Smart Trash Early Warning System Based on Internet of Things

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***Abstract*— The volume of rubbish in the city of Jakarta was getting more and more days, garbage must be transported every day from various points of the location to garbage collection sites or garbage cans. A large number of garbage collection pointed that accumulate and cause pollution plus the lack of waste management resources by the government would have an impact on the environment and the surrounding community from air pollution to the emergence of diseases that arise from the rubbish pile. The author raised this issue to build an internet of things waste early warning systems to improve effective and time-efficient waste management resources. Early detection systems for smart bins could be applied in big cities so that they made a big contribution to maintaining a clean and comfortable community environment as a form of smart city development.**

Keywords*— *Internet of things, Smart Trash, early warning system.

I. INTRODUCTION

Technological developments was needed to support survival in developing countries. The city of Jakarta was a metropolitan city with various cases, one of them was the operation of waste. The volume of waste in the city of Jakarta which increased every year was estimated to reach an average of 400 tons per year. In March 2019 the DKI Jakarta Government had targeted 7000 to 7500 tons of garbage that could be transported every day from various garbage collection sites or garbage cans. This garbage can was located in various locations that contain waste, used goods and other waste materials that were not used. The process of transporting waste was required by alarm or early warning of garbage tanks whose volume reached the maximum limit. Early warning was used so that all garbage could be transported properly and could also improve irregular garbage collection schedules. Garbage that piled up and scattered everywhere could result in environmental pollution, dirty surrounding areas that were not hygienic, and even resulted in congestion of drainage channels. Environmental pollution was a very serious threat to society in daily life that could disrupt public health.

The operation or transportation of waste from garbage cans was done by utilizing internet technology. Internet of things was one of today's artificial intelligence technologies that could be applied in various fields starting from the fields of health, environment, and even education. The workings of the Internet of things were carried out by researchers by creating tools that could transfer data between physical devices into the internet by interconnecting objects used in everyday life. The mechanism of how the tool works were to provide a warning when the garbage can was in a condition that was almost full. The process of sending the command via an internet network protocol. So that the internet of things could monitor all trash bins that were scattered from various locations, so that through this warning the decision to take the garbage using the garbage transport vehicle was immediately resolved quickly and efficiently.

Internet of things (IoT) had been used by several researchers with the advantages and disadvantages of IoT[1], but among the advantages of IoT not necessarily all people accepted because it would result in their privacy being disturbed [2], and they wanted to protect personal data [3], but IoT had also developed a lot and ensured safe interaction between IoT devices[4], by increasing the accuracy of authentication for all IoT objects [5], with the full strength of network-related services with application security capabilities [6]proven by the existence of e-applications commerce in IoT by explaining the characteristics of e-commerce and its security [7], even to overcome environmental pollution [8], health [9], cultural preservation and smart city[10] and monitor room temperature [11]and implement in scale applications big with applications that could manage fluids, control stocks and smart homes, and built alarm systems [12].

Research relating to a good waste monitoring system required a huge amount of money because the Smart Trash infrastructure that had been made already utilizes the camera, GPS, GIS, RFID technology and used SMS Technology as a warning sender that the garbage bin is full[13]. In further research, there were devices that utilize Zigbee and GSM technology in this discussion but Zigbee's communication range was not more than 50 Meters. So, it was not the current solution to use technology [14].

The use of the Internet of things was done by researchers by making tools installed in garbage bins that were scattered in various locations. The tool could detect the status of objects by applying an early warning system approach. Early detection was used as a smart dumpster that was programmed through electronic signals to produce a decision to take garbage from various locations. This smart trash could automatically manage the best schedule in trash collection by means of transporting garbage. The use of smart trash could be applied in big cities that had used smart city technology.

II. LITERATURE

A. *Internet of Things*

The Internet of Things (IoT) technology describes an object that can transmit data/information over a network without human intervention. Reference in determining garbage capacity if the waste capacity has exceeded 70%, the

device will send a ranking signal from an ultrasonic distance sensor that is measured using physic formula (1), because the sensor's working system fires waves at the object in front of it and waits for its reflection. Twice (2), so that to know the actual distance must be divided in half, half is the time the wave is fired and hits the object, half is the reflection of the wave from the object returning to the receiver. The results of using the formula as follows:

$$s = v * t \quad (1)$$

Look for distance on the HC-SR04 proximity sensor:

$$s = \left(\frac{t}{2}\right) * 29{,}1 \quad (2)$$

B. *Microcontroller*

The microcontroller is a processor that is used specifically for the sake of control. The microcontroller has a smaller form than computers in general, but the microcontroller is built with the same elements.

