of). customer) and often in English, QFDs are called customer-oriented products. development or customer-centric design. The first goal of QFD is always Avoiding marketing mistakes will force your product out of the market due to lack of competition. second goal QFD is designed to improve the speed and efficiency of the product development process.

3. METHODS

The implementation of product design uses the Kaizen method, which is carrying out continuous improvement or continuous improvement [13]. Kaizen has four stages which are commonly abbreviated as PDCA or plan, do, check, action. This method is used because it helps the implementation to be simple and easy in application in real life. This method also allows for further product development in the future.

3.1. Plan

- Identification of problems
  The implementation team identified problems in handling waste in the community by searching the library, there was an innovation in the trash can that notified the cleaning staff when it was full [14], then there was an automatic trash can that could open the trash can without touching it [15]. This has not been able to completely overcome the problems faced, especially in sorting the types of waste.

- Analysis Data
  The implementation team processes and analyzes the data so that the proposed features of the product are obtained. From the results of the analysis, six needs were obtained, namely capacity, waste sorting sensor, product design, hand sanitizer features, convenience, and trash can cover.

- Product development process
  After identifying the problem and analyzing the data, then the product design process is continued using the QFD method, namely by comparing the product to be designed with the previous product to get the best specifications of the product to be made, the following is the process:

  - Identification of customer needs
    Table 1-6 are the results of identifying customer needs based on interviews with their level of (*importanceimportance*).

Table 1. Customer needs

#	*NEED*	*Imp*
1	Requires a large capacity trash can	1
2	Needs a waste separator (sensor)	1
3	Attractive and *eye catching design*	3
4	Equipped with hand sanitizer	2
5	Ease of opening the trash	3
6	Closed trash can so that odors do not spread	3

  - Data processing and product specification formation
    Table 2 is a data processing process based on customer needs to obtain product specifications to be created.

- Preparation of Tools and Materials
  The implementation team provides the necessary materials, equipment, and components, both in terms of mechanics and electronics, both online and offline. In making the casing using the services of a vendor. The main thing that is a concern in the supply of materials to produce this product is that it is strong, wide, shatterproof, and has good aesthetic value, so iron is chosen as the main material because it has met these criteria.

3.2. Do

- Product Design Process
  The product design process is divided into 3 main processes consisting of making 3D designs, assembling electronic devices, and making casings. The manufacture of the casing uses the services of a vendor, while the assembly of electronic equipment is carried out by the time executors.

- Prototype
  At the stage of making a product that has been designed and designed, then it is realized in the form of a prototype.

Table 2. Metrics and Units

Metric#	*Needs#*	*METRIC*	*Imp*	*Units*
1	1	Volume of trash can	1	L
2	1	Weight of empty bin	5	kg
3	1	Height of bin	2	m
4	2,4,5	Length of sensor	3	mm
5	2.4 ,5	Sensor width	3	mm
6	2,4,5	Sensor weight	5	g
7	3	Eyecolor *catching*	2	
8	6	Maximum distance smell of garbage	3	m

Table 3. Link Metrics to Needs

Metric / ***Need***		1	2	3	4	5	6	7	8
		Volume of trash bin	Weight of empty	bin Height of trash can	Sensor	width Sensor width	Sensor	Eye catching color	Maximum distance smell of garbage
1	Requires a large capacity trash bin	·	·	·					
2	Requires a waste separator (sensor)				·	·	·		
3	attractive and *eye catching design*							·	
4	Equipped with hand sanitizer				·	·	·		
5	Ease of opening the trash can				·	·	·		
6	Closed trash can so odor does not spread								·

Table 4. Benchmark on Customer Needs

#Metric	**Needs #**	**Metric**	**Imp**	**Units**	**Hoza**	**prototype *Smart trash Bin***	**The trash creative and innovative**	**Green Leaf**
1	1	Volume dumpster	1	L	285	40	90	240
2	1 The	weight of the empty bin	5	kg	2.8	2	3.5	2.65
3	1 The	height of the trash can	2	m	1.1	0.5	1	0.82
4	2,4,5	Sensor length	3	mm		68 ,6		
5	2,4,5	Sensor width	3	mm		53.4		
6	2,4,5	Sensor weight	5	g		25		
7	3	Eyecolor *catching*	2					
8	6	Maximum distance smell of garbage	3	m	0.6	1	0.3	0, 35

Table 5. Assign Marginal and Ideal Values

Metric#	***METRIC***	***Units***	***Marginal Value***	***Ideal Value***
1	Trash volume	L	>210	>285
2	Weight empty trash	kg	<3.5	<2.5
3	High-bins	m	0.75	1.2
4	Long sensor	mm	70	60
5	Width sensor	mm	55	47.5
6	Weight sensor	g	28	23
7	Color *eye catching*			
8	Maximum distance of smell of garbage	m	0.8	0.3

Table 6. Set Final Specifications

Metric#	***METRIC***	***Units***	***Value***
1	Trash volume	L	>270
2	Weight of empty trash can	kg	<2.5
3	Binding	height m	1.1
4	Sensor length	mm	65
5	Sensor width	mm	50
6	Sensor weight	g	25
7	Eyecolor *catching*		Red Yellow Blue
8	Maximum distance smell of garbage	m	0.3

3.3. Actions

At this stage, improvements are made according to the results of further evaluation and implementation to improve the product in order to reduce errors and failures, so that the product can be operated according to its function.

