Project Report

1. INTRODUCTION

1.1 Project Overview

We are living in an age where tasks and systems are fusing together with the power of IOT to have a more efficient system of working and to execute jobs quickly! With all the power at our finger tips this is what we have come up with.The Internet of Things (IoT) shall be able to incorporate transparently and seamlessly a large number of different systems, while providing data for millions of people to use and capitalize. Building a general architecture for the IoT is hence a very complex task, mainly because of the extremely large variety of devices, link layer technologies, and services that may be involved in such a system. One of the main concerns with our environment has been solid waste management which impacts the health and environment of our society. The detection, monitoring and management of wastes is one of the primary problems of the present era. The traditional way of manually monitoring the wastes in waste bins is a cumbersome process and utilizes more human effort, time and cost which can easily be avoided with our present technologies. This is our solution, a method in which waste management is automated. This is our IoT Garbage Monitoring system, an innovative way that will help to keep the cities clean and healthy.

1.2 PURPOSE

A healthy existence depends heavily on environmental hygiene. In our daily lives, waste bins shouldn't be left unattended. Unattended garbage containers will overflow, leak, and emit pollutants that are hazardous to the health of both people and the environment. Population expansion and huge migrations of residents from urban and semi-urban areas to smart cities have created issues for these cities due to their rapid rise. Handling, collecting, and disposing the everyday trash generation is one of the biggest issues that Metropolitan Areas are up against. It is difficult to gather and process waste on a larger scale. In order to manage and dispose of rubbish effectively, we are creating a smart IOT-based waste management system for metropolitan areas as part of our research.

2. LITERATURE SURVEY

2.1 EXISTING PROBLEM

Waste management is one of the primary problem that the world faces irrespective of the case of developed or developing country. The key issue in the waste management is that the garbage bin at public places gets overflowed well in advance before the commencement of the next cleaning process. It in turn leads to various hazards such as bad odour &amp; ugliness to that place which may be the root cause for spread of various diseases. To avoid all such hazardous scenario and maintain public cleanliness and health this work is mounted on a smart garbage system. This process is aided by the ultrasonic sensor which is interfaced with Arduino UNO to check the level of garbage filled in the dustbin and sends the alert to the municipal web server once if garbage is filled. After cleaning the dustbin, the driver confirms the task of emptying the garbage with the aid of RFID Tag. RFID is a computing technology that is used for verification process and in addition, it also enhances the smart garbage alert system by providing automatic identification of garbage filled in the dustbin and sends the status of clean-up to the server affirming that the work is done. An Android application is developed and linked to a web server to intimate the alerts from the microcontroller to the urban office and to perform the remote monitoring of the cleaning process, done by the workers, thereby reducing the manual process of monitoring and verification.

2.2 REFERENCES

1. Monika K A, NikithaRao, Prapulla S B and Shobha G, Smart Dustbin-An Efficient Garbage Monitoring System, International Journal of Engineering Science and Computing, Volume 6 Issue No. 6, June 2016, 7113-7116.

2. Parkash and Prabu V, IoT Based Waste Management for Smart City ,International Journal of Innovative Research in Computer and Communication Engineering, Vol. 4, Issue 2, February 2016, 1267-1274.

3. Prof. Dr. Sandeep M. Chaware, Shriram Dighe, Akshay Joshi, Namrata Bajare and Rohini Korke, Smart Garbage Monitoring System using Internet of Things (IOT), International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering (IJIREEICE), Vol. 5, Issue 1, January 2017,74- 77.

4. P.R. Naregalkar, Krishna Kishore Thanvi, and RajatSrivastava, IOT Based Smart Garbage Monitoring System, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (IJAREEIE), Vol. 6, Issue 5, May 2017, 3438- 3442.

5. Ronit Chauduri, Pritthish Chattopadhyay, and Sreyam Dasgupta. 2017. Smart Garbage Monitoring System. International Journal of Engineering Research &amp; Technology, Vol. 6 Issues 5.

6. Zeinab Kamal Aldein Mohammed and Elmustafa Sayed Ali Ahmed. 2017. Internet of Things Applications, Challenges and Related Future Technologies.

7. Keyur K Patel, Sunil M Patel. 2016. Internet of Things-IOT: Definition, Characteristics, Architecture, Enabling Technologies, Application &amp; Future Challenges. International Journal of Engineering Science and Computing, Vol 6, Issues No 5

2.3 PROBLEM STATEMENT

There are several problems with the current existing system that are being identified. This will reflect the need for a new efficient system for monitoring and manage the garbage. The problems are listed as below:

1. Current garbage collection is inefficient, time waste and required a huge amount of human energy.

2. It will create an unhygienic condition for surrounding environment and creates bad smell which can lead to spread some deadly disease.

REAL TIME SCENARIO:

PROBLEM STATEMENT 1

I am a manager of the Restaurant

I’m trying to get rid of the trash quickly before overflowing from the bin. But people in these civilizations frequently put trash into overflowing trash cans, and the garbage collection services likewise frequently fail to pick up the trash on schedule. Because there is no proper management and control system for proper garbage collection which makes me feel frustrated.

