PROTOTYPE CONTAINERS OF WASTE MONITORING SYSTEM IN TPS CIROYOM AND TPS NYENGSERET

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ABSTRACT

The purpose of this research is to provide montoring of the trash loads under the truck, to make a scheduling of carry the container effectively, to make a monitoring of truck usage in the distribution of waste from TPS to TPA. The stages of this research began with an analysis of the system in POOL West Bandung with Ciroyom TPS and Nyengseret TPS as a place of research because this polling station received the largest garbage in Bandung, which is 50-60m3 per day, then analysis of the system to be built is coordinates of TPS and TPS are used as geofencing areas, making microcontrollers using ultrasonic sensors and heavy sensors as parameters for determining container volume, then making notifications via SMS gateway for information on carry the containers and monitoring containers. The results of this research indicate that the accuracy of the sensor in determining the volume of containers and the accuracy of the coordinates of the GPS is quite optimal. The disadvantages of this research are the safety of the tools in the container for the implementation phase, the accuracy of sensors and GPS that need to be improved, and the lack of direct interaction with container truck drivers. This is due to the use of medium quality sensors and GPS. The impact of this research is to facilitate the cleanliness section in monitoring container loads, container locations and scheduling in carry the containers.

Keywords : monitoring, scheduling, containers, geofencing, coordinates, sensors and GPS.

1. INTRODUCTION

TPS Ciroyom located in Ciroyom Market, Andir Subdistrict, West Bandung Territories is is a polling station that can hold up up to 7m³ of garbage each day.This polling station is a polling station that receives the most garbage every day. TPS Nyengseret also is TPS receiving more garbage. With each passing day able to handle up to 60 m³ Garbage each day.

According to the results of the author's interviews with Mr. Iwan Saripudin as Head of the Engineering Department, Managing and Implementing Landfill Waste Management of West Java, the condition of garbage containers trasported by containers trucks often exceeds the limit, which is 12,5m³ or 6 m³. If the load exceeds the limits, it will have an impact in container or truck conditions that will be damaged quickly due to carrying a bigger payload and will endanger other users of the road.

Ritasi is the process of distributing waste by TPS container transport trucks to TPA. The number of rites can be determined based on the volume obtained at each TPS. The process of ritation of the drivers of garbage trucks from TPS to TPA does take a lot of time due to the considerable distance, as well as heavy traffic conditions. The use of alternative roads is indeed an option to avoid congestion, but the use of alternative roads that are more remote will also have an impact on the use of BBM. This lack of supervision will directly affect the time needed for the distribution of waste that takes longer. In addition, lack of supervision cannot prevent drivers from abusing truck use.

In addition, based on the results of the author's interview with Mr. Hangga as Data & Information Manager at PD. Kebersihan of Bandung, container truck officers still use experience / schedules in determining when containers are ready to be transported. A full container should be immediately transferred to the landfill. The result of this is the slowing down of the rite process because it has to wait according to the specified schedule.

By considering the problems faced by PD. Kebersihan of Bandung, the authors are interested in discussing the monitoring of garbage containers in the thesis with the title "Prototype Containers of Waste Monitoring System in TPS Ciroyom and TPS Nyengseret".

2. STUDY OF LITERATURE

2.1. Container

Containers are containers to hold garbage from every community house, market and others. The type of containers spread in various regions can be seen in **Error! Reference source not found.**

Table 1.

Type	The capacity of the	Description
Container 6 m³	2.856 kg.	Images 1. **Images *2*.**
Container of 12.5 m³	5.712 kg.	Images 2.

Images 1.

Images 2.

2.2. The Global Positioning System Gps

The Global Positioning System is a satellite-based navigation system consisting of a network of 24 satellites placed into orbit [10].

2.3. Arduino

According to Heri Andrianto and Aan Darmawan Arduino is an open source microcontroller board, where schematic and PCB design so that we can use it and make modifications [14]. According to Mochamad Fajar Wicaksono and Hidayat Arduino is an electronic platform that is open source and easy to use [15]. Based on Heri Andrianto, Aan Darmawan, Mochamad Fajar Wicaksono, and Hidayat, it can be concluded that Arduino is an open source microcontroller or electronic platform where schematic and PCB designs can be freely modified.

