K.L.N COLLEGE OF ENGINEERING, POTTAPALAYAM

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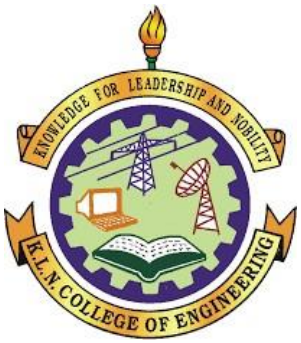

Problem statement: Smart Waste ManagementSystem for Metropolitan Cities

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BONAFIDE CERTIFICATE

Certified that this project report **"SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITAN CITIES"** is the bonafide work of "**NAVEEN KUMAR N (910619106034),**

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CHAPTER - 1

1.INTRODUCTION:

1.1.PROJECT OVERVIEW:

With increasing population and also changes in lifestyle municipal solid waste generation is increasing significantly.Hence waste management is a challenge in urban cities.The overall waste management involves three main types of entities,they are people who generate waste,waste collectors/city admin,stakeholders. Most of the waste is of organic matter, comprising 44.4%.These dataof contents in the waste management is sent to stakeholder using cloud and also in order to have a complete waste management mechanism, and it is very important to have a smart way of notifying the quantity of each type of waste and involves the stakeholders effectively.

1.2.PURPOSE:

So a proper waste management system is necessary to avoid spreading some deadly diseases. Managing the smart bins by monitoring the status of it and accordingly taking the decision. This waste is further picked up by the municipal corporations to finally dump it in dumping areas and landfills. But due to lack of resources, ineffective groundwork, some waste is not collected which poses serious health hazardto the surrounding environment. Proper cleaning intervals may provide a solution to this problem. But keeping a track of the status of the bin manually is a very difficult job.

These dustbins are interfaced with raspberry pi based system with ultrasonic sensors. Where the ultrasonic sensor detects the level of the dust in dustbin and sends the signals to raspberry pi the same signal are encoded and send to the application and it is received. 4 The data has been received, analyzedand processed in the database, which displays the status of the Garbage in the dustbin on the applicationof authoritized person mobile. The concerned authority get alert about dustbin is full and informs personwhoever is responsible for collecting garbage from the particular areas. The garbage trucks collect the garbage from the completely full dustbin and dispose it.

CHAPTER - 2

2.LITERATURE SURVEY:

2.1.Existing problem:

Seven reports were reviewed in detail for the literature review, with the majority of these providing some evidence to support the theory that the introduction of waste collections is associated with a reduction in waste arising. The following text should be reviewed with consideration given to the fact that these studies were not specifically designed to assess the impact of waste collections on at source food waste reduction. Therefore, evidence is taken from these reports to be used in different context from that in which it was collected. Overall the reports demonstrate that while there is some evidence to support the theory that implementing a waste collection can lead to an overall reduction in collected waste, there is currently no significant evidence to demonstrate to what extent this is due to prevention at source as opposed to diversion to home composting. A number of the reports support the need for further research in this area.

2.2.References:

1.Cloud based smart waste management for
smart cities
https://ieeexplore.ieee.org/document/864557
6
Authors: Mohammad Aazam, Marc St-Hilaire, Chung- Horng Lung, Ioannis Lambadaris2.An Internet of Things Based Smart Waste Management System
https://ieeexplore.ieee.org/document/9165744
Authors: Teoh Ji Sheng , Mohammad Shahidul Islam ,Norbahiah Misran3.IOT Based Smart Waste Management System’ 2021

https://ieeexplore.ieee.org/document/9528293

Authors: Gayathri N , Divagaran A R, Akhilesh C D, Aswiin V M, Charan N

2.3.Problem Statement Definition :

In the present day scenario, many times we see that the garbage bins or Dust bin are placed at public places in the cities are overflowing due to increase in the waste every day. It creates unhygienic condition for the people and creates bad smell around the surroundings this leads in spreadingsome deadly diseases & human illness, to avoid such a situation we are planning to design “Smart Waste Management System using IoT”. In this proposed System there are multiple dustbins located throughout the city or the Campus, these dustbins are provided with low cost embedded device which helps in tracking the level of the garbage bins and an unique ID will be provided for every dustbin in the city so that it is easy to identify which garbage bin is full. When the level reaches the threshold limit, the device will transmit the level along with the unique ID provided. These details can be accessed by the concern authorities from their place with the help of Internet and an immediate action can be made to clean the dustbins.

CHAPTER - 3

IDEATION & PROPOSED SOLUTION:

3.1.Empathy Map Canvas:

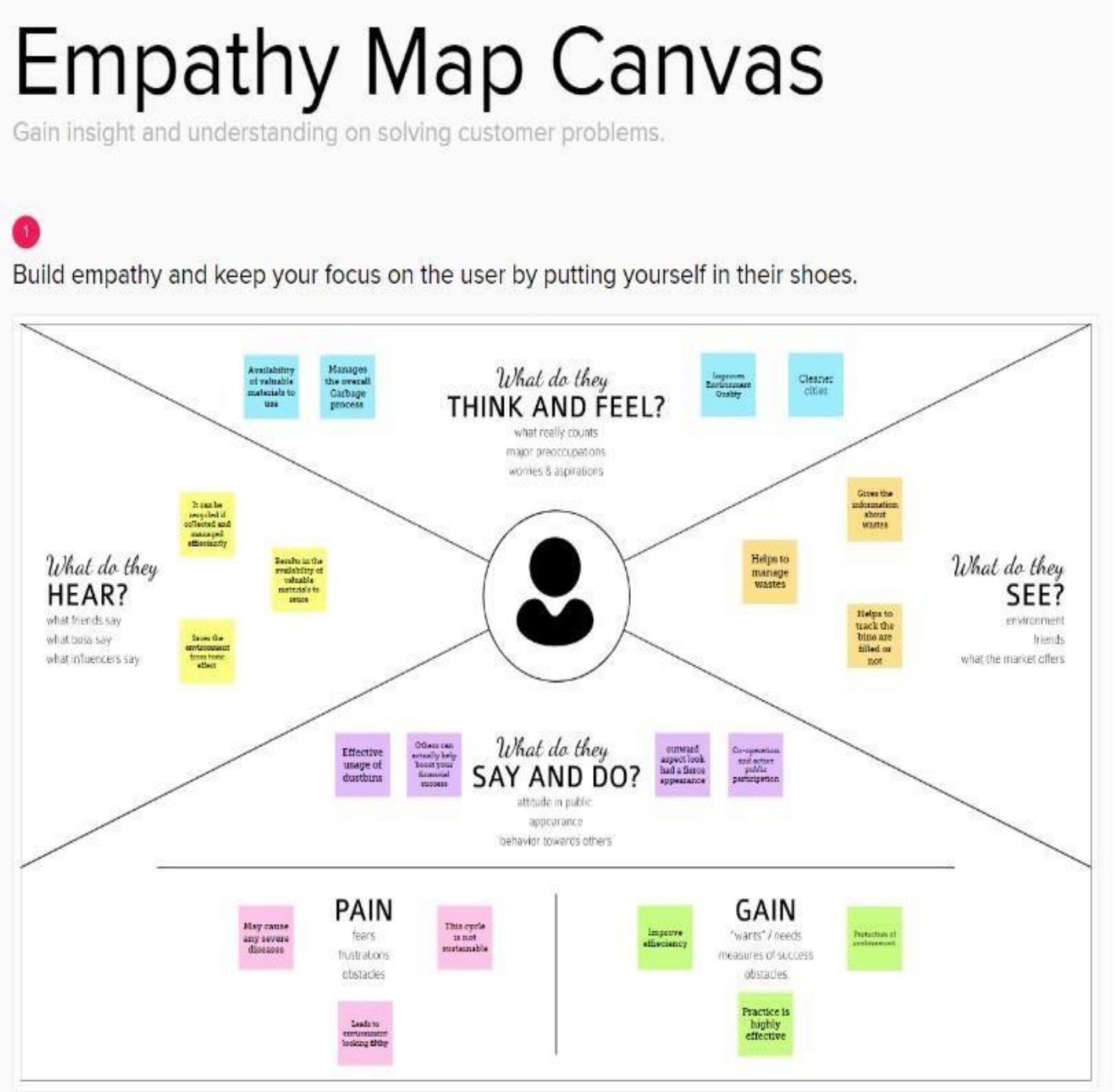

Figure 3.1

3.2.Ideation & Brainstorming:

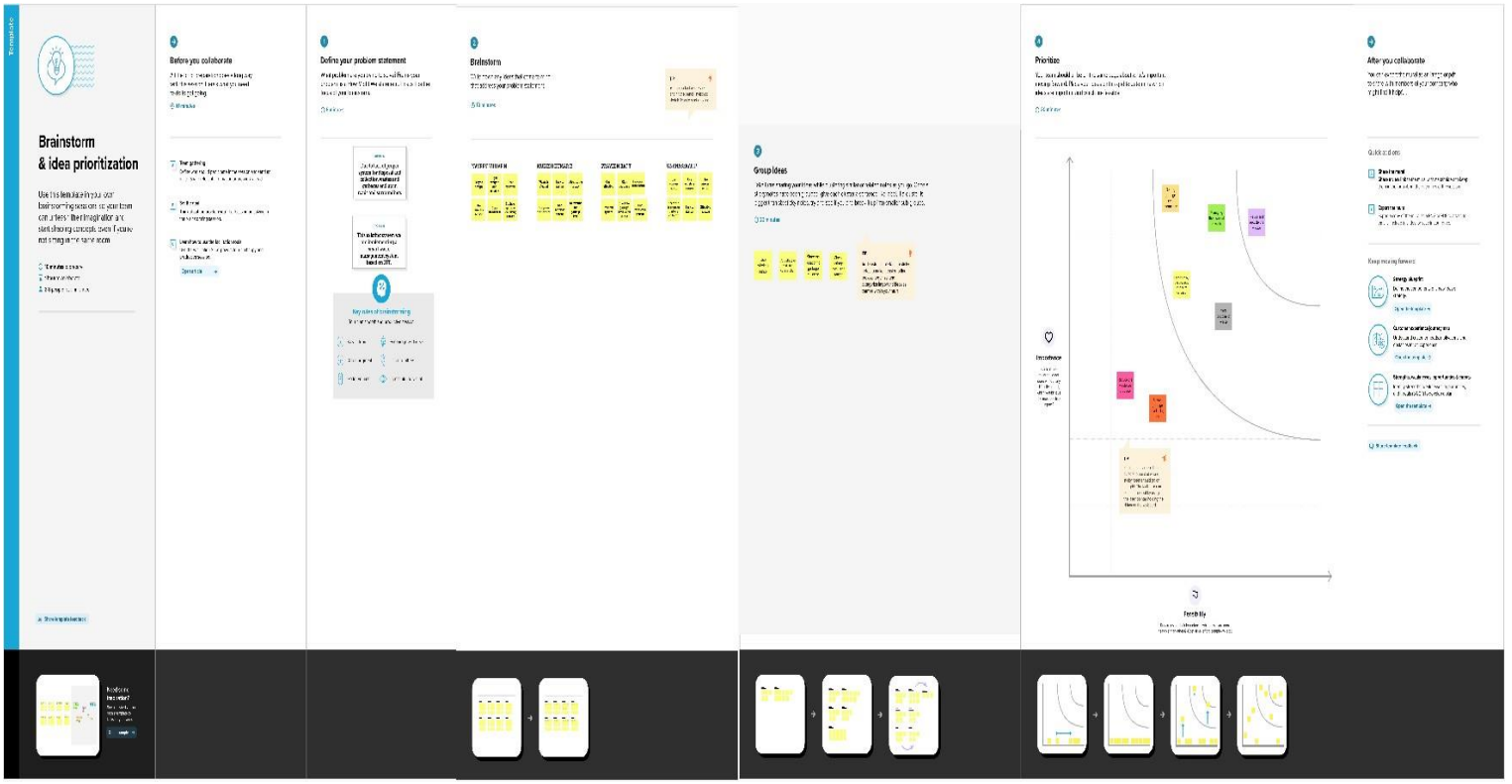

Figure 3.2

3.3.Proposed Solution:

S.No.	Parameter	Description
1.	Problem Statement (Problem to besolved)	• The manual monitoring of wastes in waste bins is a cumbersome process and utilizes more human effort, time and cost. • Irregular disposal of wastes causing trouble to people. • Foul smell around the place with uncollected wastes or garbage.
2.	Idea / Solution description	• Creating an app, there by the corporation of a particular locality inside a metropolitan city can check the garbage bins whether they are filled or not. • This process is achieved by using an ultrasonic sensor to know the levels of garbage bin through cloud connection.
3.	Novelty / Uniqueness	• To reduce the human-effort and difficultyin monitoring the garbage bins. • Unlike the conventional methods for collecting garbage bins, this method tellsus to use the transport only in required places.

4.	Social Impact / Customer Satisfaction	• People can experience a clean environment. • Reduces the human effort involving inthe garbage disposal process. • This idea will be very much beneficial for A city corporation for monitoring thecleanliness of various parts of the city.
5.	Business Model (Revenue Model)	• This project aims to support themunicipal corporations. • Provide a clean environment. • This reduces a huge fuel cost to the citycorporations by reducing the unwanted transport expenses to unnecessary places.
6.	Scalability of the Solution	• There is no need of new establishment ofthings. • Already present garbage bins aremodified slightly. • It can be updated to automated garbagecollection through vehicles.

3.4.Problem Solution fit:

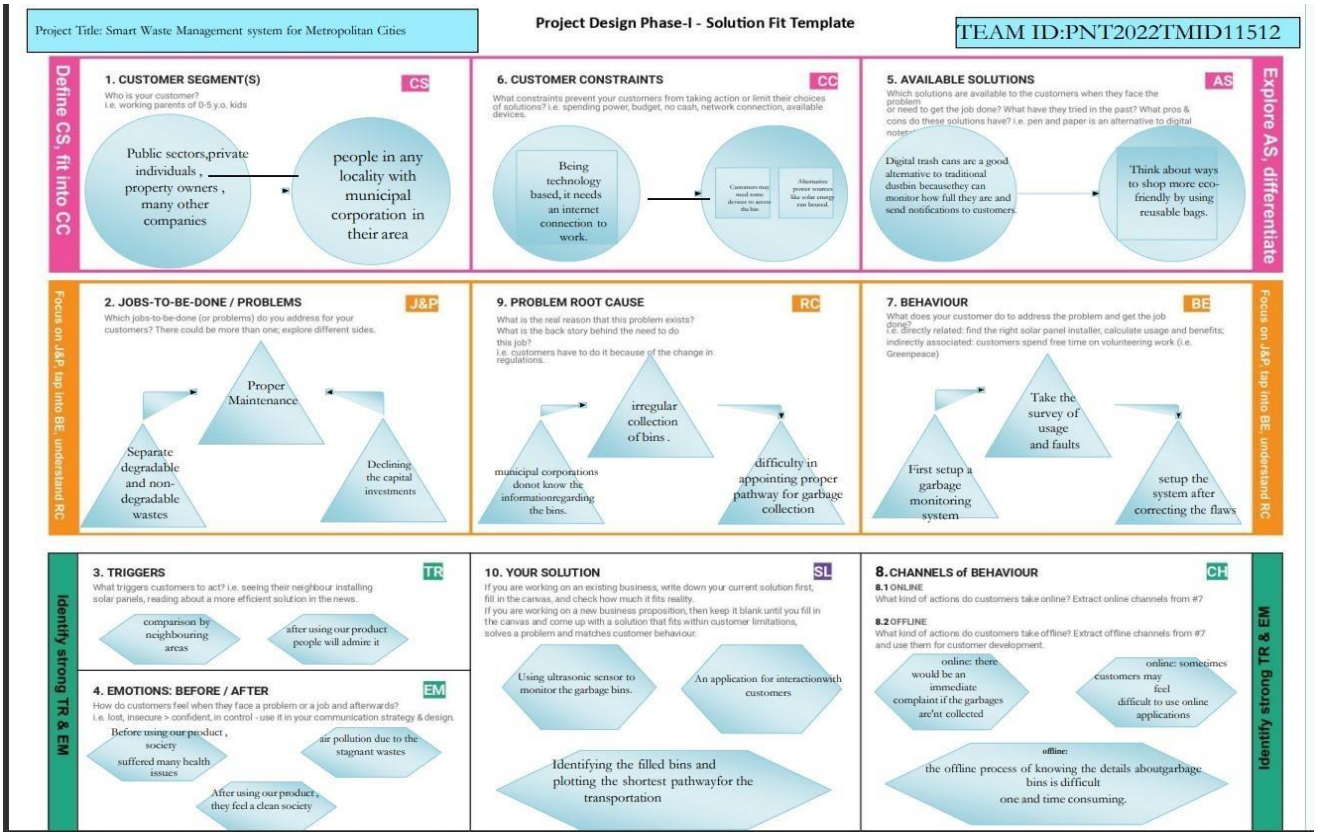

Figure 3.3

CHAPTER – 4

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	**User Registration**	Registration through Gmail
FR-2	**User Confirmation**	Confirmation via Email Confirmation via OTP
FR-3	**GPS Access**	GPS access to know the location
FR-4	**Bin level Analyzing**	Acquire the levels of Waste bins in A regular interval of time.
FR-5	**Transport Router**	To make a efficient route for the Collection of garbages around an area.

4.2.Non-Functional requirements:

Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	➢ A smart solution has been proposed to make the waste sorting more simple and accurate, and improve the user experience, usability, and satisfaction. ➢ It aims to optimize ease of use while offering maximum functionality.
NFR-2	**Security**	➢ The information of the users will be highly secured; the accounts are verifiedwith Gmail.

		➢ If the products are misplaced then the GPS driven sensor gives an alert.
NFR-3	**Reliability**	➢ Operates in a defined environment without failure resulting in lessmanpower, emissions, and fuel use and traffic congestion.
NFR-4	**Performance**	➢ The system will provide accurate reports, thus increasing the efficiencyof the system. ➢ The real-time monitoring of the garbage level with the help of sensors and wireless communication will reduce the total number of trips required of Garbage collecting truck. ➢ This will reduce the total expenditure associated with the garbagecollection.
NFR-5	**Availability**	➢ The smart waste bins are available in Convention centers, buildings, stadiums, and transportation facilities and captures high-quality waste data and informs staff when it gets full.
NFR-6	**Scalability**	➢ A versatile scalable smart waste-bin system based on limited waste management could potentially lead to great improvements. ➢ Once these smart bins are implemented on a large scale by replacing the traditional bins, the waste can be quickly managed to its efficient level as it avoids unnecessary lumping of wastes on roadside.

CHAPTER - 5

5.PROJECT DESIGN:

5.1.Data Flow Diagrams:

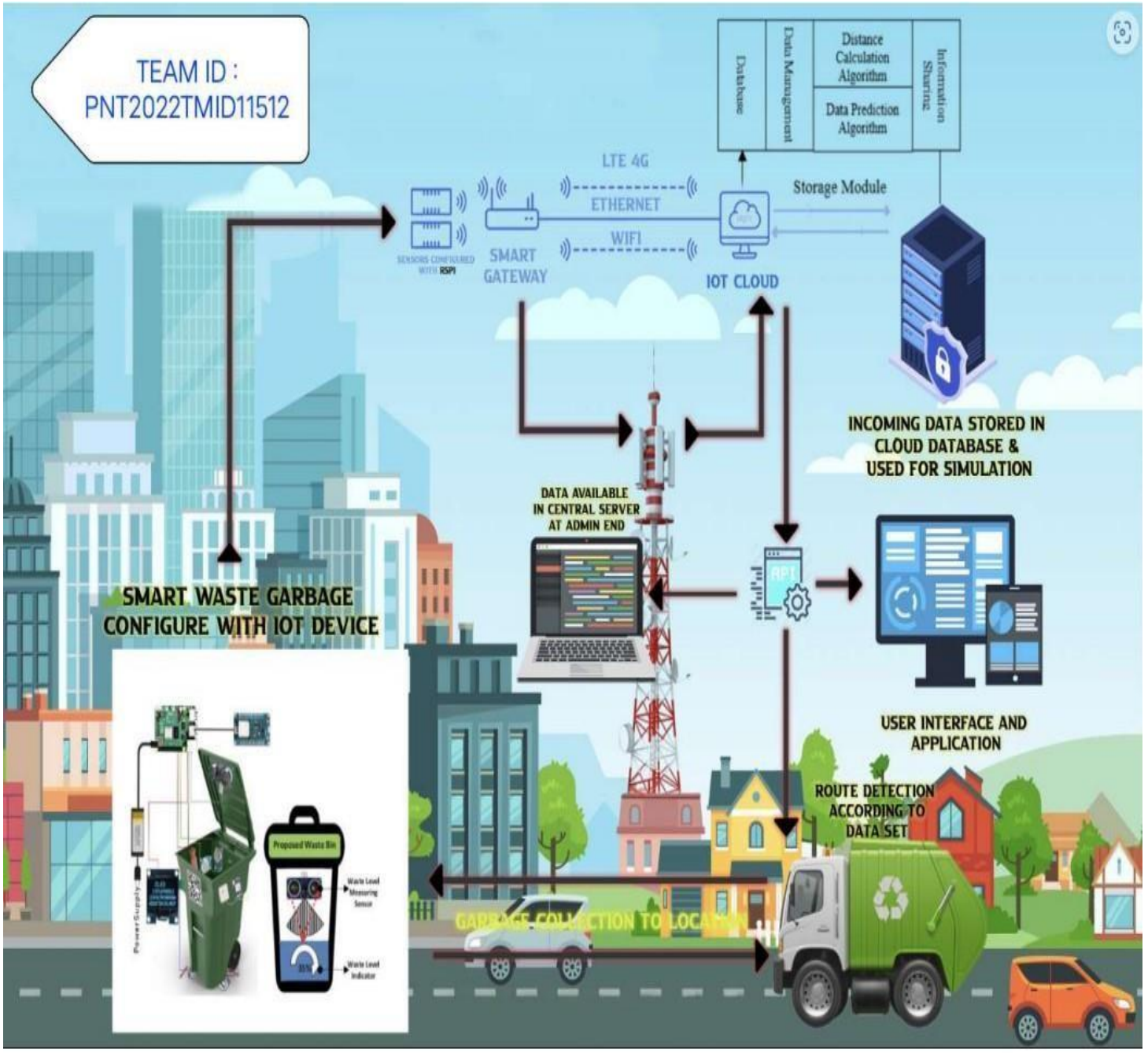

Figure 5.1

5.2.Solution & Technical Architecture:

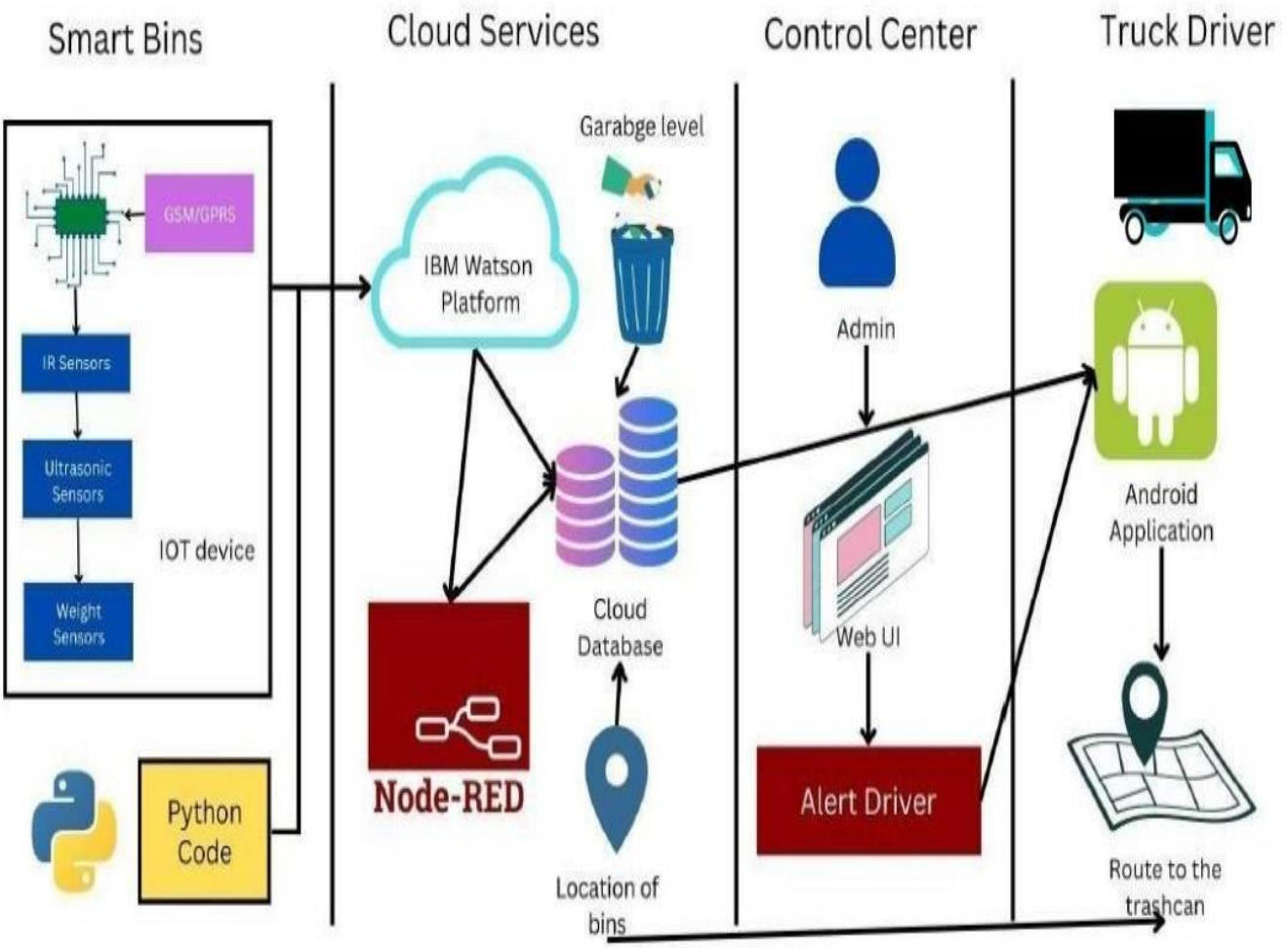

Figure 5.2

5.3.User Stories:

User Type	Functional Requirement (Epic)	User Story no	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile User)	Registration	USN-1	As a user, I created an account in the application provided.	I can access my account / dashboard	High	Sprint-1
		USN-2	As a user, I registered using my Gmail.	I can receive confirmation email.	High	Sprint-1
		USN-3	As a user, I successfully installed the app and login to see the bin level in my Area	I can register & access the dashboard	Low	Sprint-2
	Login	USN-4	As a user, I login using my Gmail andpassword easily.	The login process was easy and simple toaccess the dashboard.	High	Sprint-1
Customer (Web user)		WUSN-1	As a web user I can see whether the bins in thelocality are filled or not only after Logging in	The website must work properly so that no error occurs in the info.	High	Sprint-2

			using my Gmail account.			

CHAPTER – 6

6.PROJECT PLANNING & SCHEDULING:

6.1.Sprint Planning & Estimation:

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Login	USN-1	As Administrator, I need to give user id and pass code for ever workers over there in municipality	10	High	Naveen
Sprint-1	Login	USN-2	As Co-Admin, I'll control the waste level by monitoring them real time web portal. I'll notify trash truck with location of bin with bin ID	10	High	Mukesh
Sprint-2	Dashboard	USN-3	As Truck Driver, I'll follow Admin's Instruction to reach the filling bin in short roots and save time	20	Low	Praveen
Sprint-3	Dashboard	USN-4	As a Local Garbage Collector, I'II gather all the waste from the garbage, load it onto a garbage truck, and deliver it to	20	Medium	Sekar

			Landfills			
Sprint-4	Dashboard	USN-5	As a Municipality officer, I'll make sure everything is proceeding as planned and without any problems	20	High	Naveen

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

6.2.Sprint Delivery Schedule:

TITLE	DESCRIPTION	DATE
Literature Survey & Information Gathering	Literature survey on theselected project & gathering information by referring the, technical papers, research publications etc.	28 SEPTEMBER 2022
Prepare Empathy Map	Prepare Empathy Map Canvas to capture the user Pains & Gains, Prepare listof problem statements	24 SEPTEMBER 2022
Ideation	List the by organizing thebrainstorming session andprioritize the top 3 ideas based on the feasibility & importance.	25 SEPTEMBER 2022
Proposed Solution	Prepare the proposed solution document, which includes the novelty, feasibility of idea, business model, social impact,scalability of solution, etc.	23 SEPTEMBER 2022

Problem Solution Fit	Prepare problem - solution fitdocument.	30 SEPTEMBER 2022
Solution Architecture	Prepare solution architecturedocument.	28 SEPTEMBER 2022

Customer Journey	Prepare the customer journey maps to understand the user interactions & experiences withthe application	20 OCTOBER 2022
Functional Requirement	Prepare the functional requirement document.	8 OCTOBER 2022
Data Flow Diagrams	Draw the data flow diagrams and submit forreview.	9 OCTOBER 2022
Technology Architecture	Prepare the technology Architecture diagram	10 OCTOBER 2022
Prepare Milestone & ActivityList	Prepare the milestones &activity list of the project.	22 OCTOBER 2022
Project Development - Delivery of Sprint-1, 2, 3 &4	Develop & submit the developed code by testing it.	14 NOVEMBER

6.3.JIRA SOFTWARE:

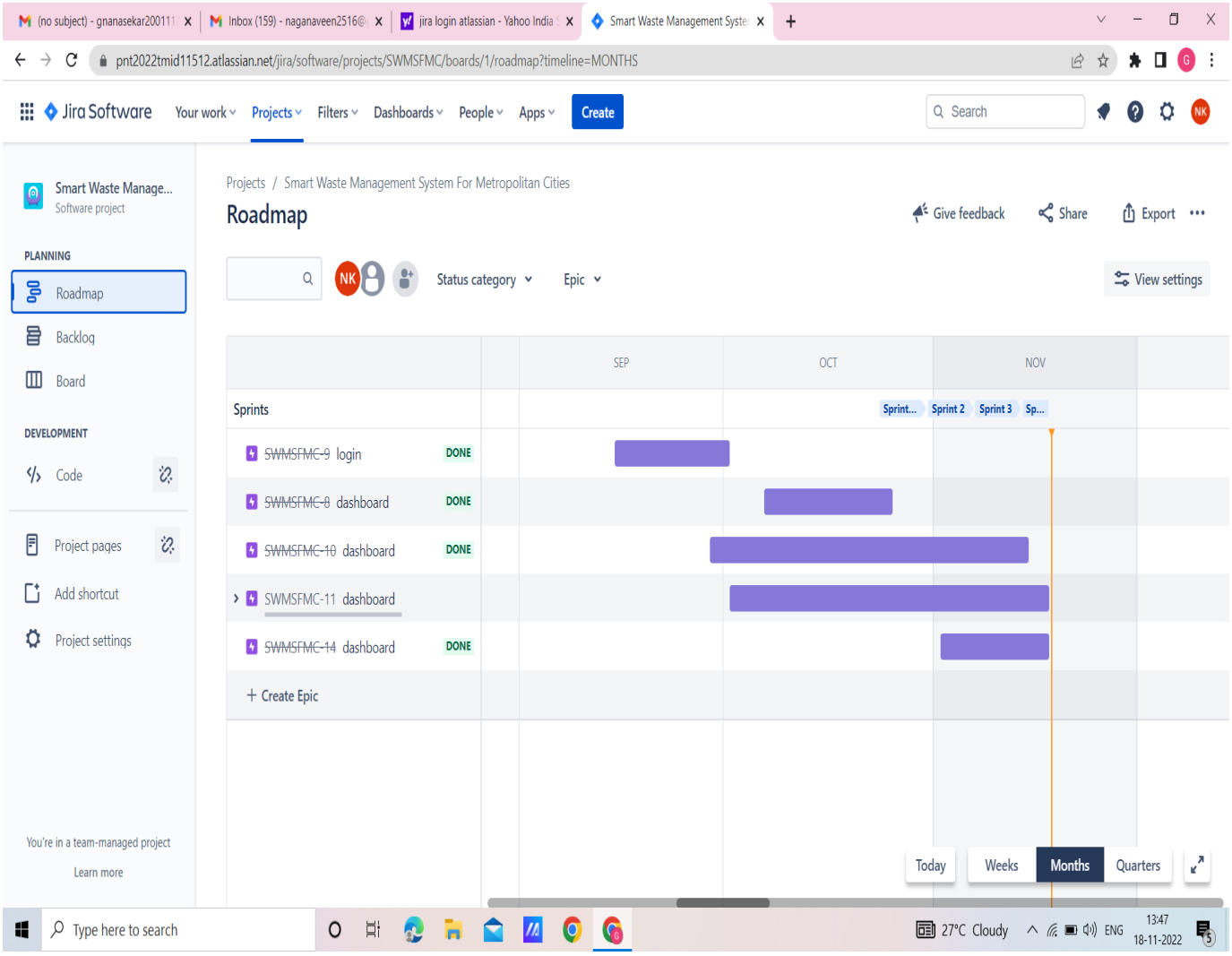

Figure 6.1

CHAPTER – 7

7.CODING & SOLUTIONING:

7.1.PYTHON CODE:

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

#Provide your IBM Watson Device
Credentialsorganization = “cbseji”
deviceType = “abcd”
deviceId = “1234”
authMethod =
“token” authToken =
“12345678”

# Initialize GPIO
def myCommandCallback(cmd):
   print(“Command received: %s” %
   cmd.data[‘command’])
   status=cmd.data[‘command’]
```

```
  if
     status==”lighto
     n”:print (“led
     is on”)
  else :
     print (“led is
 off”)#print(cmd)
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()

# Connect and send a datapoint “hello” with value “world” into the cloud as an
event of type“greeting” 10 times
deviceCli.connect()

while True:
     #Get Sensor Data from
     DHT11
     level=random.randint(0,10
     0)
     weight=random.randint(0,100)
```

```
    data = { ‘level’ : level, ‘weight’:
    weight }#print data
    def myOnPublishCallback():
      print (“Published level = %s C” % level, “weight = %s %%” %
weight, “to IBMWatson”)

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

    if not success:
      print(“Not connected to
    IoTF”)time.sleep(1)
    deviceCli.commandCallback =
myCommandCallbackif (level>=75):
      print(“Full LED ON”)