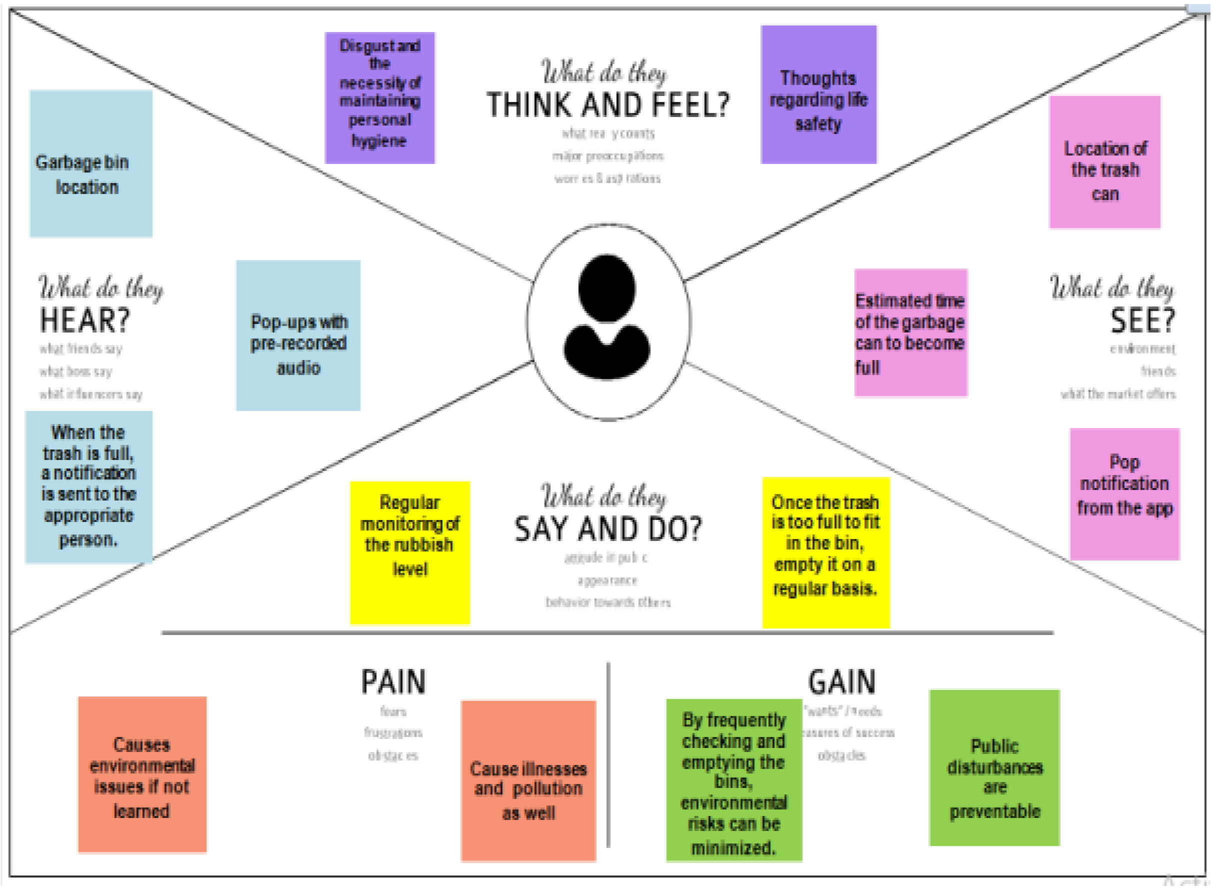
PROBLEM STATEMENT 2

I am a shopkeeper

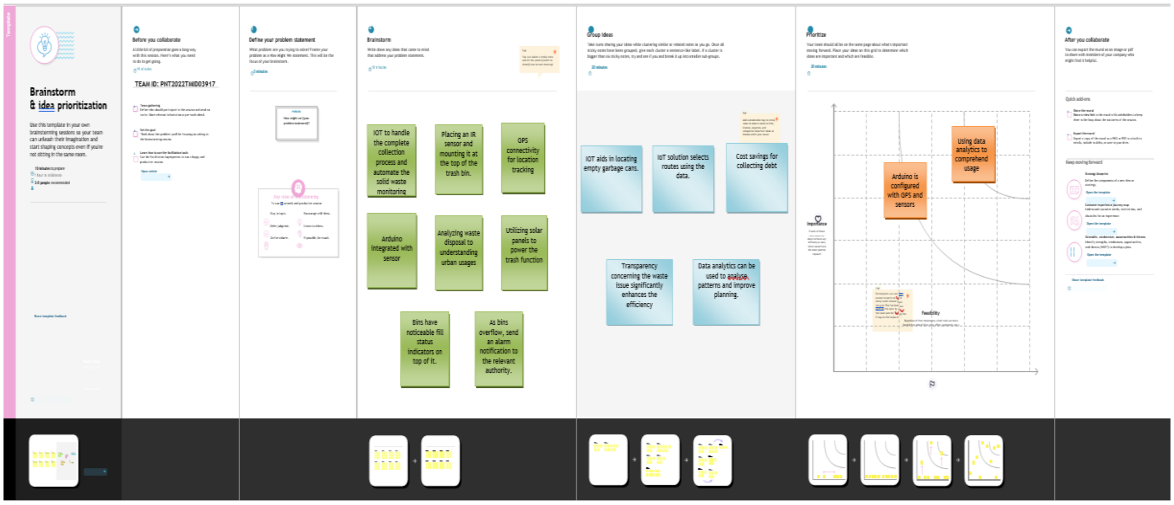
I’m trying to clear the trash can before it causes any health - related problems. But the disposal of waste in a way that has negative consequences for the environment. Because there is no managing of waste and monitoring of waste which makes me feel annoyed.

3. IDEATION & PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS


What do they THINK AND FEEL?
what really counts
major preoccupations
worries & aspirations
Disgust and the necessity of maintaining personal hygiene
Thoughts regarding life safety
What do they HEAR?
what friends say
what boss say
what influencers say
Garbage bin location
Pop-ups with pre-recorded audio
When the trash is full, a notification is sent to the appropriate person.
What do they SEE?
environment
friends
what the market offers
Location of the trash can
Estimated time of the garbage can to become full
Pop notification from the app
What do they SAY AND DO?
attitude in public
appearance
behavior towards others
Regular monitoring of the rubbish level
Once the trash is too full to fit in the bin, empty it on a regular basis.
PAIN
fears
frustrations
obstacles
Causes environmental issues if not learned
Cause illnesses and pollution as well
GAIN
"wants" / needs
measures of success
obstacles
By frequently checking and emptying the bins, environmental risks can be minimized.
Public disturbances are preventable

3.2 IDEATION & BRAINSTROMING


Brainstorm
& idea prioritization
Before you collaborate
TEAM ID: PNT2022TMID03917
Define your problem statement
Brainstorm
IOT to handle the complete collection process and automate the solid waste monitoring
Placing an IR sensor and mounting it at the top of the trash bin.
GPS connectivity for location tracking
Arduino integrated with sensor
Analyzing waste disposal to understanding urban usages
Utilizing solar panels to power the trash function
Bins have noticeable fill status indicators on top of it.
As bins overflow, send an alarm notification to the relevant authority.
Group Ideas
IOT aids in locating empty garbage cans.
IoT solution selects routes using the data.
Cost savings for collecting debt
Transparency concerning the waste issue significantly enhances the efficiency
Data analytics can be used to analyse patterns and improve planning.
Prioritize
Arduino is configured with GPS and sensors
Using data analytics to comprehend usage
Importance
Feasibility
After you collaborate

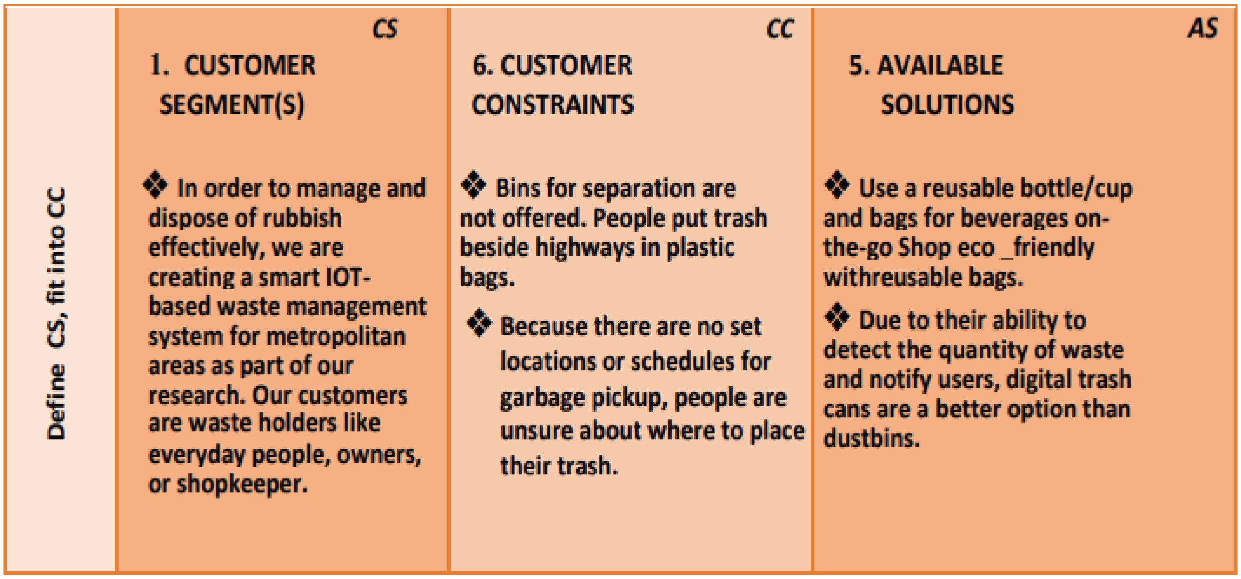
3.3 PROPOSED SOLUTION

S. No	Parameter	Description
1.	Problem Statement (Problem to be solved)	In the current situation, we frequently observe that the trash cans located in public areas in cities are overflowing as a result of the daily production in waste. We are planning to construct "IoT Based Waste Management for Metropolitan Cities" to prevent this from happening because it makes people's living conditions unclean and causes a terrible stench to spread throughout the neighbourhood.
2.	Idea / Solution description	Developing a web application to track the location and status of any bin. The designated individual receives the alert message with the location of the trash can when the bin is full.
3.	Novelty / Uniqueness	It is intended to install a sensor that will open and close the trash can when a person is detected, as well as a MOS sensor to detect harmful gas levels and display those levels through a web application.
4.	Social Impact / Customer Satisfaction	Municipalities and waste management firms have seldom

		ever utilized technological advancements to increase operational efficiency. What they have accomplished thus far is an increase in route efficiency. The waste collection trucks must physically verify the level of trash in each bin, even with superior route optimization. Trucks frequently visit bins that don't need to be emptied, which wastes time and money when done manually. The use of intelligent IOT-based waste management systems results in time and cost savings.
5.	Business Model (Revenue Model)	Waste Management makes money by offering a variety of waste management, disposal, and recycling services. This recyclable garbage can be used as a source of raw materials after being improperly collected and deposited into landfills. It can be a very profitable method of earning income if appropriately classified and processed further. For the year ending December 31, 2021, Waste Management, Inc. recorded operating revenue of 17.9 billion dollars. This represented a 2.7 billion dollar, or 17.8%, yearly gain. The acquisition of Advanced Disposal by Waste Management, Inc. was one factor in the company's remarkable revenue development.
6.	Scalability of the Solution	The weight sensor is positioned at the bottom of the trash cans to gauge their weight, and the ultrasonic sensor is positioned at the top to determine the trash can's condition. A weighing system can be designed using weight sensors because they are known for their accuracy and reliability in producing precise weight data. The web

		application designed will provide a vehicle with a quick path to save on gasoline. This layout offers greater effectiveness.