2.4. Sensor

A sensor is a device used to detect changes in nature, then convert it to digital or analog values depending on the type of sensor used [22].

3. Research methods

3.1. Research Methodology

The research methodology used is the descriptive analysis method.

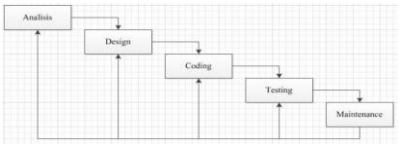
3.2. Methods of data collection

Data collection methods are obtained directly from the object of research. The stages of data collection used are:

a. Study of literature
   This study was carried out by studying, the literature sourced from books, texts and readings which had to do with the topic of research.
b. Field Studies
   This study is conducted by visiting the place to be studied and conducting data collection directly. This includes the following:
   - The survey and interviews
     The survey conducted directly at TPS Ciroyom interviewed Mr. Samsul as Head of Hygiene Affairs at Ciroyom TPS, TPS Nyengseret interviewed Mr Djaja as Head of Hygiene Affairs at Nyengseret polling station. In addition, the author also interviewed Mr. Rustandi as the Regional Bandung Technical and Operational Coordinator.
   - Observation
     The observation is done with direct observation of the data required for the development of this system.

3.3. A method of software development

The design stage used for making this application is the waterfall or waterfall method. Phases in the Waterfall Model according to Pressman's reference can be seen in Images 3. **:**



Images 3.

In the Images 3, Here's the explanation:

a. Analysis: At this stage the writer analyzes the need for system development based on the data that has been obtained and the results of the interview.
b. Design: At this stage the author will make a description of the system design that will be built based on the analysis that has been done.
c. Coding: At this stage the author makes a system based on the system design that has been made before.
d. Testing: At this stage the author tests the system that has been built.
e. Maintenance: After testing, the next step is to do a survey again about the system that has been built, by interviewing and questionnaire PD. Kebersihan.

4. RESULT AND SESSION

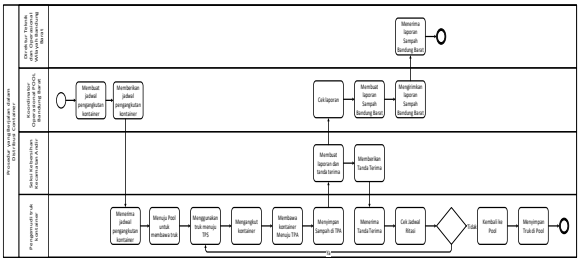
4.1. Running System Analysis

The ongoing system analysis is carried out by interviewing PD Data and Information Managers. Hygiene and Head of the Technical Implementation Unit of the Regional Environmental Management Agency's TPA / TPS Waste Management Unit (UPTDPSTRDLH) of West Java Province to get an overview of the current system. The following is the procedure for transporting waste to the Sarimukti Landfill. The procedure for transporting containers to Sarimukti TPA is:

a. West Bandung POOL Operational Coordinator made a transportation schedule.

b. The Operational Coordinator for POOL West Bandung provides a transportation schedule to Container truck drivers
c. The container truck driver receives the container transport schedule.
d. Container truck drivers carry trucks from the pool.
e. Container truck drivers go to TPS by truck.
f. The container truck driver transports containers according to the specified schedule.
g. Container truck drivers go to TPA.
h. Container truck drivers store container contents at Sarimukti TPA.
i. Sarimukti Cleanliness Section makes a report and receipt.
j. The Cleanliness Section gives a receipt for the container truck.
k. If a container truck is determined for rite, the container truck returns to the specified TPS. If not, the container truck driver returns to the specified pool.
l. The container truck driver receives a receipt.
m. Container truck drivers return to the designated pool
n. Container truck drivers park trucks in the pool.
o. Operational Coordinator for POOL Bandung Barat accesses garbage data online.
p. West Bandung POOL Operational Coordinator reports on container distribution in the West Bandung region.
q. Operational Coordinator for POOL Bandung Barat provides a report on West Bandung waste to the Main Coordinator.
r. The West Bandung Region Technical and Operations Director received a report on the West Bandung Region container distribution.

The procedures for transporting containers to Landfill can be seen Images 4.



