NALAIYATHIRAN IBM PROJECT

SMART WASTE MANAGEMENT FOR METROPOLITAN CITIES

PROJECT REPORT

TEAM ID	**PNT2022TMID06149**
PROJECT NAME	**SMART WASTE MANAGEMENT FOR METROPOLITAN CITIES**
TEAM MEMBERS	**R.S. KARNICA SHIVANI** **S. LAKSHMIDEVI** **S. RAMADEVI** **A.SUGAPRIYA**

1.INTRODUCTION:

1.1 Project Review:

The world is currently facing with lots of health hazards, The amount of waste produced everyday by the industries and the households is increasing at an appalling rate, and the major reason for this is soaring use of packaged items, textiles, paper, food, plastics, metals, glass etc., thus management of this refuse becomes a crucial part in our everyday life. Due to the increasing waste, the public bins which are used for collecting this waste are overflowing, the locality is jumbled of trash, causing not only malodorous streets but also a negative impact on the health and environment. Waste is a crucial issue, which needs to be addressed smartly. we segregate the waste at our homes for ease at processing and recycling. We observed trash vans come irregular to homes creating a despoliation of households. Due to this many civilians empty their overloaded dustbins in open spaces. This in turn increases environmental pollution. Some of them are like government should enact stringent laws against the people throwing trash, against the industries for not using biodegradable material, more use of recycle items, reduce the use of non-degradable stuff, reuse the items, thus implementing this can reduce the waste up to some extent. Along with this use of technology for proper dumping of trash and diminishing its hazardous effects is the concept put forward.

1.2 Purpose:

Wi-Fi facility for dumping waste into the dustbin would solve the issue of waste and the internet facility plus availability of free service would help people go crazy and would act as reward for maintain cleanliness in the locality. We amalgamate technology along with waste management in order to effectively create a safe and a hygienic environment. Smart waste management is about using technology and data to create a more efficient waste industry based on IoT (Internet of Things) technology. This makes it possible to plan more efficient routes for the trash collectors who empty the bins, but also lowers the chance of any bin being full for over a week. A good level of coordination exists between the garbage collectors and the information supplied via technology. This makes them well aware of the existing garbage level and instigate them whenever the bins reach the threshold level. They are sent with alert messages so that they can collect the garbage on time without littering the surrounding area. Moreover we have provided with a servo motor in each garbage can so whenever the threshold level reaches, the servo motor which is connected with lid of the garbage closes automatically so there is no overflow of waste in the surroundings. The fill patterns of specific containers can be identified by historical data and managed accordingly in the long term. In addition to hardware solutions, mobile applications are used to overcome the challenges in the regular waste management system, such as keeping track of the drivers while they are operating on the field. Thus, smart waste management provides us with the most optimal way of managing the waste in an efficient manner using technology.

2. LITERATURE SURVEY:

2.1 Existing Problems:

Lots of Ideas were implemented in the early days to manage the waste. Only alerting the system was initially provided but the main problem is even before the truck driver arrives to collect the garbage, the garbage starts overflowing in the surroundings which may result in some serious health hazards to the people as well as the animals. The main problems of the existing solid waste collection process and management system are as follows:

- More complications in the processing
- Many controlling units linked with each other
- Higher implementation cost

2.2 References:

SI.NO	TITLE OF THE PAPER	AUTHOR	METHODOLOGY	MERITS	YEAR OF PUBLICATIO
1	Smart waste bin Management	Parthasarathi Manickaraja	Uses the Ultrasonic sensor to level the dustbin and also uses the GSM module	Provides an alert message once the level has reached to the authority	2022
2	Smart waste management using IOT	Tejashree Kadus	Technology used is a load cell and a Wi-Fi module	Segregate the waste in the dustbin and provides and alert message	2020
3	Smart waste management systems using machine learning	David Rutgvist	Uses automated machine learning for a real life smart waste management	It focusses on problems of detection of emptying of a recycling container using sensor measurements	2019
4	Real time solid waste	Thiyagapriyadharshini	Smart bin based on a microcontroller	Waste management	2019

	bin monitoring system framework using wireless sensor network		based platform Arduino which is interfaced with GSM module	efficiency and it avoids lumping of wastes	
5	Smart waste collection system	Muhamad Javed Ramzan	Technology based on sensor based collection and uses route algorithm	It identifies the status of waste bin levels along with the location to replace the bin	2018
6	Waste management and tracking	Ben choon yeong	Integration of Near field communication with web and mobile application	To improve the efficiency of waste collection process, provides real-time bin status for householders	2017
7	Smart waste collection system based on location intelligence	Jose .M.guiterrez	Uses an ultrasonic sensor to identify the level of waste	Provides information to the authority once the can is filled	2015