3.4 PROBLEM SOLUTIN FIT



Define CS, fit into CC	CS 1. CUSTOMER SEGMENT(S)	CC 6. CUSTOMER CONSTRAINTS	AS 5. AVAILABLE SOLUTIONS
	❖ In order to manage and dispose of rubbish effectively, we are creating a smart IOT-based waste management system for metropolitan areas as part of our research. Our customers are waste holders like everyday people, owners, or shopkeeper.	❖ Bins for separation are not offered. People put trash beside highways in plastic bags. ❖ Because there are no set locations or schedules for garbage pickup, people are unsure about where to place their trash.	❖ Use a reusable bottle/cup and bags for beverages on-the-go Shop eco _friendly withreusable bags. ❖ Due to their ability to detect the quantity of waste and notify users, digital trash cans are a better option than dustbins.

Focus on J&P, tup into BE,understand RC	J&P	RC	BE
	2. JOBS-TO-BE-DONE / PROBLEMS ❖ organize and manage waste disposal, collection and recycling facilities. ❖ detect location, temperature, and fill level in real time. ❖ this data is then used to plan optimal collection routes, resulting in an efficient pickup process.	9. PROBLEM ROOT CAUSE ❖ The waste/recycling business has considerable safety problems. ❖ Chemical exposure, flammable dust explosions, machine guarding risks, and contact with machinery are a few of them.. ❖ Poor disposal of hospital waste cause major health issue.	7. BEHAVIOUR ❖ less waste collections would be required, which would require less labour, emissions, fuel, and road congestion.

Identify strong TR & EM	TR	SL	CH
	3. TRIGGER By implementing this initiative, we may inspire individuals by showing them how their neighbors are using technology more effectively and by reading about a more effective approach in the news.	10. YOUR SOLUTION ❖ Our solutions aim to effectively manage waste by alerting users to the volume of waste as well as authenticating individuals who collect it and move on to further processing with the garbage.	8.CHANNELS of BEHCHANAVIOUR ONLINE: ❖ If it is in online mode, people may review about the overflow of waste OFFLINE: ❖ If it is offline every day the waste collecting trucks will collect garbage from home.
	EM 4.EMOTIONS: BEFORE /AFTER ❖ Before development of this technology, air pollution from waste products caused health problems in society and directly affects many ecosystems and species. ❖ After implementation of smart waste management system our environment will be neat and clean.		

4. REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENT

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Detailed bin inventory.	All monitored bins and stands can be seen on the map, and you can visit them at any time via the Street View feature from Google. Bins or stands are visible on the map as green, orange or red circles. You can see bin details in the Dashboard – capacity, waste type, last measurement, GPS location and collection schedule or pick recognition.
FR-2	Real time bin monitoring.	The Dashboard displays real-time data on fill-levels of bins monitored by smart sensors. In addition to the % of fill-level, based on the historical data, the tool predicts when the bin will become full, one of the functionalities that are not included even in the best waste management software.. Sensors recognize picks as well; so you can check when the bin was last collected. With real-time data and predictions, you can eliminate the overflowing bins and stop collecting half-empty ones.
FR-3	Expensive bins.	We help you identify bins that drive up your collection costs. The tool calculates a rating for each bin in terms of collection costs. The tool considers the average distance depo-bindischarge in the area. The tool assigns bin a rating (1-10) and calculates distance from depo-bin discharge.
FR-4	Adjust bin distribution.	Ensure the most optimal distribution of bins. Identify

		areas with either dense or sparse bin distribution. Make sure all trash types are represented within a stand. Based on the historical data, you can adjust bin capacity or location where necessary.
FR-5	Eliminate inefficient picks.	Eliminate the collection of half-empty bins. The sensors recognize picks. By using real-time data on fill-levels and pick recognition, we can show you how full the bins you collect are. The report shows how full the bin was when picked. You immediately see any inefficient picks below 80% full.
FR-6	Plan waste collection routes.	The tool semi-automates waste collection route planning. Based on current bin fill-levels and predictions of reaching full capacity, you are ready to respond and schedule waste collection. You can compare planned vs. executed routes to identify any inconsistencies.

4.2 NON-FUNCTIONAL REQUIREMENT

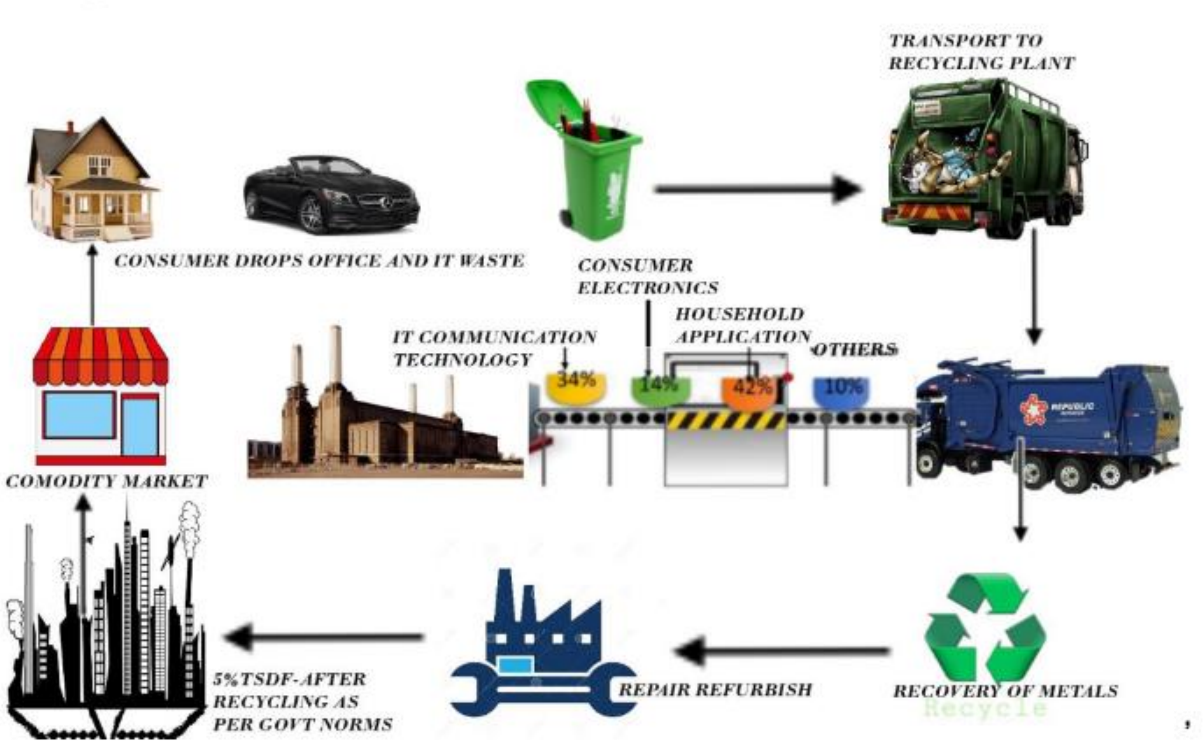
Following are the non-functional requirements of the proposed solution

FR No.	Non-Functional Requirement	Description
NFR-1	Usability	IoT device verifies that usability is a special and important perspective to analyze user requirements, which can further improve the design quality. In the design process with user experience as the core, the analysis of users’ product usability can indeed help designers better understand users’ potential needs in waste management, behavior and experience.
NFR-2	Security	Use a reusable bottles Use reusable grocery bags Purchase wisely and recycle Avoid single use food and drink containers.