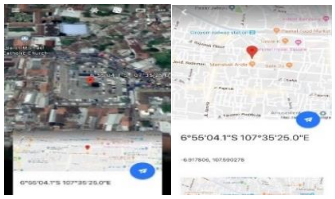
Images 4.

4.2. Analysis of TPS Ciroyom

TPS Ciroyom analysis is data collection to build system requirements at TPS Ciroyom.

4.2.1. Analysis of TPS Ciroyom Coordinate

Analysis of TPS Ciroyom Coordinate was made to determine the container tracking starting point. The following is a coordinate image of the Ciroyom polling station that can be seen on Images 5.



Images 5.

The coordinates of the Images 5 show that TPS Ciroyom was at the point with the coordinates (-6.917810) latitude and longitude 107.590265.

4.2.2. Schedule Analysis at TPS Ciroyom

The number of rites that must be done is 3 times per visit. The following is the TPS Ciroyom container transport schedule can be seen at Table 2.

Table 2.

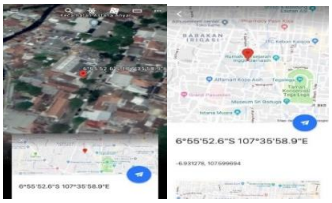
Day	Time
Every day	At 06.00 AM At 12.00 PM At 18.00 PM

4.3. Analysis of TPS Nyengseret

TPS Nyengseret analysis is data collection to build system requirements at TPS Nyengseret.

4.3.1. Nyengseret Coordinate TPS Analysis

Analysis of TPS Nyengseret Coordinate was made to determine the container tracking starting point. The following is a coordinate image of the Nyengseret polling station that can be seen on Images 6.



Images 6.

The coordinates of the Images 6 show that TPS Nyengseret was at the point with the coordinates (-6.931288) latitude and longitude 107.599691.

4.3.2. Schedule Analysist in TPS Nyengseret

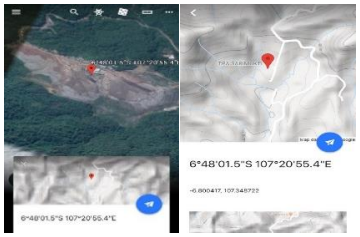
The number of rites that must be done is 3 times per visit. The following is the TPS Nyengseret container transport schedule can be seen at Table 3.

Table 3.

Day	TIME
Every day	At 06.00 PM At 12.00 PM

4.4. Analysis of Sarimukti Landfill Coordinate

Analysis of Landfill Sarimukti coordinates created to define the endpoint Tracking Containers. Here is a picture of the coordinates of landfill Sarimukti can be seen in Images 7.

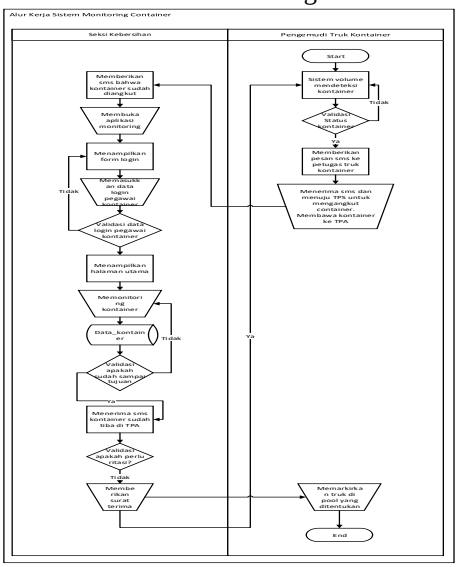


Images 7.

The coordinates of the Images 7. show that landfill Sarimukti was at point with coordinates (-6.800421) latitude and longitude 107.348723.

4.5. The Workflow System

The system to be built aims to provide monitoring of containers by monitoring the condition of high and heavy waste and the coordinates of the location of container transport trucks. The system work flow to be built can be seen in Images 8.

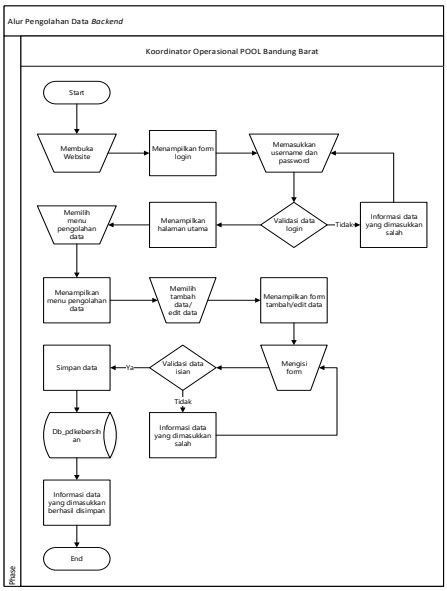


Images 8.