2.3 Problem Statement:

A Smart way to monitor the level of the waste generated

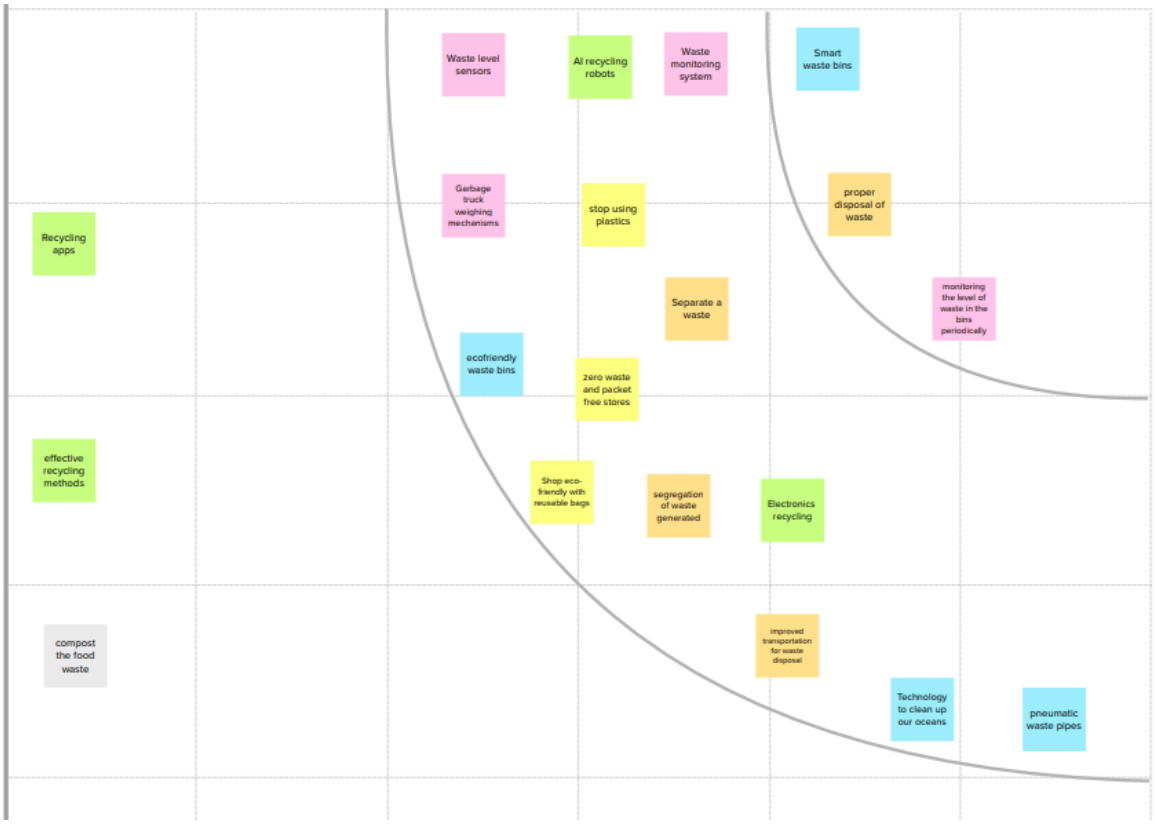
Malarvizhi, a domestic scavenger, is asked to manually monitor the garbage bin at all times, regardless of the weather.

- Current garbage collection is inefficient
- This problem is slowly killing the planet
- It creates unhygienic conditions and spreads deadly diseases
- Adversely affect the local economy
- This problem causes extreme climate changes
- Results in land, air contamination