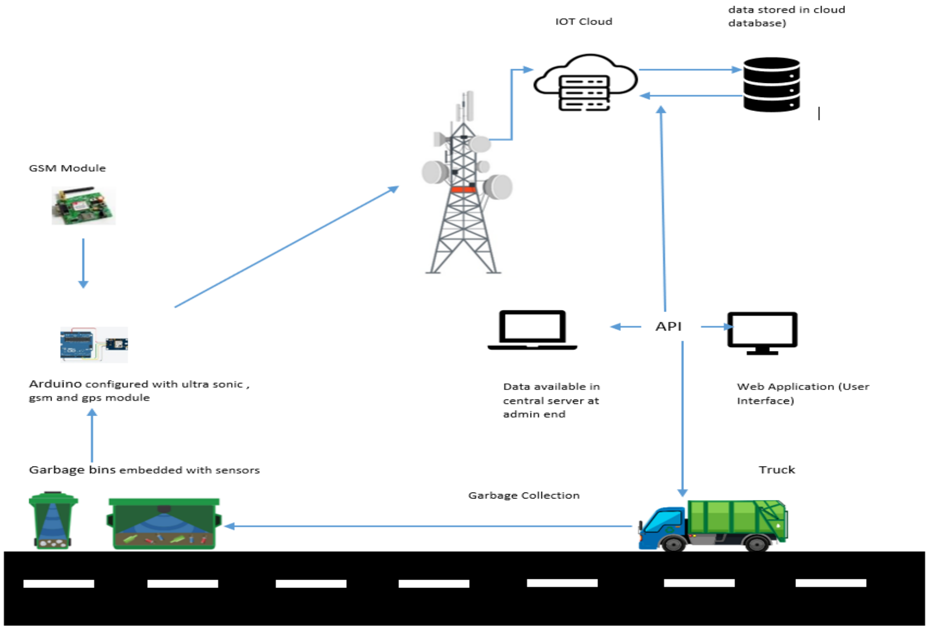
NFR-3	Reliability	Smart waste management is also about creating better working conditions for waste collectors and drivers. Instead of driving the same collection routes and servicing empty bins, waste collectors will spend their time more efficiently, taking care of bins that need servicing.
NFR-4	Performance	The Smart Sensors use ultrasound technology to measure the fill levels (along with other data) in bins several times a day. Using a variety of IoT networks ((NB-IoT,GPRS), the sensors send the data to Sensoneo’s Smart Waste Management Software System, a powerful cloud-based platform, for datadriven daily operations, available also as a waste management app. Customers are hence provided data-driven decision making, and optimization of waste collection routes, frequencies, and vehicle loads resulting in route reduction by at least 30%
NFR-5	Availability	By developing & deploying resilient hardware and beautiful software we empower cities, businesses, and countries to manage waste smarter.
NFR-6	Scalability	Using smart waste bins reduce the number of bins inside town , cities coz we able to monitor the garbage 24/7 more cost effect and scalability when we moves to smarter.

5. PROJECT DESIGN

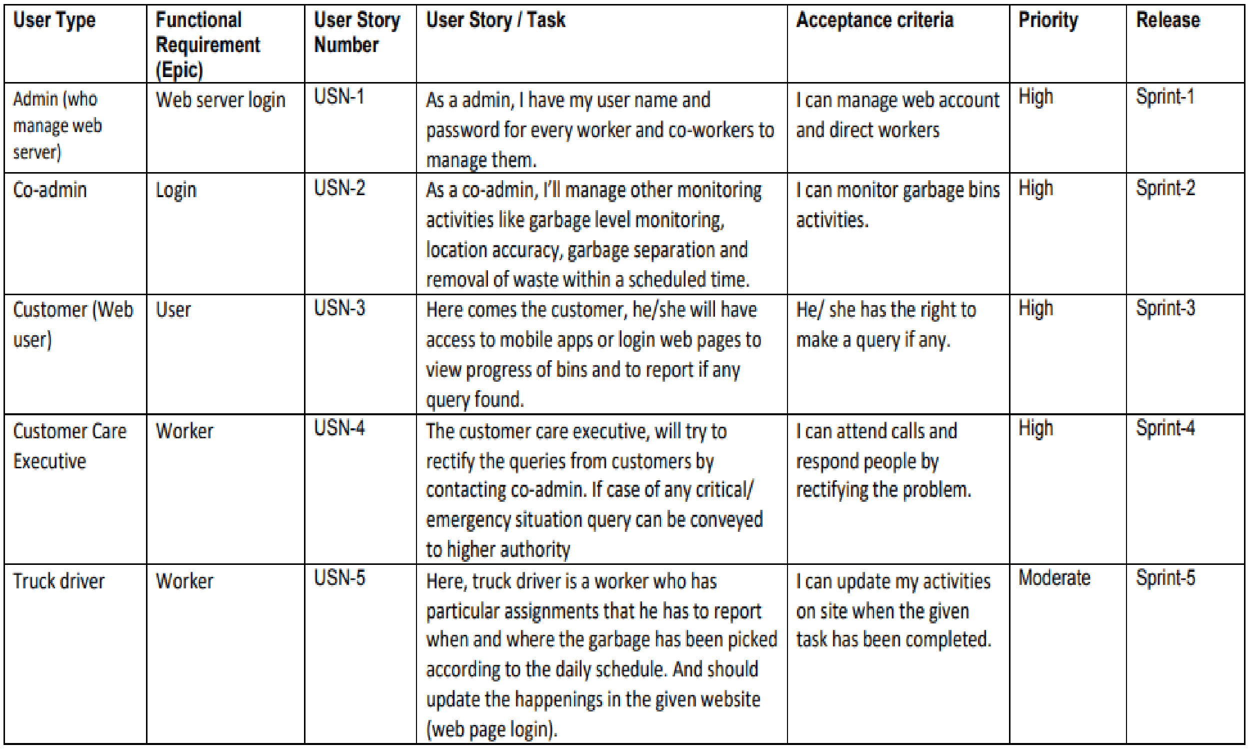
DATA FLOW DIAGRAMS


TRANSPORT TO RECYCLING PLANT
CONSUMER DROPS OFFICE AND IT WASTE
CONSUMER ELECTRONICS
HOUSEHOLD APPLICATION
IT COMMUNICATION TECHNOLOGY
OTHERS
34%
14%
42%
10%
COMODITY MARKET
5%TSDF-AFTER RECYCLING AS PER GOVT NORMS
REPAIR REFURBISH
RECOVERY OF METALS
Recycle

5.2 SOLUTION & TECHNICAL ARCHITECTURE


IOT Cloud
data stored in cloud database)
GSM Module
Arduino configured with ultra sonic , gsm and gps module
API
Data available in central server at admin end
Web Application (User Interface)
Garbage bins embedded with sensors
Garbage Collection
Truck

5.3 USER STORIES



User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Admin (who manage web server)	Web server login	USN-1	As a admin, I have my user name and password for every worker and co-workers to manage them.	I can manage web account and direct workers	High	Sprint-1
Co-admin	Login	USN-2	As a co-admin, I'll manage other monitoring activities like garbage level monitoring, location accuracy, garbage separation and removal of waste within a scheduled time.	I can monitor garbage bins activities.	High	Sprint-2
Customer (Web user)	User	USN-3	Here comes the customer, he/she will have access to mobile apps or login web pages to view progress of bins and to report if any query found.	He/ she has the right to make a query if any.	High	Sprint-3
Customer Care Executive	Worker	USN-4	The customer care executive, will try to rectify the queries from customers by contacting co-admin. If case of any critical/ emergency situation query can be conveyed to higher authority	I can attend calls and respond people by rectifying the problem.	High	Sprint-4
Truck driver	Worker	USN-5	Here, truck driver is a worker who has particular assignments that he has to report when and where the garbage has been picked according to the daily schedule. And should update the happenings in the given website (web page login).	I can update my activities on site when the given task has been completed.	Moderate	Sprint-5

6. PROJECT PLANNING & SCHEDULING

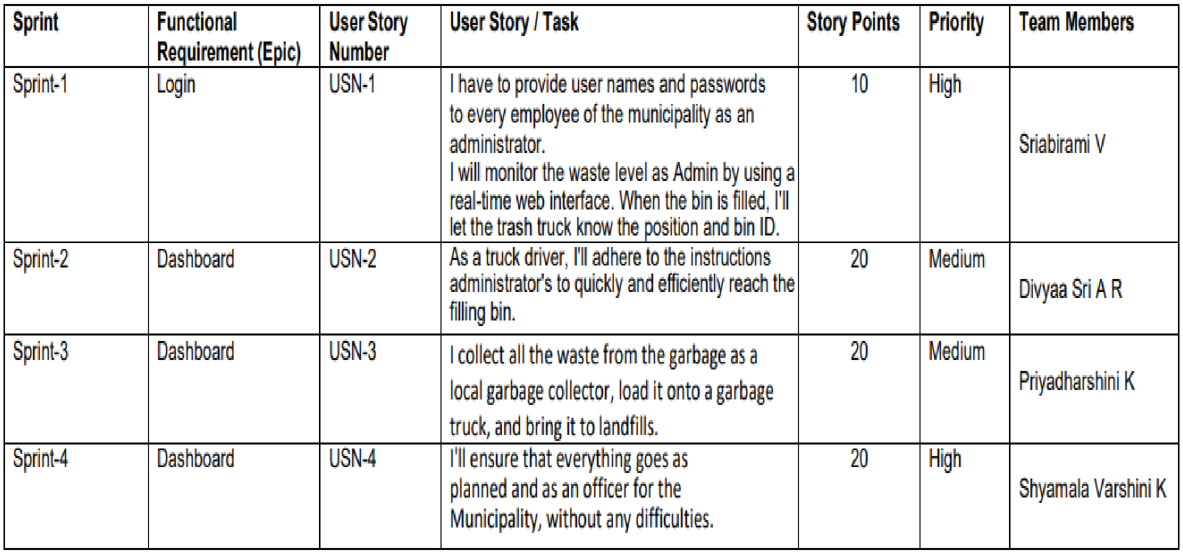
6.1 Sprint Planning & Estimation

TITLE	DESCRIPTION	DATE
Literature Survey & Information Gathering	Literature survey on the selected project & gathering information by referring the, technical papers, research publications etc.	16 OCTOBER 2022
Prepare Empathy Map	Prepare Empathy Map Canvas to capture the user Pains & Gains, Prepare list of problem statements	18 OCTOBER 2022