The explanation of the Frontend workflow system in Images 8. is as follows:

a. The system checks the status of containers with ultrasonic sensors, to measure the height and weight of waste in containers.
b. If the container has not been fully loaded, the sensor will continue to check the container status, if the system is full, the SMS Gateway notification will be given to the container truck driver, to immediately transport the container to the landfill.
c. The driver will receive a notification from the SMS, then take the truck from the pool to the specified polling station and bring the container directly to the landfill.
d. Monitoring Cleanliness Section by receiving a notification that the container has been transported to the landfill.
e. The Cleanliness Section opens the application.
f. The system displays the Cleanliness Section login page.
g. Cleanliness Section enter login data.
h. If the data does not match, the system will return to the login page. If appropriate the system will display the main page.
i. Cleanliness Section monitors containers.
j. Each point passed by a container truck will be entered into the tracking history.
k. If the container hasn't arrived at the TPA, the Cleanliness Section will continue to monitor the container. If the container has arrived at the landfill, the system will send a notification to the Landfill Management and Control Section.
l. The Landfill Management and Control Section will enter incoming waste data.
m. Waste data is entered into the database
n. If, the amount of waste transported to the landfill is still less than the garbage that enters the TPS, the truck driver must do the recitation, returning to the system process checking the volume of containers with ultrasonic sensors. If not, then the Landfill Management and Control Section will provide a receipt.
o. Drivers of container trucks are allowed to drive trucks and park them in the specified pool area.

The workflow system in the backend can be seen in Images 9.



Images 9.

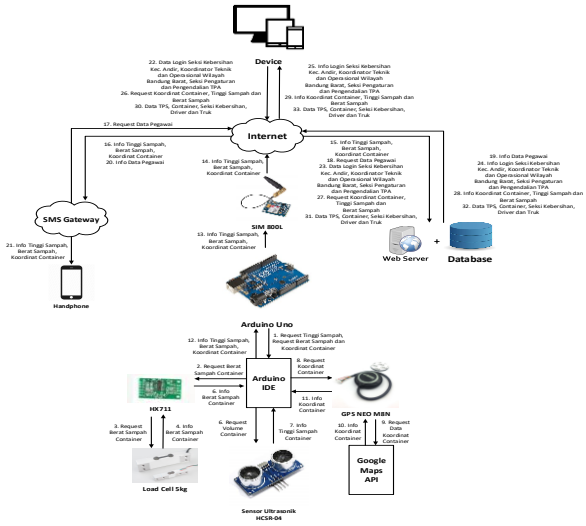
The explanation of the Images 9. is as follows:

a. POOL West Bandung Operational Coordinator opened a container monitoring website.
b. The system displays the login form.
c. The Operational Coordinator for POOL in West Bandung includes a login username and password.
d. The system validates login data.

e. If the data entered incorrectly displays incorrect login data information then returns to step 3.
f. If the data entered is correct, the system displays the main page.
g. POOL West Bandung Operational Coordinator chooses one of the data management menus (tps data, driver data, container data, truck data, and cleanliness section data).
h. The system displays the managed data menu.
i. POOL West Bandung Operational Coordinator chooses one option from data processing (add / edit).
j. The system displays the form fill (add / edit).
k. Operational Coordinator POOL West Bandung fill the data into the form then press the save button.
l. The system performs data validation.
m. If the data entered is incorrect, the system displays incorrect data information and returns to fill in the data.
n. If the data entered is correct, the system will save data to the database.
o. The system displays information about the data saved successfully.

4.6. Systems Architecture

System architecture analysis aims to identify the architecture to be built. The following is a picture of the system architecture can be seen on Images 10.



Images 10.