C. *Ultrasonic distance sensor (HC-SR04)*

Ultrasonic wave-based distance measuring sensor. The working principle of this controller is similar to ultrasonic radar. Ultrasonic waves are emitted by a trigger then received back by the ultrasonic echo. The distance between transmit time and receiving time is a representation of the distance of the object. Ultrasonic wave-based distance measuring sensor can be seen in the Fig.1

Fig. 1. Ultrasonic Distance Sensor (HC-SR04).

D. *NodeMcu V3 Lua WIFI Internet of Things Development Board Based ESP8266.*

The microcontroller development board was based on ESP8266 chip with a small form. This device was said as more practical and efficient because this thing was a microcontroller device that had been integrated with the wireless module without the need to add support devices to be able to connect to the wireless network where the prices offered were relatively cheaper, the device could be seen in the Fig.2

Fig. 2. NodeMcu V3.

III. METHOD

Data collection by making direct observations of various objects, and the location of the presence of garbage bins in the city of Jakarta. The process of sending information was done by spreading the points of the host to these locations, then through the internet network could monitor all the scattered waste bins, the results of monitoring as a decision to early detect the volume of garbage bins for transportation by garbage transportation. The observation results were used as a reference for making this research.

Research conducted in India, one of the developing countries in the Asian region [15], the proposed system used ultrasonic sensors to detect the level of waste fullness. The tools used are Arduino UNO, microcontroller and Raspberry Pi2. Tool cooperation through the system globally shows that drivers of garbage collection vehicles would receive information via SMS while the government could monitor the status of trash bins through web pages. Another study was still one country [16] that state waste production was an increasingly high need to implement intelligent systems in monitoring and disposal of waste. With the IoT-based approach (Internet of Things) researchers used ultrasonic sensors and MQ4, ultrasonic sensors checked the fullness of waste. The results of the study were referred to as "smart bins" which automatically separated recyclable waste from waste that could not be recycled biologically. If the garbage crossed the threshold in a smart trash bin with rubbish that could not be recycled, the help of application information would be sent to the municipal company for garbage disposal. If the rubbish crossed the threshold of a smart rubbish bin with recyclable rubbish, the rubbish lid would slip and the rubbish would be disposed of into the underlying space.

Research conducted in India [17], that the increasing population of the country resulted in landfill waste in the surrounding environment, so an intelligent waste management system based on the internet of things is needed. Systems with microcontroller areas an interface and the sensor system would detect the level of waste and then displayed it via GSM/GPRS based on Android.

Research conducted [18], that in some big cities in Thailand country, overflowing rubbish bins caused disgusting odors that would pollute the surrounding environment which results in the growth of bacterias and viruses that result in various types of diseases. To overcome this situation, an efficient waste collection system was developed based on IoT.

The development of research in applying the Internet of Things (IoT) was carried out [19], Operation of a smart trash bin where the GSM board sent a message by detecting the level of waste with the help of IR (Infrared Ray) installed in the trash. The main purpose of this system was how to control waste, as a human effort to realize smart cities.

The development of IoT was carried out in the USA [19]. This study aimed to describe the security of the alarm system using a low processing power chip. IoT helped in monitoring and getting alarms when a motion was detected and sending photos and videos to the cloud server. Also, Internet-based applications could be used remotely to view activities and get notifications when motion is detected. Photos and videos were sent directly to the cloud server when the cloud was not available then the data was stored locally in Raspberry Pi and

would be sent if there was a connection. I hope this IoT application could monitor activity in a location.

Other related research [20] suggested that garbage collection trucks in public places come irregularly, resulting in increased environmental pollution. Using the Low Energy Energetic Adaptive Hierarchy Algorithm (LEACH), the researchers proposed a minimum distance of the collection truck's travel time to the location of a garbage bin that was almost full and even detected the location of the trash that produced hazardous gas. This project was implemented and simulated using Network Simulator version 2 and the Arduino UNO developer board.

Research began by determining the data needed, and the tools needed. The initial stage of making a tool starts with the design of a microcontroller based on the ESP8266 chip to receive signals from the ultrasonic distance sensor (HC-SR04). The identification of early detection of garbage cans built by the ultrasonic sensor HC-SR04 which would emit ultrasonic waves to an object, in this case, was the location of the trash bins and then received the reflected waves, so that based on travel time (the initial time sending waves to receive back waves of reflection) could be known the distance between the sensors and the object. Then the information obtained was forwarded to the ESP8266 chip and processing the data. The ESP8266 chip would transmit information in the form of the volume of garbage bins, through a wireless access point at the 2.4 GHz frequency which would be forwarded to the server. The information would be on the cloud that would display on the website so that it could be easy to get 70% waste bin information.