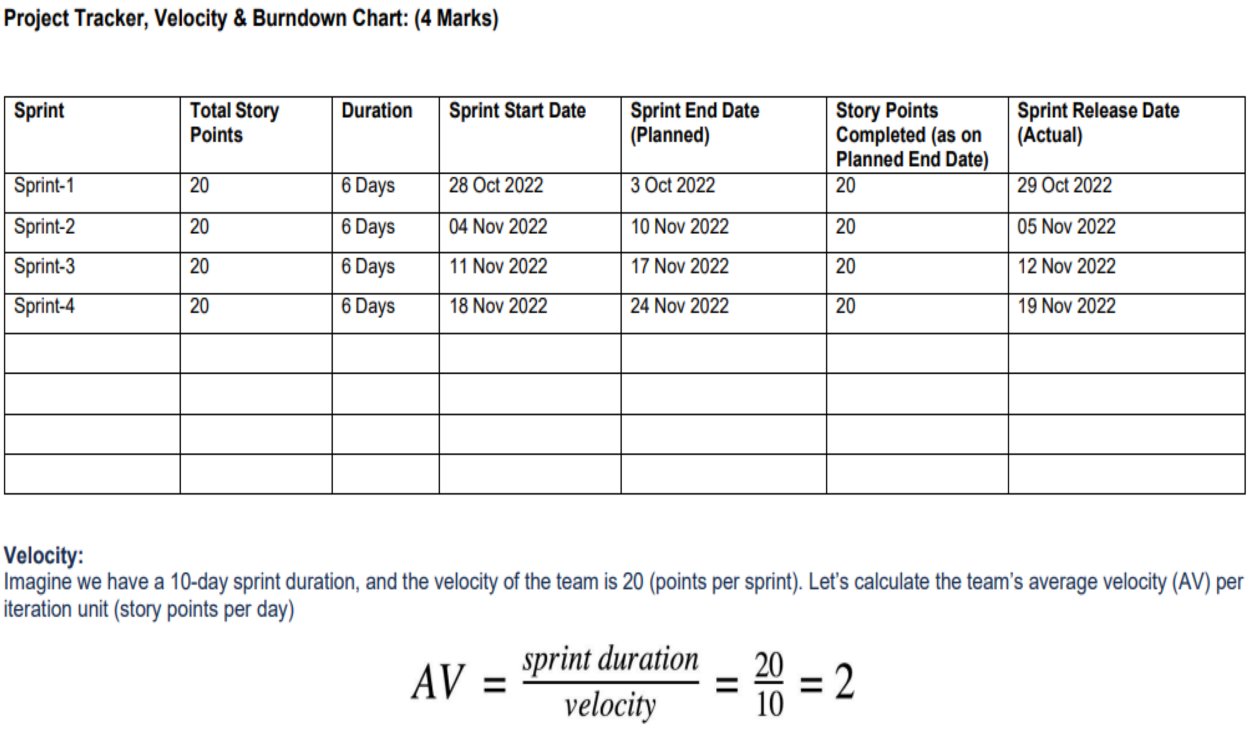
Ideation	List the by organizing the brainstorming session and prioritize the top 3 ideas based on the feasibility & importance.	23 OCTOBER 2022
Proposed Solution	Prepare the proposed solution document, which includes the novelty, feasibility of idea, business model, social impact, scalability of solution, etc.	22 OCTOBER 2022
Problem Solution Fit	Prepare problem - solution fit document.	23 OCTOBER 2022
Solution Architecture	Prepare solution architecture document.	23 OCTOBER 2022
Customer Journey	Prepare the customer journey maps to understand the user interactions & experiences with the application (entry to exit).	22 OCTOBER 2022
Functional Requirement	Prepare the functional requirement document.	22 OCTOBER 2022
Data Flow Diagrams	Draw the data flow diagrams and submit for review.	22 OCTOBER 2022
Technology Architecture	Prepare the technology architecture diagram.	21 OCTOBER 2022
Prepare Milestone & Activity List	Prepare the milestones & activity list of the project.	28 OCTOBER 2022

Project Development - Delivery of Sprint-1, 2, 3 & 4	Develop & submit the developed code by testing it.	20 OVEMBER 2022

6.2 Sprint Delivery Schedule



Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Login	USN-1	I have to provide user names and passwords to every employee of the municipality as an administrator. I will monitor the waste level as Admin by using a real-time web interface. When the bin is filled, I'll let the trash truck know the position and bin ID.	10	High	Sriabirami V
Sprint-2	Dashboard	USN-2	As a truck driver, I'll adhere to the instructions administrator's to quickly and efficiently reach the filling bin.	20	Medium	Divyaa Sri A R
Sprint-3	Dashboard	USN-3	I collect all the waste from the garbage as a local garbage collector, load it onto a garbage truck, and bring it to landfills.	20	Medium	Priyadharshini K
Sprint-4	Dashboard	USN-4	I'll ensure that everything goes as planned and as an officer for the Municipality, without any difficulties.	20	High	Shyamala Varshini K



Project Tracker, Velocity & Burndown Chart: (4 Marks)

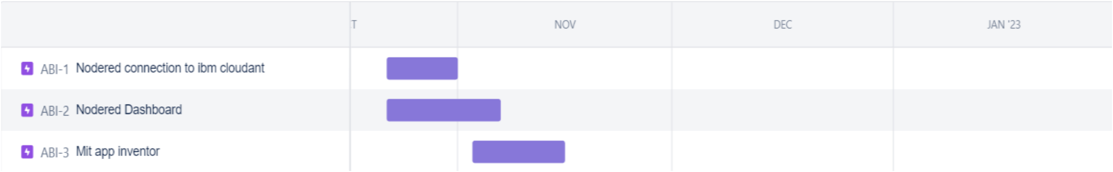
Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	28 Oct 2022	3 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	04 Nov 2022	10 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	11 Nov 2022	17 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	18 Nov 2022	24 Nov 2022	20	19 Nov 2022

Velocity:
Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day)