The explanation of the Images 10. is as follows:

a. Arduino uses the Arduino IDE, requests data on garbage height, garbage weight and container coordinates.
b. Request junk via HX711.
c. HX711 requests heavy waste with 5kg loadcell.
d. 5kg Loadcell provides heavy trash info through HX711
e. HX711 sends heavy junk info to Arduino IDE.
f. Request volume container by HCSR-04 Ultrasonic Sensor.
g. The HCSR-04 Ultrasonic Sensor provides container volume info, accepted by the IDE.
h. Request coordinate by GPS NEO M8N.
i. GPS requests coordinates with Google maps API.
j. The API provides coordinate info to GPS.
k. GPS provides info to the Arduino IDE.
l. The Arduino IDE sends info on trash, garbage weight and container coordinates.
m. Info on the height of garbage, the weight of the garbage and container coordinates is received by Arduino UNO, then sent via SIM800L.
n. Info on waste height, garbage weight and container coordinates is received by Arduino UNO, then sent via SIM800L to the internet.
o. Through the SMS Gateway, Info on waste height, garbage weight and coordinates.
p. Before sending via SMS Gateway, Employee data requests via the Internet.
q. Request data for employees through Web Server and Database.
r. Info on employee data sent via the internet.
s. Info on employee data sent by the internet.
t. Info on employee data is received by the SMS Gateway.
u. Provide info on the height of garbage, the weight of the garbage and container coordinates to the driver's mobile number.
v. Data Login in the Cleanliness Section, West Bandung Regional Technical and Operational Coordinator, TPA Management and Control Section is entered via the device to the internet.
w. Data Log in Cleanliness Section, West Bandung Region Technical and Operational Coordinator, Landfill Management and Control Section verified by the database.
x. Login Info Cleanliness Section, West Bandung Region Technical and Operational Coordinator, Landfill Management and Control Section received through the internet.
y. Login Info Cleanliness Section, Technical and Operational Coordinator of the West Bandung Region, TPA Management and Control Section is received through the device used.
z. Request for garbage, weight of garbage and container coordinates by the Cleanliness Section and the TPA Control and Settings Section via the device.
aa. Request for garbage height, garbage weight and container coordinates by the Hygiene Section and the Landfill Management and Control Section via the internet.
bb. The Container Volume and Coordinate info through the database server is provided via the internet.

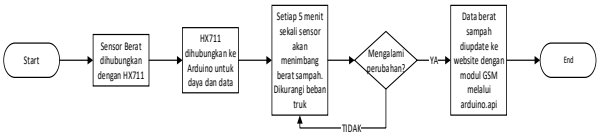
cc. The Volume and Container Coordinate info through the database server is displayed by the device.
dd. Data on TPS, Container, Driver, Cleanliness Section, Truck by the West Bandung Regional Technical and Operational Coordinator are entered via the device.
ee. Data on TPS, Container, Driver, Cleanliness Section, Truck by the West Bandung Region Technical and Operational Coordinator are included through the website and internet.
ff. Info on TPS, Containers, Drivers, Cleanliness Section, Trucks through a database server is provided via the internet.
gg. Info on TPS, Container, Driver, Cleanliness Section, Truck through the database server displayed by the device.

4.7. Analysis of Reading Tools

Analysis of reading tools is a description of concepts for the process of reading and calculating the sensors and modules used for application development.

4.7.1. Weight Sensor Reading Analysis

Analysis of weight sensor readings is a depiction of the basic concept for a heavy sensor process in calculating the weight of garbage in a container. Waste depth readings are using 5kg and HX711 loadcell sensors. For the sensor reading process can be seen at Images 11.



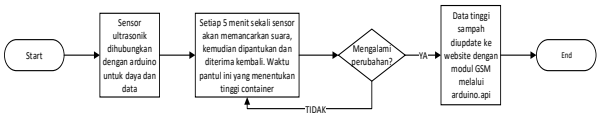
Images 11.

Explanation of the weight sensor reading in Images 11. is as follows:

a. The weight sensor is connected to the HX711.
b. The HX711 is connected to Arduino with 5V 1A, and pin 10 for TX and pin 11 for RX
c. Every 5 minutes will calculate the heavy load of waste, with a maximum load of 0.2 kg for this prototype. Because the remote control truck used is only capable of running with a maximum capacity of 0.2 kg. The maximum capacity of containers in type 6m3 is 2,856kg, while at 12.5m3 is 5,712kg, so the scale of comparison between containers of type 6m3, container type 12.5m3 and prototype is 14,280: 28,560: 1.
d. Make a check, if it doesn't change again to the second process.
e. If 'Yes' changes, the data will be updated to the website via Arduino.api

4.7.2. Ultrasonic Sensor Readings Analysis

Ultrasonic sensor reading analysis is a depiction of the basic concept for the ultrasonic sensor process in calculating the depth of waste in a container. The reading of the waste depth is by using an ultrasonic sensor HC-SR04. For the ultrasonic sensor reading process can be seen at Images 12.