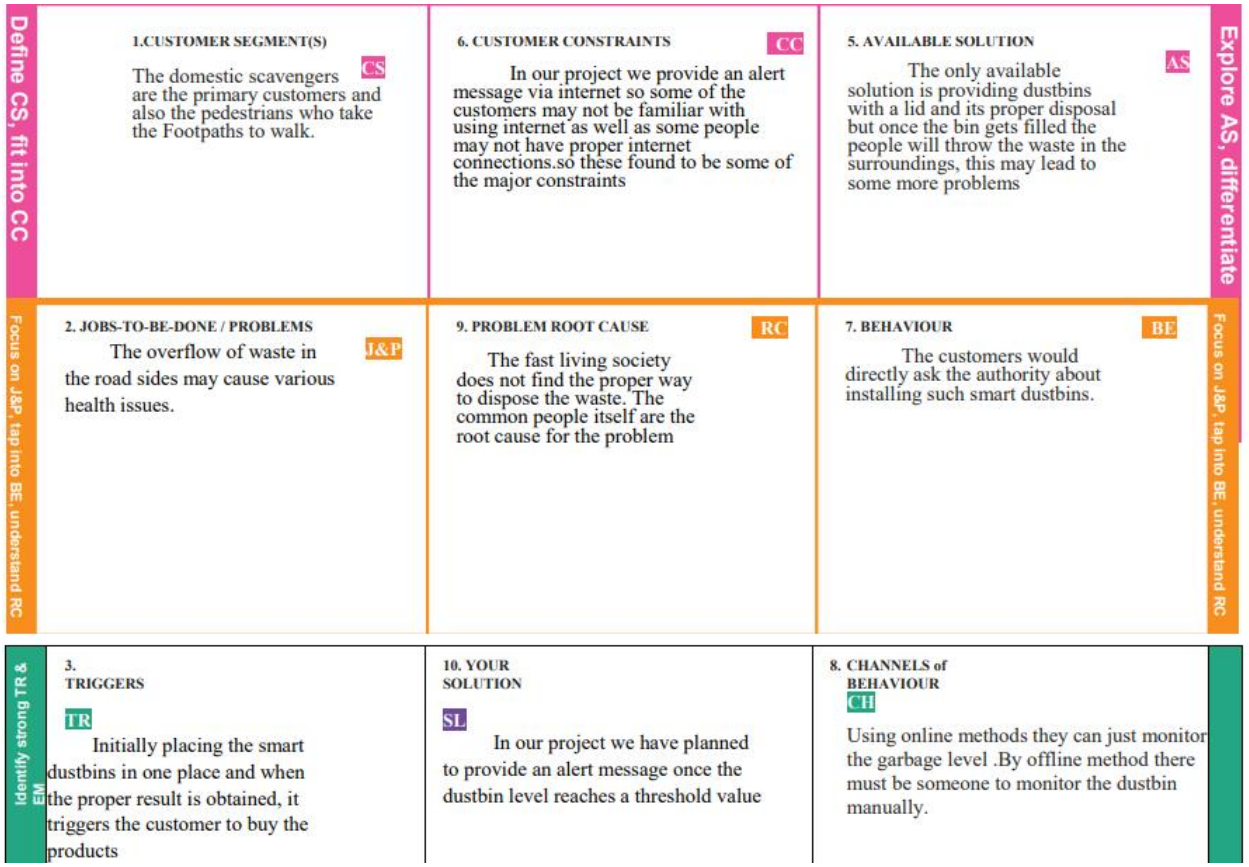
3. IDEATION AND PROPOSED SOLUTION

3.1 Empathy map canvas

3.2 Brainstorming and Idea Prioritization:



3.3 Problem solution:



3.4 Proposed solution:

SI NO	PARAMETER	DESCRIPTION
1	Problem Statement (Problem to be solved	The dumping of waste in the surroundings leads to serious health issues and there is no proper method to manage the waste generated
2	Idea / Solution description	A smart way to manage the waste generated and thereby providing an alert message to the authority.
4	Social Impact / Customer Satisfaction	There is no need for manual monitoring, the time is saved, prevents from several health issues.
5	Business Model (Revenue Model)	It is user-friendly. It is beneficiary for all kinds of people.
6	Scalability of the Solution	It is possible to implement in any surroundings and it can withstand any kind of temperature and pressure