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

6.3 Reports from JIRA

Roadmap



ABI-1 Nodered connection to ibm cloudant

ABI-2 Nodered Dashboard

ABI-3 Mit app inventor

7. CODING & SOLUTIONING

7.1 Feature 1 - wokwi

Python Code

```
#include <WiFi.h> // library for wifi
#include <PubSubClient.h> // library for MQ
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 20, 4);
//credentials of IBM Accounts -
#define ORG "ykru5d" // IBM organisation id
#define DEVICE_TYPE "GarbageBin_1" // Device type mentioned in ibm watson iot platform
#define DEVICE_ID "Garbage1" // Device ID mentioned in ibm watson iot platform
#define authMethod "use-token-auth"
#define TOKEN "DKD_K)lt0Yn!yQIeUf" // Token

// customise above values -
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";
// server name
char publishTopic[] = "iot-2/evt/data/fmt/json";
char topic[] = "iot-2/cmd/led/fmt/String"; // cmd Represent type and command is test format of strings
char authmethod[] = "use-token-auth"; // authentication method
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID; //Client id
//
WiFiClient wifiClient; // creating instance for wificlient
PubSubClient client(server, 1883, wifiClient);
#define ECHO_PIN 12
#define TRIG_PIN 13
float dist;
void setup()
{
Serial.begin(115200);
pinMode(LED_BUILTIN,OUTPUT);
pinMode(TRIG_PIN, OUTPUT);
pinMode(ECHO_PIN, INPUT);
//pir pin
```

```
pinMode(4, INPUT);
//ledpins
pinMode(23,OUTPUT);
pinMode(2,OUTPUT);
pinMode(4,OUTPUT);
pinMode(15, OUTPUT);
lcd.init();
lcd.backlight();
lcd.setCursor(1, 0);
lcd.print("");
wifiConnect();
mqttConnect();
}
float readcmCM()
{
digitalWrite(TRIG_PIN, LOW);
delayMicroseconds(2);
digitalWrite(TRIG_PIN, HIGH);
delayMicroseconds(10);
digitalWrite(TRIG_PIN, LOW);
int duration= pulseIn(ECHO_PIN, HIGH);
return duration * 0.034 / 2;
}
void loop()
{
lcd.clear();
publishData();
delay(500);
if (!client.loop())
{
mqttConnect(); // function call to connect to IBM
}
}
/* -retrieving to cloud */
void wifiConnect()
{
Serial.print("Connecting to ");
Serial.print("Wifi");
WiFi.begin("Wokwi-GUEST", "", 6);
while (WiFi.status() != WL_CONNECTED)
{
delay(500);
Serial.print(".");
}
Serial.print("WiFi connected, IP address: ");
Serial.println(WiFi.localIP());
}
void mqttConnect()
{
if (!client.connected())
{
Serial.print("Reconnecting MQTT client to ");
Serial.println(server);
while(!client.connect(clientId, authMethod, token))
{
Serial.print(".");
delay(500);
}
initManagedDevice();
Serial.println();
}
}
void initManagedDevice()
{
if (client.subscribe(topic))
{
Serial.println("IBM subscribe to cmd OK");
}
else
{
Serial.println("subscribe to cmd FAILED");
}
}
void publishData()
{
float cm = readcmCM();
if(digitalRead(34)) //PIR motion detection
{
Serial.println("Motion is Detected");
Serial.println("GarbageLid Opened");
digitalWrite(15, HIGH);
}
else
{
digitalWrite(15, LOW);
}
if(digitalRead(34)== true)
{
if(cm <= 100) //Bin level detection
{
```

```
digitalWrite(2, HIGH);
Serial.println("High Alert!!!,Garbage bin is about to be full");
Serial.println("GarbageLid Closed");
lcd.print("Garbagebin is Full! Don't use");
delay(2000);
lcd.clear();
digitalWrite(4, LOW);
digitalWrite(23, LOW);
}
else if(cm > 150 && cm < 250)
{
digitalWrite(4, HIGH);
Serial.println("Warning!!,Garbage is about to cross 50% of bin level");
digitalWrite(2,LOW);
digitalWrite(23, LOW);
}
else if(cm > 250 && cm <=400)
{
digitalWrite(23, HIGH);
Serial.println("Bin is available");
digitalWrite(2,LOW);
digitalWrite(4, LOW);
}
delay(10000);
Serial.println("GarbageLid Closed");
}
else
{
Serial.println("No motion is detected");
}
if(cm <= 100)
{
digitalWrite(21,HIGH);
String payload = "{\"High Alert!!!\":\"";
payload += cm;
payload+= "left\" }";
Serial.print("\n");
Serial.print("Sending payload: ");
Serial.println(payload);
if (client.publish(publishTopic, (char*) payload.c_str())) // if data is uploaded to cloud successfully,prints publish ok or prints publish failed
{
Serial.println("Publish OK");
}
}
```

```
if(cm <= 250)
{
digitalWrite(22,HIGH);
String payload = "{\"Warning!!!\":\"";
payload += dist;
payload += "left\" }";
Serial.print("\n");
Serial.print("Sending Distance: ");
Serial.println(cm);
if(client.publish(publishTopic, (char*) payload.c_str()))
{
Serial.println("Publish OK");
}
else
{
Serial.println("Publish FAILED");
}
}
float inches = (cm / 2.54); //print on LCD lcd.setCursor(0,0); lcd.print("Inches");
lcd.setCursor(4,0);
lcd.setCursor(12,0);
lcd.print("cm");
lcd.setCursor(1,1);
lcd.print(inches, 1);
lcd.setCursor(11,1);
lcd.print(cm, 1);
lcd.setCursor(14,1);
delay(1000);
lcd.clear();
}
```

diagram.json

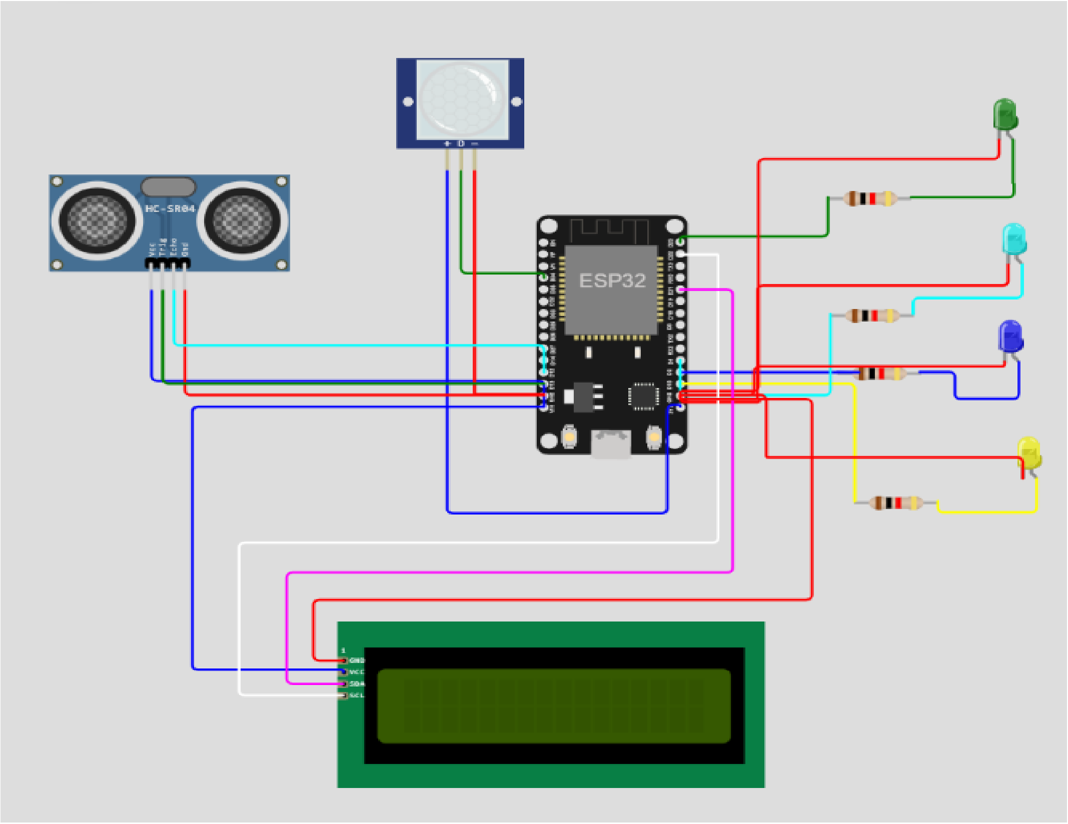
```
{
  "version": 1,
  "author": "Sriabirami Abirami",
  "editor": "wokwi",
  "parts": [
    { "type": "wokwi-esp32-devkit-v1", "id": "esp", "top": -111.56, "left": 101.92, "attrs": {} },
    {
      "type": "wokwi-led",
      "id": "led1",
      "top": -213.1,
      "left": 413.8,
      "attrs": { "color": "green" }
```

```
},
{
  "type": "wokwi-hc-sr04",
  "id": "ultrasonic1",
  "top": -142.17,
  "left": -242.86,
  "attrs": { "distance": "365" }
},
{
  "type": "wokwi-resistor",
  "id": "r1",
  "top": -133.19,
  "left": 307.84,
  "attrs": { "value": "1000" }
},
{
  "type": "wokwi-resistor",
  "id": "r2",
  "top": -37.77,
  "left": 309.53,
  "attrs": { "value": "1000" }
},
{
  "type": "wokwi-resistor",
  "id": "r3",
  "top": 9.5,
  "left": 314.15,
  "attrs": { "value": "1000" }
},
{
  "type": "wokwi-resistor",
  "id": "r4",
  "top": 115.02,
  "left": 326.73,
  "attrs": { "value": "1000" }
},
{
  "type": "wokwi-led",
  "id": "led2",
  "top": -111.26,
  "left": 420.36,
  "attrs": { "color": "cyan" }
},
{
  "type": "wokwi-led",
      "id": "led3",
      "top": -31.79,
      "left": 417.81,
      "attrs": { "color": "blue" }
    },
    {
      "type": "wokwi-led",
      "id": "led4",
      "top": 63.47,
      "left": 430.7,
      "attrs": { "color": "yellow" }
    },
    { "type": "wokwi-pir-motion-sensor", "id": "pir1", "top": -237.67, "left": 2, "attrs": {} },
    {
      "type": "wokwi-lcd1602",
      "id": "lcd1",
      "top": 222.1,
      "left": -39.22,
      "attrs": { "pins": "i2c" }
    }
  ],
  "connections": [
    [ "esp:TX0", "$serialMonitor:RX", "", [] ],
    [ "esp:RX0", "$serialMonitor:TX", "", [] ],
    [ "led1:A", "r1:2", "green", [ "v35.7", "h0.69", "v0" ] ],
    [ "led2:A", "r2:2", "cyan", [ "v27.12", "h-70.25" ] ],
    [ "led3:A", "r3:2", "blue", [ "v30.21", "h-45.17", "v49.52" ] ],
    [ "led4:A", "r4:2", "yellow", [ "v27.71", "h-0.92" ] ],
    [ "r4:1", "esp:D15", "yellow", [ "v0" ] ],
    [ "esp:D2", "r3:1", "blue", [ "h141.7", "v-0.34" ] ],
    [ "r2:1", "esp:D4", "cyan", [ "v66.32", "h-136.15" ] ],
    [ "r1:1", "esp:D23", "green", [ "v31.92", "h-134.46" ] ],
    [ "led1:C", "esp:GND.1", "red", [ "v15.69", "h-170.16", "v0", "h0", "v189.42", "h-4.71" ] ],
    [
      "led2:C",
      "esp:GND.1",
      "red",
      [ "v17.21", "h-177.67", "v92.35", "h1.88", "v2.83", "h-2.83" ]
    ],
    [ "led3:C", "esp:GND.1", "red", [ "v3.77", "h-177.36", "v23.56" ] ],
    [ "led4:C", "esp:GND.1", "red", [ "v-17.29", "h-178.76", "v0", "h-2.83", "v-49.95" ] ],
    [ "pir1:VCC", "esp:3V3", "blue", [ "v279.57", "h155.93", "v0", "h0", "v-88.58", "h16.96" ] ],
    [ "ultrasonic1:VCC", "esp:VIN", "blue", [ "v73.39", "h186.05" ] ],
    [ "esp:VIN", "lcd1:VCC", "blue", [ "h-249.26", "v214.7", "h12.25" ] ],
    [
      "esp:D22",
      "lcd1:SCL",
      "white",
      [ "h26.87", "v1.83", "h0", "v233.71", "h-339.26", "v18.85" ]
    ],
    [ "pir1:OUT", "esp:D34", "green", [ "v83.5", "h27.47" ] ],
    [ "pir1:GND", "esp:GND.2", "red", [ "v182.13", "h0.87", "v0", "h0" ] ],
    [ "ultrasonic1:GND", "esp:GND.2", "red", [ "v0" ] ],
    [ "ultrasonic1:ECHO", "esp:D12", "cyan", [ "v44.44", "h170.52" ] ],
    [ "ultrasonic1:TRIG", "esp:D13", "green", [ "v0" ] ],
    [ "esp:D21", "lcd1:SDA", "magenta", [ "h37.23", "v230.93", "h-315.81", "v85.23" ] ],
    [ "lcd1:GND", "esp:GND.1", "red", [ "h-21.18", "v-49.54", "h352.85", "v-163.82", "h-24.06" ] ]
  ]
}
```