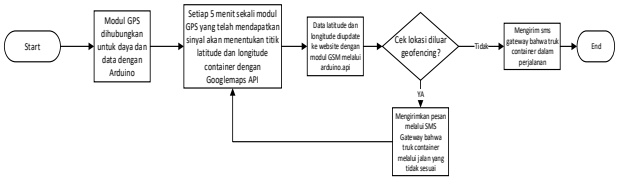
Images 12.

Explanation of Ultrasonic sensor reading in Images 12. is as follows:

a. Ultrasonic sensors are given 5V 1A power, with Echo and Trigger pins on pins 6 and. 7 on Arduino Uno.
b. Every 5 minutes on pin 6 emits sound (high), (low) and (high), the echo will receive sound reflections, with the calculation of the sound reflection time. Reflection time is what determines the height of waste in the container. The container height of type 6m3 is 120cm, while at 12.5m3 is 150cm, using prototype containers which are 4.5cm high, so the scale of comparison between container types 6m3, container types 12.5m3 and prototypes is 26.7: 33.3: 1.
c. Checking changes in high garbage data, if it does not change back to the second process.
d. If 'Yes' changes, the data will be updated to the website via Arduino.api

4.7.3. GPS Module Reading Analysis

Analysis of GPS module readings is a depiction of the basic concepts for the GPS module process in determining the coordinates of a container truck. Location reading is by using GPS NEO M8N. For the process of reading the location can be seen on Images 13.



Images 13.

Explanation of the GPS module reading in Images 13. is as follows:

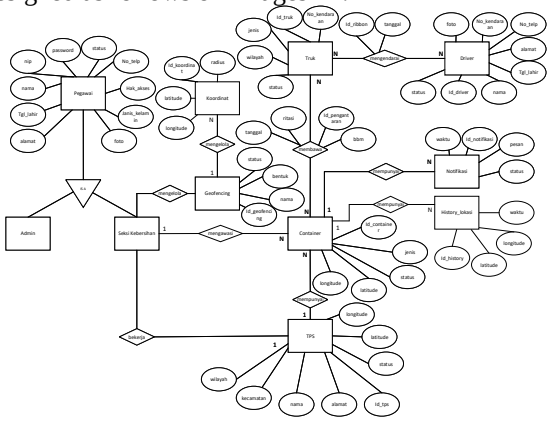
a. The GPS module is supplied with 3.3V 1A, with RX 2 TX 1 pin on Arduino.
b. Every 5 minutes the GPS module that has received a GPS signal will determine latitude and longitude container points with the Google Maps API.
c. Latitude and longitude data is updated to the website with a GSM module via Arduino.api.
d. Checking geofencing, if 'Yes' is outside the geofencing area, it will send a message via the SMS gateway that the container truck is going

through an improper way. And return to process 2.

e. If not, it will send a message via the SMS gateway that the container is in the process of ritation.

4.8. Entity realationship Diagrams (ERD)

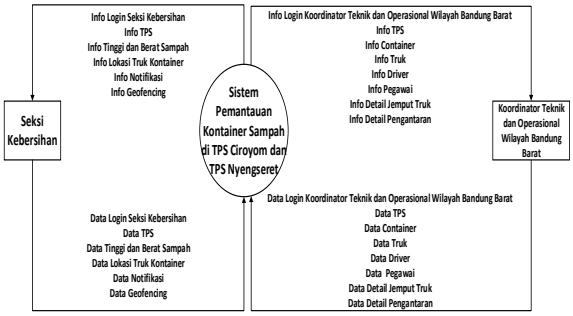
ERD is a system design for existing entities and relations. The following is the ERD that will be designed as follows on Images 14.



Images 14.