4.REQUIREMENT ANALYSIS

4.1. Functional Requirements:

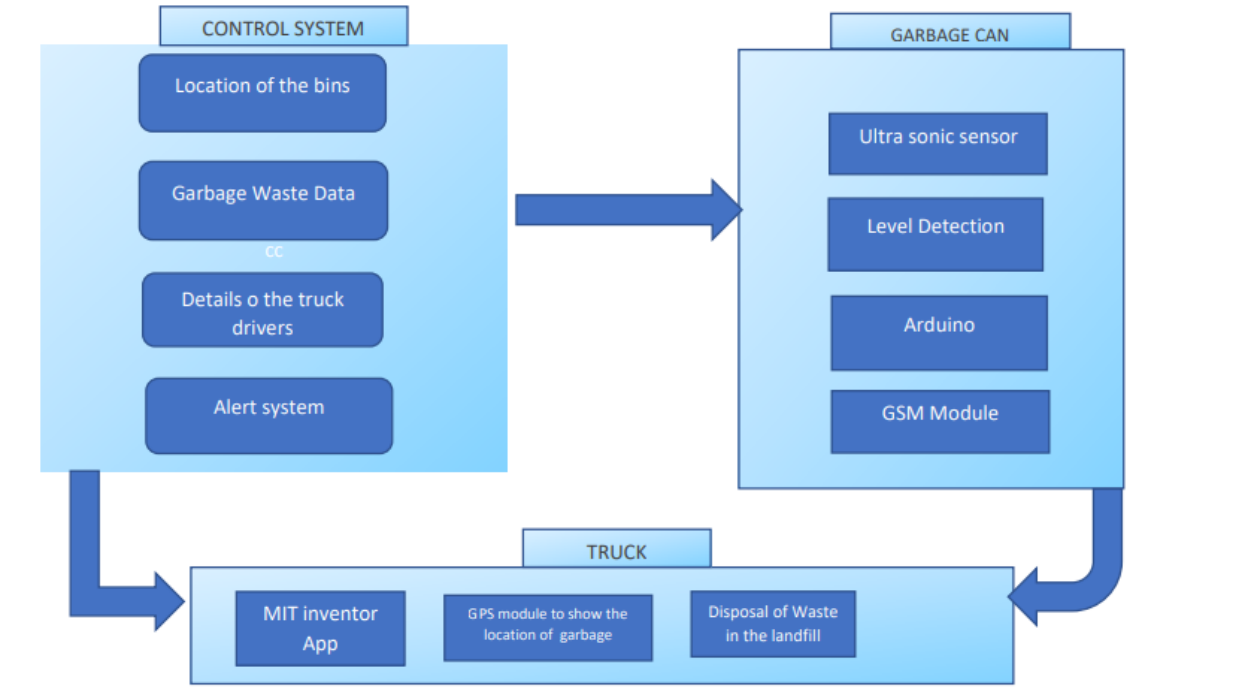
	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
1	Location of Bins	The particular authority must contain the location details of all the garbage cans in that particular location for easy accessing of the location.
2	Bin Monitoring System	Once the garbage can is installed the next step is to monitor the level of the waste generated by using an ultrasonic sensor and also a servo motor is installed to close the garbage can once the waste is dumped so that the waste does not spread in the surroundings.
3	Message Alerting System	A threshold level must be set, and once that waste level is reached then the sensor must sense the level and provide an alert message to the particular authority.
4	Truck Arranging System	When the authority receives an alerting message then it must identify the location of the bin and it must send the message along with the GPS location of the bin to the truck that is available to collect the garbage can using the GSM module

4.2 Non-functional Requirements:

SI.No	Non-Functional Requirement	Description
1	Usability	The IOT based project is easily usable by all kinds of people, because it is user-friendly and a basic knowledge on internet is sufficient to use this product
2	Security	There is no security problems with this product .It is highly secured
3	Reliability	The Product is highly reliable that it can withstand any kind of situations. The garbage cans can be installed in any kind of environment and can withstand all kinds of weather conditions and moreover the network facility is possible even in rural areas.
4	Performance	In terms of performance , it is highly efficient .
5	Availability	By developing the required hardware and software we empower cities ,businesses and countries to manage waste smarter
6	Scalability	Since the project is IOT based it is much cost effective and it has high scalability