7.2 Features - Components

1. **Ultrasonic Sensor**
2. **ESP32 Arduino Microcontroller**
3. **PIR Motion Sensor**
4. **LED'S**
5. **LCD**

Sensor with ESP32 Controller



8.TESTING

8.1 Test Cases

Max Size of Bin : 200 cm
Safe limit: below 100 cm
Min threshold limit of bin: 100 cm
Max threshold limit of bin: 180 cm

S.NO	BIN LEVEL(in cm)	STATUS	LOCATION
1	44	Safe	Coimbatore
2	75	Safe	Kanyakumari
3.	113	Warning	Ooty
4.	195	High_Alert	Trichy

8.2 User Acceptance Testing

1. Purpose of Document

The purpose of this document is to briefly explain the test coverage and open issues of the Smart Waste Management System for Metropolitan Cities project at the time of the release to User Acceptance Testing (UAT).

2. Defect Analysis

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved

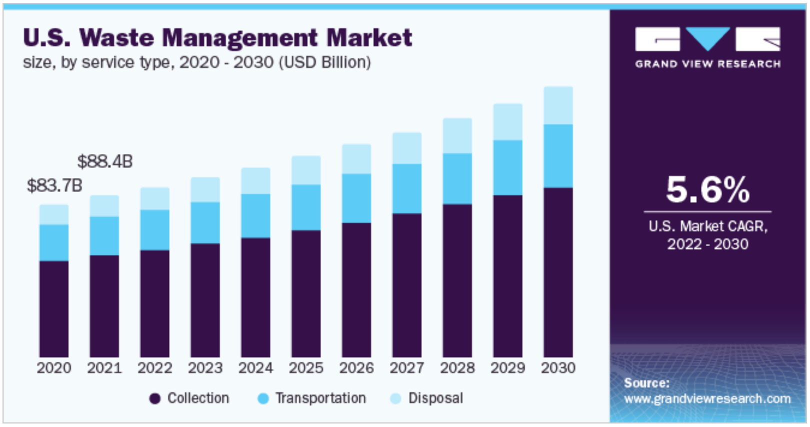
Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	10	4	2	3	20
Duplicate	1	0	3	0	4
External	2	3	0	1	6
Fixed	11	2	4	20	37
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	0	5	2	1	8
Totals	24	14	13	26	77

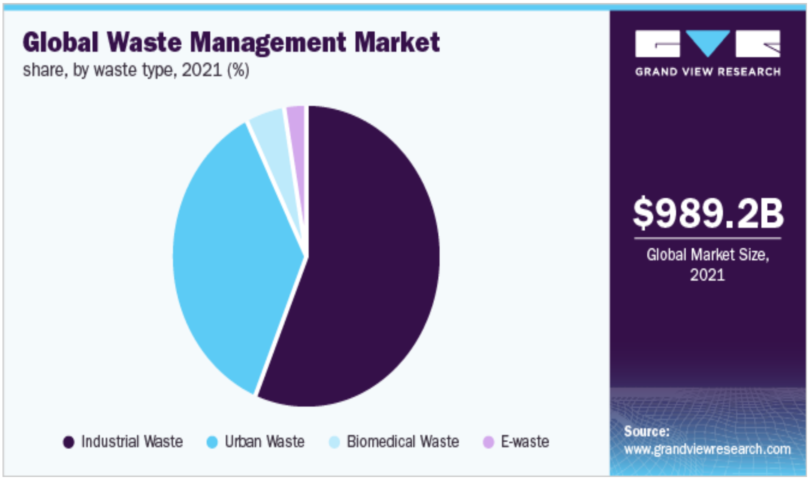
Test Case Analysis

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	7	0	0	7
Client Application	51	0	0	51
Security	2	0	0	2
Outsource Shipping	3	0	0	3
Exception Reporting	9	0	0	9
Final Report Output	4	0	0	4
Version Control	2	0	0	2

9. RESULTS

9.1 Performance Metrics





10. ADVANTAGES & DISADVANTAGES

Advantages :

- Elimination of Missed Pickups,
- Elimination of Overflows,
- Analysis of Waste Generation
- Location

Disadvantages :

- In order to collect separate waste, the system needs more trash cans than the city's population.
- This has a high initial cost because smart dustbins are more expensive than other techniques.
- The dustbin sensor nodes only have a little amount of memory.

11. CONCLUSION

By employing sensors to track the filling of bins, a Smart Waste Management system that is more effective than the one now in use can be created. Our idea of a "smart waste management system" focuses on tracking waste management, providing intelligent technology for waste systems, doing away with human intervention, reducing human time and effort, and creating a clean, healthy environment. In smart cities where citizens have hectic schedules that provide little time for garbage management, the suggested solution can be applied.

12. FUTURE SCOPE

The following are a few upcoming tasks and enhancements for the suggested system:
alters the automatic lock of bins and user authentication systems

- As smart Dustbins are maintained in real time, it will stop dustbins along roadsides and in neighbourhoods from overflowing.
- The waste can be swiftly controlled to its efficient level once these smart bins are introduced on a big scale by replacing the regular bins since it prevents the wasteful lumping of wastes on the roadside.