4.9. A context diagram

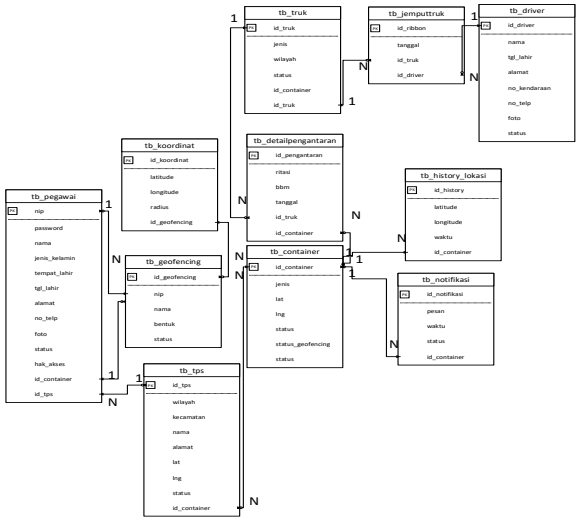
Context diagram is the main data flow diagram that describes the process in general and not in detail. The following is Images 15. Context Diagram for software to be built.



Images 15.

4.10. Schema relationship

A relation scheme is a series of relationships between two tables or more in a database system. And combine the attributes that have the main key. The following is a relation scheme of the monitoring system for trash containers at Ciroyom TPS and Nyengseret TPS can be seen on Images 16.



Images 16.

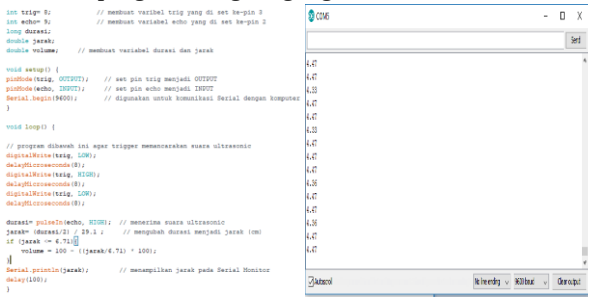
4.11. Implementing System Architecture

Implementation of system architecture is an implementation of the system architecture that has been built. Next is the system implementation can be seen on Table 4.

Table 4.

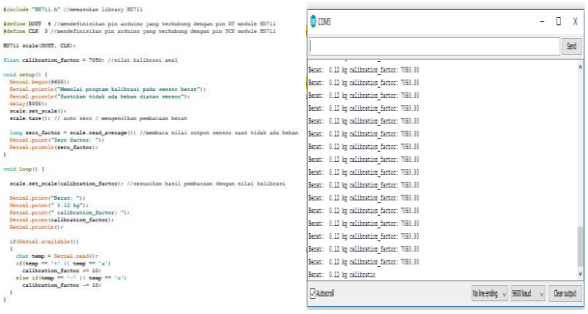
Tool	Parameters	Description
Ultrasonic Sensors SR04-HC	Processing high waste data	Images 17.
Weight Sensor 5 kg Loadcell + HX711	Processing weight waste data	Images 18.
SIM800L GSM Module	Send data	Images 19.
GPS M8N Module	Processing placeholder coordinates data	Images 20.

The following is a picture for the implementation of the Ultrasonic Sensor and Serial Monitor programming language.



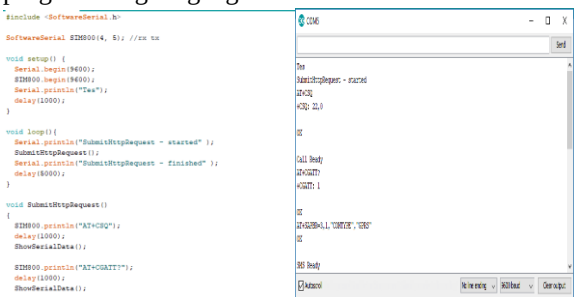
Images 17.

The following is a picture for the implementation of the Weight Sensor and Serial Monitor programming languages.



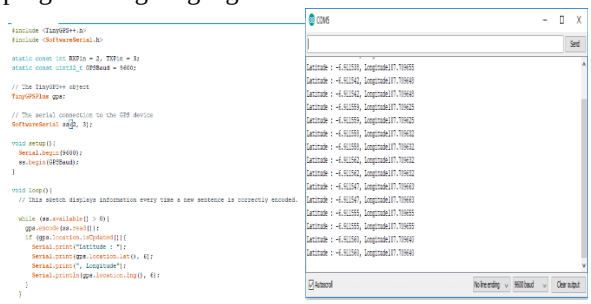
Images 18.