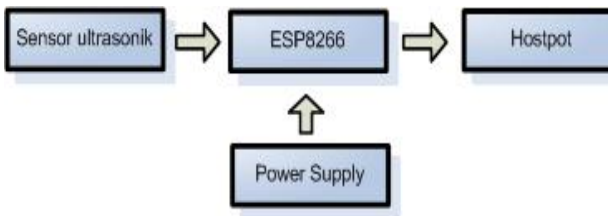

Fig. 3. System architecture.

The client SSID produced a volume of garbage that had reached 70%, then through the WiFi signal the information would be forwarded to the webserver and the webserver would display early warning information about the trash.

IV. RESEARCH RESULT

The results of this research project were evidence of the development of smart bins by utilizing information technology in smart cities where devices were built with consideration of lower cost estimates and effective device selection from previous studies. The proposed system was built for processing waste that was currently still being done manually, where the system could reduce the use of fuel from garbage collection vehicles. The mechanism for warning or sending signals generated by this smart bin was to read the distance of objects in front of the proximity sensor. The result of the distance reading of objects received by ultrasonic distance sensors that were sent directly to the microcontroller device which would be processed with decision-support algorithm formulas in smart bins and at the end of the process would be issued in the form of a percentage of the trash capacity sent to the webserver through the facility Hotspot.

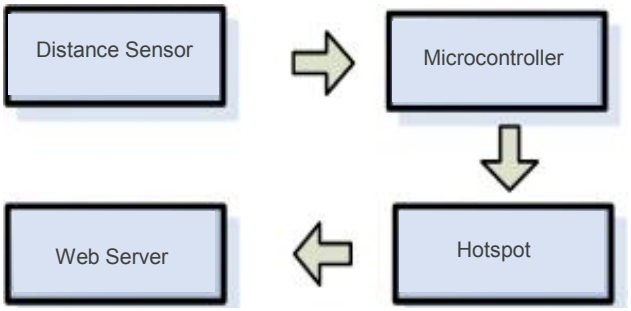

Fig. 4. Block Diagram Of Device Prototype On Smart Trash.

The design of the microcontroller system used the basis of the ESP8266 module device embedded in the NodeMcu V3 and then coupled with input in the form of a proximity sensor to produce a warning signal sent directly to the webserver.

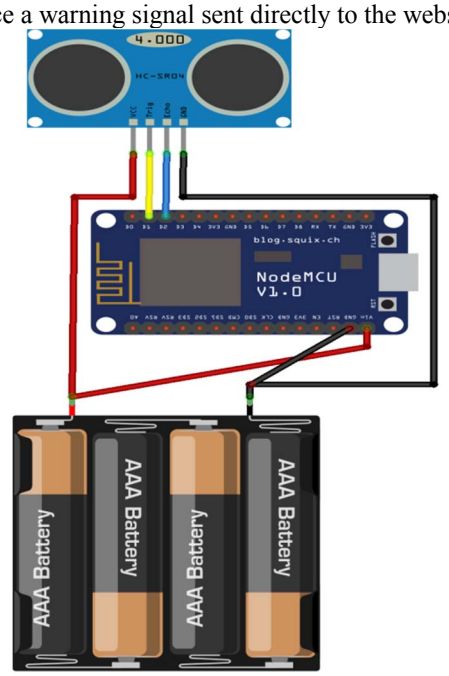

Fig. 5. Design of a microcontroller system in the smart trash.

Microcontroller based on the ESP8266 chip to receive signals from the ultrasonic distance sensor (HC-SR04) with a small form. This device was said as more practical and efficient because it had been integrated with the wireless module without the need to add support devices to be able to connect to the network wireless. The results of the series of tools could be seen in Fig.6. This device had been installed in the trash can could be seen in Fig. 7.

Fig. 6. Tool Prototype for Smart Trash.

Fig. 7. Smart Trash Prototype.