4. RESULT AND DISCUSSION

4.1. Prototype

Prototyping of Smart Trash Can is done by creating a 3D design using the Solidworks application. The design of the prototype on the Smart Trash Can is carried out by considering the material, effectiveness, and working mechanism. The size of the tool is made as minimal as possible so that someone can be comfortable and easy when they want to dispose of garbage using the Smart Trash Can. Figure 2 is the prototype of Smart Trash Can. The prototype size used is 60 cm in diameter and 60 cm in height and is divided into 3 automatic containers that function to accommodate types of organic, inorganic, and metal waste. In the manufacture of the Smart Trash Can, a casing or body with iron material is used so that it can accommodate up to 15 kg of garbage.

Users can use the product by attaching waste to the sensor, then the LCD will show what type of waste was detected so as to provide education to the public about the types of waste so that people can dispose of waste according to the type of waste. Then one of the containers will open and the user can put trash in it. In addition, the Smart Trash Can prototype has a hand sanitizer feature that can be used to clean hands and also functions as self-protection from Covid-19.

Figure 2 Prototype

4.2. Prototype Testing

The prototype was tested 30 times with 3 different types of waste and different test time. The results show that the Smart Trash Can prototype can detect organic, inorganic, and metal types of waste and the container can open automatically. In addition, the hand sanitizer feature can detect the presence of hands and spray hand sanitizer by the indicator lamp (red color). The following are the results of the prototype trials that have been carried out.

Figure 3. Test result metal waste

In Figure 3., the spoon is brought closer to the sensor to test the sensor identification results for several types of objects. The spoon that has been identified as a "sampah logam" or metal object can be seen in the results of Figure 4.

Figure 4 Test result

After the type of object or waste is identified, the linear actuator will push the container to open according to the type of waste, so that the user can enter it. Figure 5. shows the open containers of this type of metal waste. In Figure 6., the bottle shows the result trial of inorganic waste. In Figure 7., the leaf shows the result trial of organic waste.

Figure 5 Test result of container

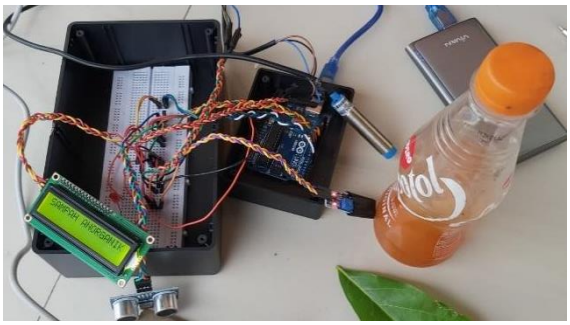

Figure 6 Test result inorganic waste

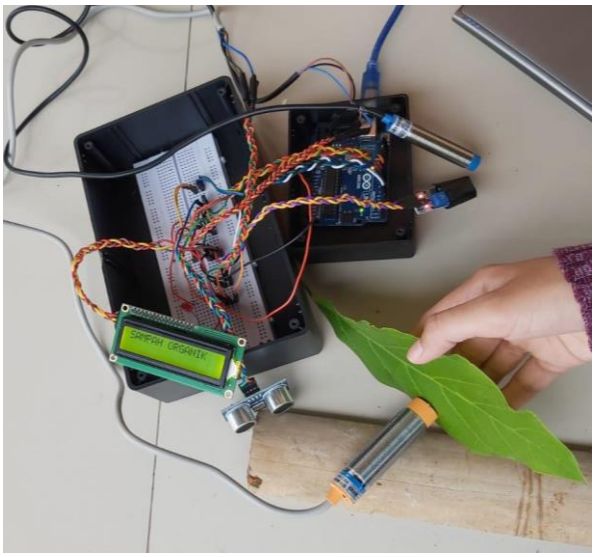

Figure 7 Test result organic waste

4.3. Design Concept Advantage

The advantage of the Smart Trash Can product is that it can detect types of organic, inorganic, and metal waste automatically. In addition, the container on the product can also be opened automatically. The addition of an LCD component to the product can provide education to the public about sorting waste by type of waste. This product can identify the type of waste that is disposed of by bringing the waste closer to the sensor, then the sensor can read or identify the waste and display the type of waste on the LCD screen. Of the three existing sensors, the inductive proximity sensor can read metal types of waste, the capacitive proximity sensor can read the types of organic waste, and the infrared sensor can read the inorganic waste types. Then arduino uno will provide information regarding what garbage was detected. Then, one of the containers of the identified waste type will be pushed by the linear actuator and will open automatically, so that the user can put the waste into the container. Then the container is closed again.The hand sanitizer feature can be used after disposing of garbage so that a person can maintain hand hygiene and can prevent the transmission of the Covid-19 virus.

4.4. Special Potential

It is hoped that this trash can product has a good market opportunity and becomes a business unit that can attract a lot of workers and provide benefits for its users and the general public. In terms of benefits, Smart Trash Can has superior potential compared to similar products, namely the product is designed to help and educate the public in disposing of waste based on its type. By using several sensors that can detect types of organic, inorganic, and metal waste and integrated with Arduino Uno. The containers in the Smart Trash Can will open automatically based on the type of trash. The hand sanitizer feature can be a means of maintaining hand hygiene and preventing the transmission of the Covid-19 virus. Therefore, the Smart Trash Can product have a major contribution in helping waste management in the community with an environmental perspective as an effort to support the global action plan for the Sustainable Development Goals (SDGs).

5. CONCLUSION

The Smart Trash Can has been created which is designed to increase public awareness and knowledge about environmentally sound waste management as an effort to support the global action plan for Sustainable Development Goals (SDGs). Smart Trash Can is a detector of organic, inorganic, and metal waste, as well as a hand sanitizer feature that is intended to make users care more about cleanliness after disposing of garbage, all of these features are controlled by Arduino Uno. Smart Trash Can has been tested 30 times on each feature and has good results because each feature is able to run well, so it is hoped that Smart Trash Can can be mass-produced and can be a solution to the waste problem in Indonesia.

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