The following is a picture for the implementation of the GSM Module and Serial Monitor programming language.



Images 19.

The following is a picture for the implementation of the GPS Module and Serial Monitor programming language.



Images 20.

4.12. Implementing the Installation Tool

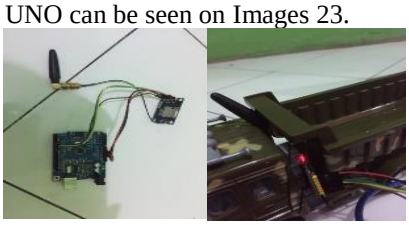
Implementation of installation of tools is an implementation of the analysis phase of communication tools with Arduino UNO. The ultrasonic sensor is installed on pin 9 for Echo and 8 for Trigger. The following is a picture of the installation of ultrasonic sensors and Arduino UNO can be seen on Images 21.

Images 21.

The installation of a heavy sensor on the Arduino UNO. The heavy sensor is mounted on pin 10 for TX and 11 for RX. The following is a picture of the installation of a heavy sensor on the Arduino UNO can be seen on Images 22.

Images 22.

The installation of GSM modules on Arduino UNO. The GSM module is installed on pin 4 for TX 5 for RX and 6 for reset. The following is a picture of the installation of a GSM module on the Arduino UNO can be seen on Images 23.



Images 23.

The installation of GPS modules on Arduino UNO. The GPS module is installed on pin 2 for TX and 3 for RX. The following is a picture of the installation of a GPS module on the Arduino UNO can be seen on Images 24.

Images 24.

4.13. Alpha System Testing

Alpha testing is a test carried out by the author. The following is the alpha testing done by the author.

a. Select Container Volume Test can be seen in the Table 5 following.

Table 5.

Test Cases and Results (True)			
Entering data	**The expected**	**Observations**	**Conclusion**
The Cleanliness Section was successfully logged in, the Cleanliness Section chose the Container volume menu	Displays the height of waste and the weight of garbage in containers	Display High trash and heavy trash in containers data	[✓]Accepted [ ]Rejected

b. Select Containers Placeholder Test can be seen in the Table 6 Following.

Table 6.

Test Cases and results (True)			
Entering data	**The expected**	**Observations**	**Conclusion**
The Cleanliness Section was successfully logged in, the Cleanliness Section chose the Container tracking menu	Display data on the location of container truck coordinates with the Googlemaps API	Googlemaps API appears with container coordinates	[✓]Accepted [ ]Rejected

c. Select Geating Menu Test can be seen at the table 10 Following.

Table 7.

Test Cases and results (True)			
Entering data	**The expected**	**Observations**	**Conclusion**
The Cleanliness Section succeeded in Login, the Cleanliness Section chose the Geofencing menu	Display geofencing data with the Googlemaps API	Googlemaps API appears with geofencing	[✓]Accepted [ ]Rejected

4.14. Beta Test Results

This test was conducted directly on the West Bandung Region Technical and Operational Coordinator and Employees, namely the Cleanliness Section as the user of the Waste Container Monitoring System at Ciroyom TPS and Nyengseret TPS, with data collection methods namely interviews with the West Bandung Regional Technical and Operational Coordinator and POOL Bandung West, Ciroyom polling station and Nyengseret polling station to the cleanliness section. The questionnaire was distributed to 10 respondents for the cleanliness section of each branch in West Bandung polling station.

5. CONCLUSION

Based on the test results it can be concluded that the prototype of the garbage container monitoring system can facilitate the Cleanliness Section in determining the condition of the volume of waste in containers based on the height of the landfill and the weight of the garbage, supervising container trucks that are trapping garbage from TPS to landfill and can make scheduling more effective and right by using a transport notification via SMS to the driver.

Some suggestions that can be used for the development of the next application are implementation of garbage containers, increasing location accuracy in containers, ultrasonic sensors and heavy sensors, adding chat features between the driver and cleanliness section to facilitate communication, add reports for every day, week and month. on the amount of garbage

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