13. APPENDIX

Ultrasonic Sensor :

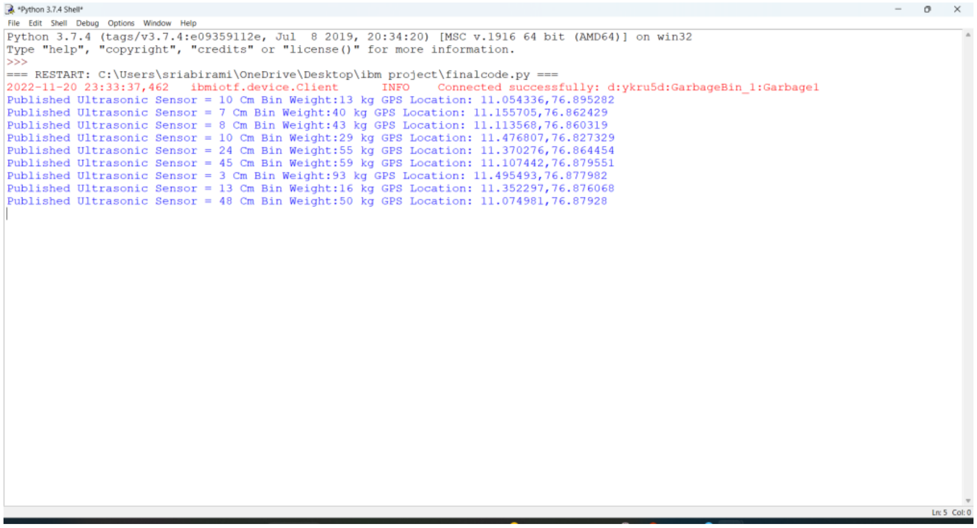
As the name indicates, ultrasonic sensors **measure distance by using ultrasonic waves**. The sensor head emits an ultrasonic wave and receives the wave reflected back from the target. Ultrasonic Sensors measure the distance to the target by measuring the time between the emission and reception.

ESP32 :

ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth. The ESP32 series employs either a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variations, Xtensa LX7 dual-core microprocessor or a single-core RISC-V microprocessor and includes built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules. ESP32 is created and developed by Espressif Systems, a Shanghai-based Chinese company, and is manufactured by TSMC using their 40 nm process.[2] It is a successor to the ESP8266 microcontroller.

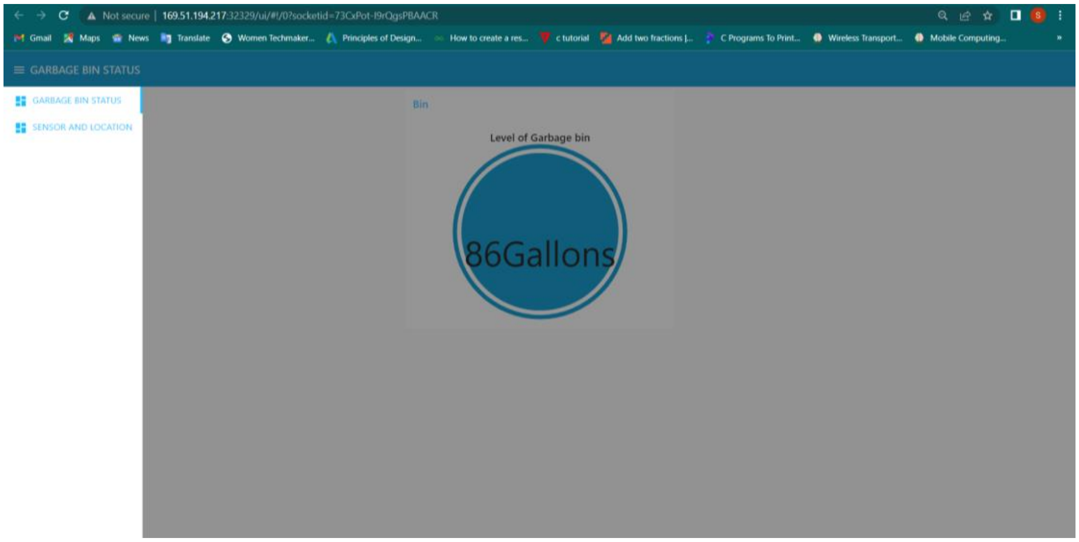
Source Code

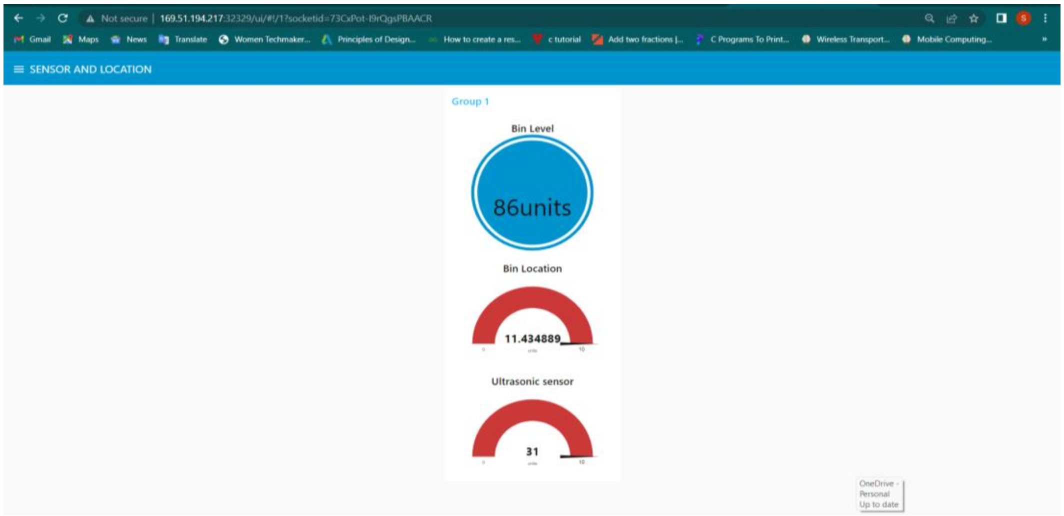
```
import time
import sys
import ibmiotf.application
import ibmiotf.device
import random
#Provide your IBM Watson Device Credentials
organization = "ykru5d"
deviceType = "GarbageBin_1"
deviceId = "Garbage1"
authMethod = "token"
authToken = "DKD_K)lt0Yn!yQIeUf"
# Initialize GPIO
def myCommandCallback(cmd):
    print("Command received: %s" % cmd.data['command'])
    status=cmd.data['command']
    if status =="lighton":
        print("led in on")
    else :
        print ("led is off")
try:
    deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method": authMethod,"auth-token": authToken}
    deviceCli = ibmiotf.device.Client(deviceOptions)
#..............................................
except Exception as e:
    print("Caught exception connecting device: %s" % str(e))
    sys.exit()
deviceCli.connect()
while True:
#Get Sensor Data from DHT11
    time.sleep(5)
    ult_son=random.randint(0,80)
    weight=random.randint(0,100)
    lat = round(random.uniform(11.03, 11.50), 6)
    long = round(random.uniform(76.80, 76.90), 6)
    gps = str(lat) + str(',') + str(long)
    data = {'Ultrasonic' : ult_son, 'Weight' : weight , 'GPS' : gps}
  #print data
    def myOnPublishCallback():
      print ("Published Ultrasonic Sensor = %s Cm" %ult_son, "Bin Weight:%s kg" %weight, "GPS Location: %s" %gps)
    success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0,on_publish=myOnPublishCallback)
    if not success:
      print("Not connected to IoTF")
  time.sleep(1)
  deviceCli.commandCallback = myCommandCallback
  # Disconnect the device and application from the cloud
  deviceCli.disconnect()
```



```
Python 3.7.4 (tags/v3.7.4:e09359112e, Jul  8 2019, 20:34:20) [MSC v.1916 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
=== RESTART: C:\Users\sriabirami\OneDrive\Desktop\ibm project\finalcode.py ===
2022-11-20 23:33:37,462   ibmiotf.device.Client      INFO    Connected successfully: d:ykru5d:GarbageBin_1:Garbage1
Published Ultrasonic Sensor = 10 Cm Bin Weight:13 kg GPS Location: 11.054336,76.895282
Published Ultrasonic Sensor = 7 Cm Bin Weight:40 kg GPS Location: 11.155705,76.862429
Published Ultrasonic Sensor = 8 Cm Bin Weight:43 kg GPS Location: 11.113568,76.860319
Published Ultrasonic Sensor = 10 Cm Bin Weight:29 kg GPS Location: 11.476807,76.827329
Published Ultrasonic Sensor = 24 Cm Bin Weight:55 kg GPS Location: 11.370276,76.864454
Published Ultrasonic Sensor = 45 Cm Bin Weight:59 kg GPS Location: 11.107442,76.879551
Published Ultrasonic Sensor = 3 Cm Bin Weight:93 kg GPS Location: 11.495493,76.877982
Published Ultrasonic Sensor = 13 Cm Bin Weight:16 kg GPS Location: 11.352297,76.876068
Published Ultrasonic Sensor = 48 Cm Bin Weight:50 kg GPS Location: 11.074981,76.87928
```

Web UI





GitHub

https://github.com/IBM-EPBL/IBM-Project-25088-1659953529

Project Demo Link

https://app.flonnect.com/view/video/srii2492000/637a79cde746641a4b9c0ecd