5. PROJECT DESIGN:

5.1 Data flow:

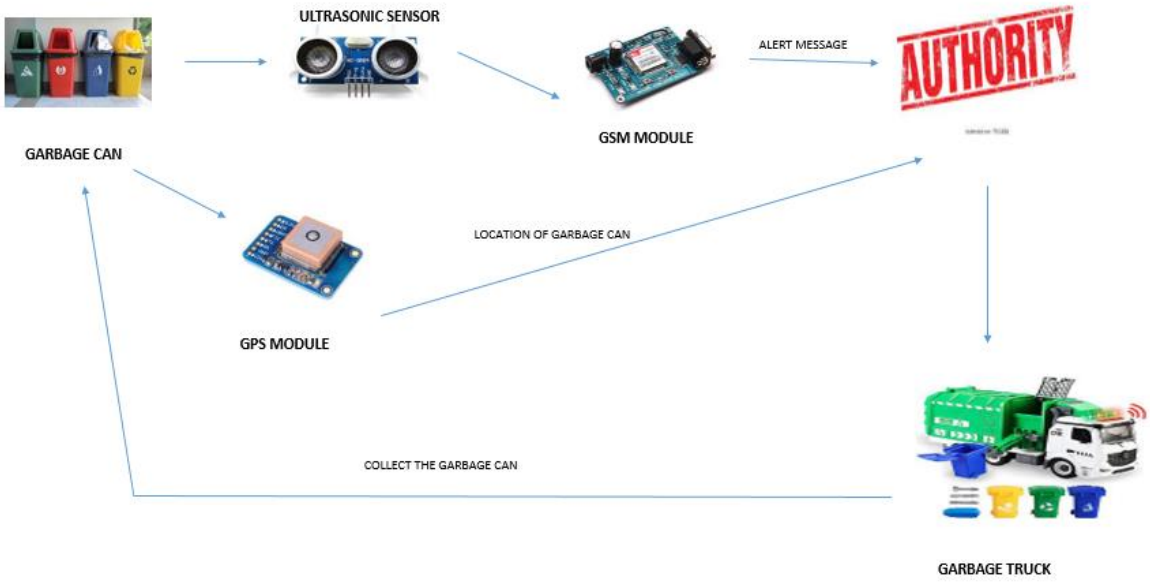


5.2 User stories:

User Type	Functional Requirement (Epic)	User Story Number	User story	Acceptance criteria	Priority	Sprint
Admin	Location of Bins	**USN 1**	The particular authority must contain the location details of all the garbage cans in that particular	Managing the web	**Medium**	**Sprint 2**

			location for easy accessing of the location	accou nt		
Coadmi n	Bin monitoring	**USN 2**	Once the garbage can is installed the next step is to monitor the level of the waste generated by using an ultrasonic sensor and also a servo motor is installed to close the garbage can once the waste is dumped so that the waste does not spread in the surroundings	Monit oring the level of the waste	**High**	**Sprint 1**
Co-admin	Message alerting system	**USN 3**	A threshold level must be set, and once that waste level is reached then the sensor must sense the level and provide an alert message to the particular authority	Provid ing an alert messa ge	**High**	**Sprint 1**
Truck Driver	Truck arranging system	**USN 4**	When the authority receives an alerting message then it must identify the location of the bin and it must send the message along with the GPS location of the bin to the truck that is available to collect the garbage can using the GSM module	Arran ging the truck to collect the garbag e can	**High**	**Sprint 1**
Municip ality	Supervision	**USN 5**	The municipality officers must supervise whether all the process is on its proper way.	Supervi sing the process	**High**	**Sprint 1**

5.3 Solution Architecture:



6. PROJECT PLANNING & SCHEDULING:

6.1 Sprint planning and Estimation:

Title	Description	Date
Literature survey and Information gathering	Literature survey on the selected project& gathering information by referring the technical papers, research publications etc	10 September 2022
Prepare Empathy Map Prepare empathy map canvas	To capture the user pains and gains. Prepare list of problem statement	10 September 2022
Ideation	List the by organizing the brainstorming session and prioritize the top three ideas based on the feasibility and importance.	18 September 2022
Proposed solution	Prepare the proposed solution document which includes the novelty, feasibility of idea, business model, social impact, scalability of solution etc.	24 September 2022
Problem solution	Prepare problem solution fit document	01 October 2022
Solution Architecture	Prepare solution architecture document	08 October 2022
Customer journey	Prepare the customer journey maps to understand the user interactions and experiences with the application	17 October 2022
Functional requirements	Prepare the functional requirements document	18 October 2022

Data flow diagrams	Draw the data flow diagrams and submit for review	16 October 2022
Technology Architecture	Prepare the technology architecture diagram.	16 October 2022
Prepare Milestone and Activity	List Prepare the milestone and activity list of the project.	31 October 2022
Sprint Delivery plan	Prepare the sprint delivery plan.	31 October 2022
Project DevelopmentDelivery of sprint-1,2,3 & 4	Develop and submit the developed code by testing it.	19 November 2022

6.2 Sprint Delivery Plan:

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Member
sprint-1	Location of Bins	USN-1	The particular authority must contain the location details of all the garbage cans in that particular location for easy accessing of the location.	10	High	Karnica shivani
Sprint-2	Bin Monitoring	USN-2	Once the garbage can is installed the next step is to monitor the level of	20	High	Lakshmidevi