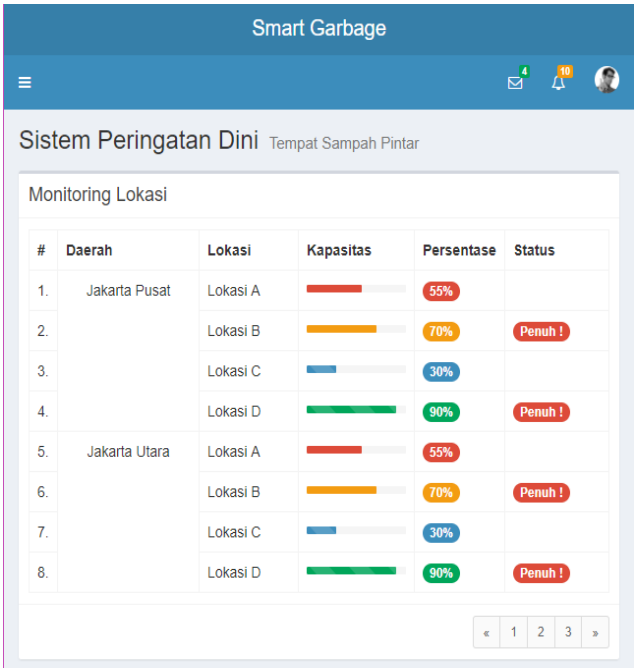

Fig. 8. Monitoring Page For Smart Trash Manager.

The locations of smart trash cans were located in the Jakarta City area in various locations connected via a wireless access point. Early warning information systems for smart bins were located in the cloud that would display on the website. Monitoring the location would display information in the form of the city and the location of the trash, followed by the capacity of the trash, the percentage, and the status of each trash can. On the website monitoring page, the smart trash can displayed the different statuses of each trash can. Status differences could be seen in Fig. 8 and could be described as follows:

1. The blue color indicated that the capacity of the trash can was still very large or indicates that the garbage in the trash can had just been taken by the transport carrier.
2. The red color indicated that the trash can had been filled with approximately 50%.
3. Yellow indicated that the trash can had been filled with approximately 70% almost full. When the status was almost full, the program automatically issued a sound like an early warning system that the waste bin was full, so that the garbage was ready to be transported by the garbage transport means.
4. While the green color indicated that the capacity of the trash can is full in the range of 90% — 100% so that the garbage had to be transported by means of transporting garbage.

The flow of information delivery as a way of working the internet of things smart trash early warning system could be described in Fig. 9.

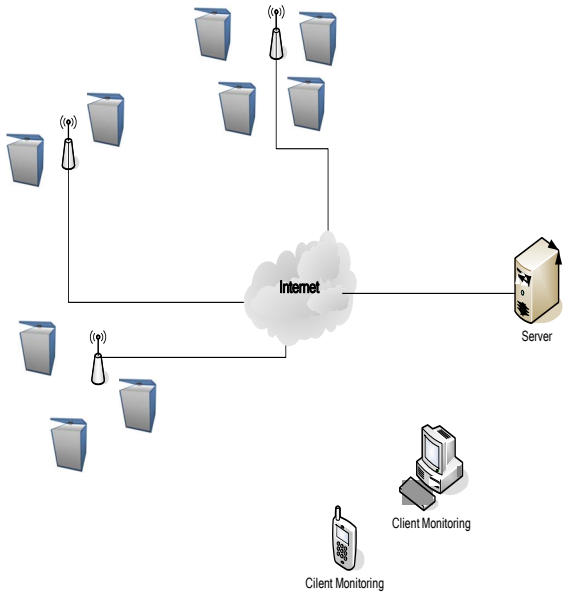

Fig. 9. Roadmap Prototype Smart Trash.

The making of the tool started with the design of a microcontroller based on the ESP8266 chip in order to receive signals from the ultrasonic distance sensor (HC-SR04). This device was said to be more practical and efficient because it had been integrated with the wireless module without the need to add support devices to be able to connect to the network wireless. The trial was carried out by installing devices at various points of garbage collection in the city of Jakarta. The client SSID produces a volume of garbage that has reached 70%, then through the wifi signal the information would be forwarded to the webserver and the webserver would display the early warning information about the trash. Then through the wireless access point on the 2.4 GHz frequency, it would be forwarded to the server. The information would be on the cloud that would be displayed on the website so that it could quickly get information on the trash that has reached 70%.

The monitoring results were displayed on the website page as an early warning decision on the volume of trash that had exceeded 70% for transportation by garbage transportation. Smart Trash would make a decision with the distance of the object capacity of garbage that had exceeded 70% would send a notification of notification to the webserver page. The hope was that the early warning system could improve the effectiveness and efficiency of waste management resources so that the surrounding environment could be clean and avoid air pollution that disrupts life. The early warning system automatically scheduled transportation of garbage carriers properly so that it could reduce the cost of fuel use. The application of an early warning approach to the smart waste bin system based on the internet of things was a manifestation of the development of a smart city.

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