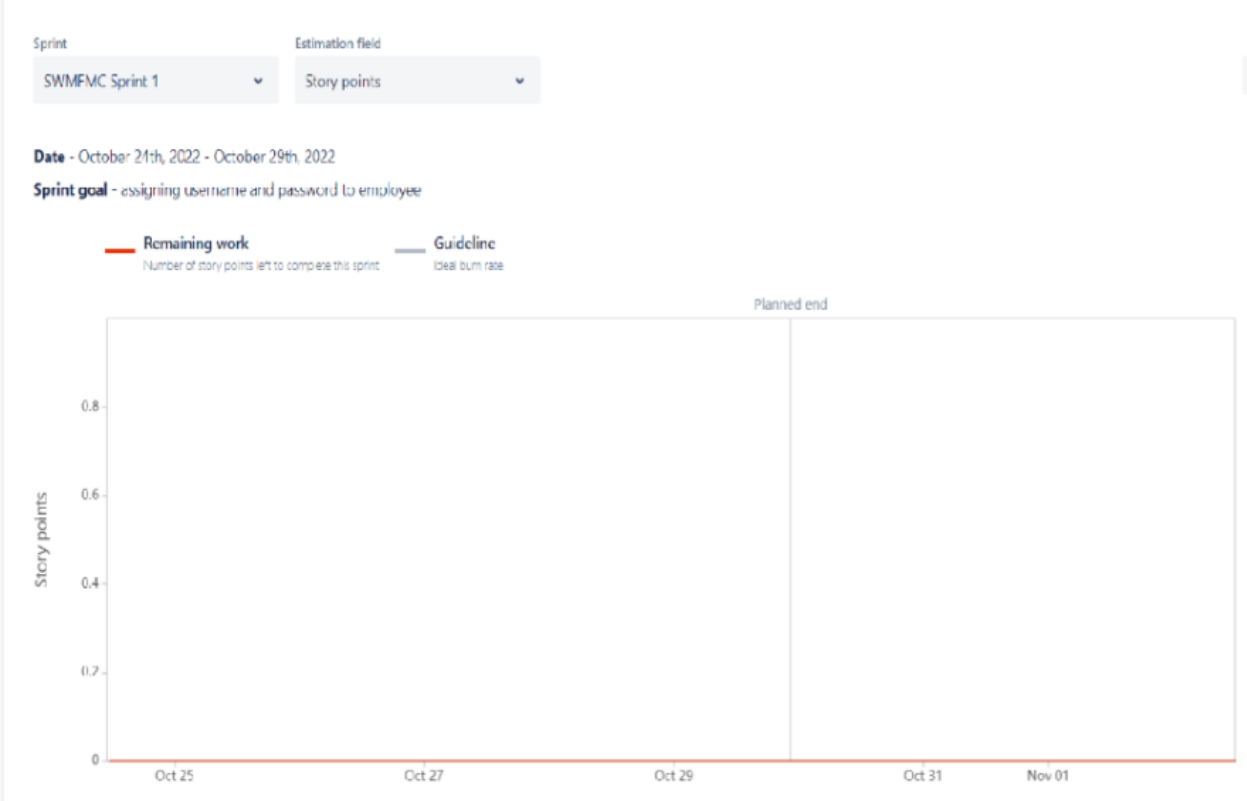
			the waste generated by using an ultrasonic sensor and also a servo motor is installed to close the garbage can once the waste is dumped so that the waste does not spread in the surroundings 20 High Lakshmidevi			
Sprint-3	Message Alerting System	USN-3	Threshold level must be set, and once that waste level is reached then the sensor must sense the level and provide an alert message to the particular authority	20	High	Ramadevi
Sprint-4	Truck Arranging System	USN-4	When the authority receives an alerting message then it must identify the	20	High	Sugapriya

			location of the bin and it must send the message along with the GPS location of the bin to the truck that is available to collect the garbage can using the GSM module.			

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	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

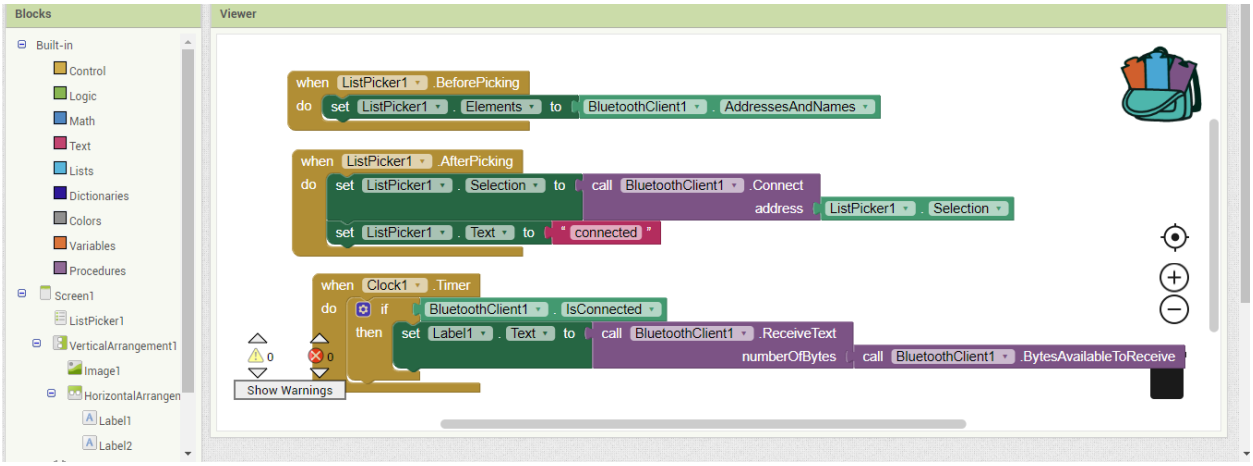
Average = 20/10 =2

Jira Software:

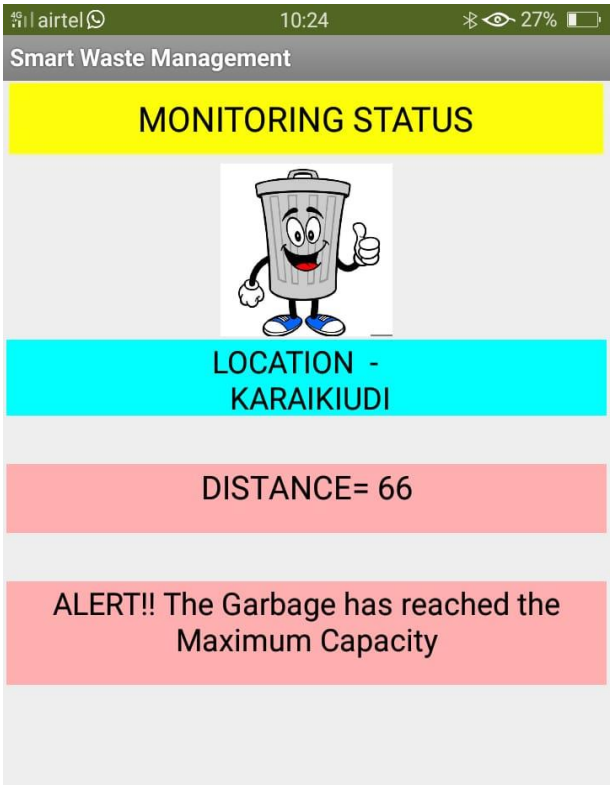


7.Coding And Solutioning:

7.1 Feature 1:



7.2 Feature 2:


airtel
10:24
27%
Smart Waste Management
MONITORING STATUS
LOCATION -
KARAIKIUDI
DISTANCE= 66
ALERT!! The Garbage has reached the
Maximum Capacity

8. TESTING:

Section	Total Cases	Not Tested	Fail	Pass
Web page	5	0	0	7
Node red Dashboard	32	0	0	32
IBM Watson IOT platform	2	0	0	2
MIT app Inventor	3	0	0	3

9.RESULTS

9.1 Performance Metrics

10. ADVANTAGES AND DISADVANTAGES:

10.1 Advantages:

- There is no need for manual monitoring
- Cost efficient
- Can withstand any kind of temperature
- Reduced overflow of waste around the surroundings

10.2 Disadvantages:

- System requires a greater number of waste bins for separate waste collection as per population in the city.
- Sensor nodes used in the dustbins have limited memory size.

11.CONCLUSION:

Improper disposal and improper maintainance of domestic waste create issues in public health and environment pollution thus this paper attempts to provide practical solution towards managing the waste collaborating it with the use of IOT i.e. providing free internet facilities for a specific time once the trash is dumped into the bin. The proposed system will definitely help to overcome all the serious issues related to waste and keep the environment clean.

12.FUTURE SCOPES:

- Change the system of user authentication and atomic lock of bins, which would aid in protecting the bin from damage or theft.
- The moisture sensor can be implemented hand in hand with the other sensors and the compartments for segregating the dry and wet waste can be created which will solve the issues related to waste segregation.

13. SOURCE CODE:

```
#include <WiFi.h>
#include <PubSubClient.h>
#include <LiquidCrystal_I2C.h>
#include <ESP32Servo.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);

#define ORG "i5w9m5"
#define DEVICE_TYPE "smart"
#define DEVICE_ID "smartID"
#define TOKEN "123456789"
char server[] = ORG
".messaging.internetofthings.ibmcloud.com";
char publishTopic[] = "iot-2/evt/data/fmt/json";
char topic[] = "iot-2/cmd/led/fmt/String";
char authMethod[] = "use-token-auth";
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
//
WiFiClient wifiClient; // creating instance for wificlient
PubSubClient client(server, 1883, wifiClient);
#define echoPin 14
#define trigPin 12
#define led 2
Servo myservo;
long duration;
float distance;
void setup()
{
  pinMode(12, OUTPUT);
  pinMode(14, INPUT);
  pinMode(2, OUTPUT);
  myservo.attach(13);
  Serial.begin(115200);
  lcd.init();
  lcd.backlight();
```

```
  lcd.setCursor(1, 0);
  lcd.print("");
  wifiConnect();
  mqttConnect();
}
float readcmCM()
{
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
duration = pulseIn(echoPin, 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(distance>=100)
  {
    Serial.println("distance:"+String(distance));
    digitalWrite(2, LOW);
    myservo.write(0);

  }
  else
```

```
  {
    Serial.println("ALERT!! The garbage has reached the
maximum capacity value");
    digitalWrite(2, HIGH);
    myservo.write(180);

  }

String payload = "{\"Warning!!\":\"";
payload += distance; 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();
}
```

PYTHON CODE:

```
import requests
import json
import ibmiotf.application
import ibmiotf.device
import time
import random
import sys

# watson device details

organization = "ms9s41"
devicType =  "Project"
deviceId = "TMID01046"
authMethod= "token"
authToken= "13150415"

#generate random values for randomo variables for distance and loadcell



def myCommandCallback(cmd):
    global a
    print("command recieved:%s" %cmd.data['command'])
    control=cmd.data['command']
    print(control)

try:
        deviceOptions={"org": organization, "type": devicType,"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()

#connect and send a datapoint "distance and loadcell" with value integer value
into the cloud as a type of event for every 10 seconds
deviceCli.connect()

while True:

    distance= random.randint(10,70)
```

```
    data= {'dist':distance,'load':loadcell}


    if loadcell < 13 and loadcell > 15:
        load = "90 %"

    elif loadcell < 8 and loadcell > 12:
          load = "60 %"

    elif loadcell < 4 and loadcell > 7:
          load = "40 %"
    else:
          load = "0 %"

    if distance < 15:
          dist = 'Risk warning:' 'Dumpster poundage getting high, Time to
collect :) 90 %'


    elif distance < 40 and distance >16:
          dist = 'Risk warning:' 'dumpster is above 60%'

    elif distance < 60 and distance > 41:
          dist = 'Risk warning:' '40 %'
    else:
          dist = 'Risk warning:' '17 %'



    if load == "90 %" or distance == "90 %":
          warn  = 'alert :' 'Risk Warning: Dumpster poundage getting high,
Time to collect :)'

    elif load == "60 %" or distance == "60 %":

          warn = 'alert :' 'dumpster is above 60%'
    else :
          warn = 'alert :' 'No need to collect right now '
    if distance <20:
        warn={'alert':'NEED BIN CHANGE!!!!!!'}


    time.sleep(10)


    success=deviceCli.publishEvent ("IoTSensor","json",warn,qos=0,on_publish=
myOnPublishCallback)

    success=deviceCli.publishEvent ("IoTSensor","json",data,qos=0,on_publish=
myOnPublishCallback)



    if not success:
        print("not connected to ibmiot")
    time.sleep(10)



    deviceCli.commandCallback=myCommandCallback
#disconnect the device
deviceCli.disconnect()
```

GIT HUB LINK:

https://github.com/IBM-EPBL/IBM-Project-15256-1659595999

DEMO LINK:

https://drive.google.com/folderview?id=1aHbpmJBtTJQfHRlXNjVmsctAkilvUUPE