# Disconnect the device and application from
the clouddeviceCli.disconnect()
```

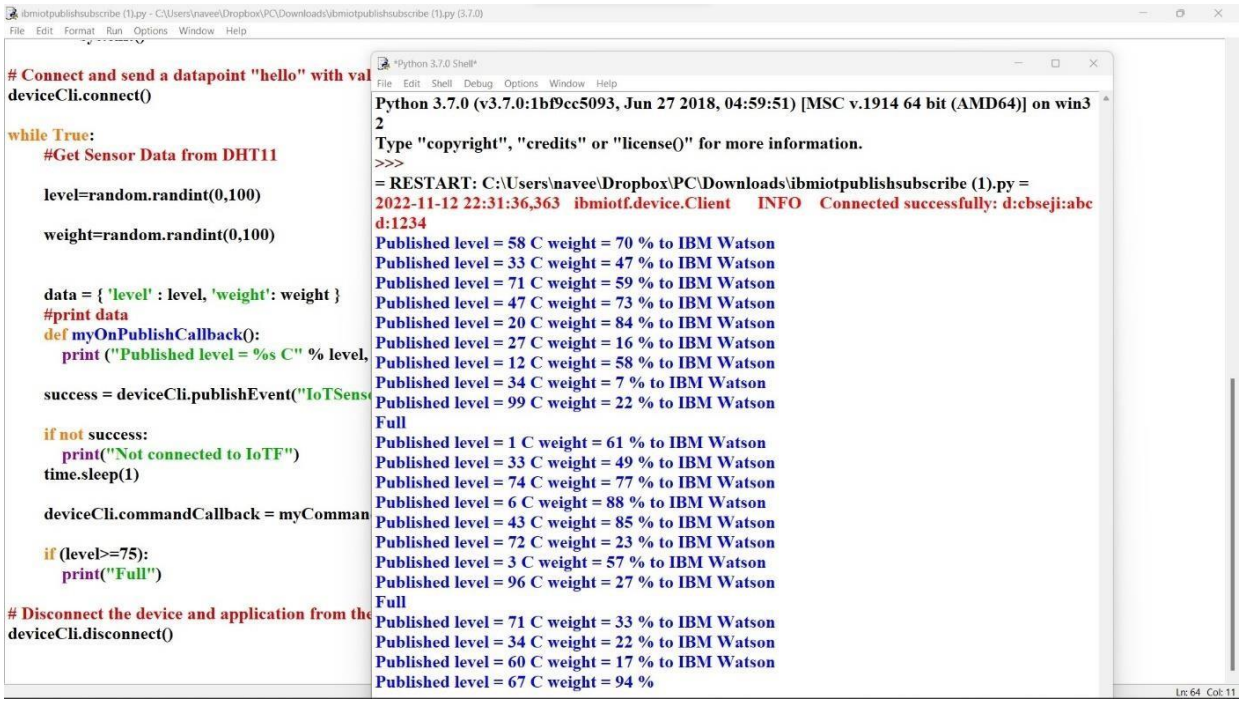

Figure 7.1

7.2.WOWKI CODE:

```
#include <WiFi.h>                    // library for wifi
#include <PubSubClient.h>            // library for
MQTT#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 20, 4);

//.....credentials of IBM Accounts .....

#define ORG "cbseji"                 // IBM organisation id
#define DEVICE_TYPE "abcd"           // Device type mentioned in ibm watson iot
platform#define DEVICE_ID "1234"                 // Device ID mentioned in ibm
watson iot platform #define TOKEN "12345678"  // Token

//.....customise above values .....
```

```
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";     // server
name char publishTopic[] = "iot-2/evt/data/fmt/json";      // topic name and
type ofevent perform and format in which data to be send
char topic[] = "iot-2/cmd/led/fmt/String";                  // cmd Represent type
andcommand is test format of strings
char authMethod[] = "use-token-auth";                       // authentication
methodchar token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;   //Client id

//------------------------------------------------------------------------
---


WiFiClient wifiClient;                                  // creating instance for
wificlientPubSubClient client(server, 1883, wifiClient);


#define ECHO_PIN 12
#define TRIG_PIN
13float dist;


void setup()
{
  Serial.begin(115200);
  pinMode(LED_BUILTIN,
  OUTPUT);pinMode(TRIG_PIN,
  OUTPUT);
```

```
  pinMode(ECHO_PIN, INPUT);
  //pir pin
  pinMode(34, INPUT);

  //ledpins
  pinMode(23,
  OUTPUT);
  pinMode(2,
  OUTPUT);
  pinMode(4,
  OUTPUT);
  pinMode(15,OUTPU
  T);
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);
     }
    initManagedDevic
    e();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 Detected");
  Serial.println("Lid
  Opened");
  digitalWrite(15, HIGH);

 if(digitalRead(34)== true)
{
 if(cm <= 60)                           //Bin level detection
 {
  digitalWrite(2, HIGH);
  Serial.println("High Alert!!!,Trash bin is about to
  be full");Serial.println("Lid Closed");
  lcd.print("Full! Don't
```

```
 use");delay(2000);
 lcd.clear();
 digitalWrite(4,
 LOW);
 digitalWrite(23,
 LOW);
}
else if(cm > 60 && cm < 120)
{
 digitalWrite(4, HIGH);
 Serial.println("Warning!!,Trash is about to cross 50% of
 bin level");digitalWrite(2, LOW);
 digitalWrite(23, LOW);

}
else if(cm > 120)
{
 digitalWrite(23, HIGH);
 Serial.println("Bin is
 available");
 digitalWrite(2,LOW);
 digitalWrite(4, LOW);

}
 delay(10000);
 Serial.println("Lid
 Closed");
```

```
 }
 else
 {
  Serial.println("No motion
   detected");digitalWrite(2,
   LOW); digitalWrite(15,
   LOW); digitalWrite(4, LOW);
   digitalWrite(23, LOW);
 }
}
 else
 {
   digitalWrite(15, LOW);
 }
 if(cm <= 60)
{
digitalWrite(21,HIGH);
String payload =
"{\"High_Alert\":";payload +=
cm;
payload += " }";
Serial.print("\n");
Serial.print("Sending
payload: ");
Serial.println(payload);
if (client.publish(publishTopic, (char*) payload.c_str())) // if data is uploaded
to cloudsuccessfully,prints publish ok else prints publish failed
```

```
{
Serial.println("Publish OK");
}
}
else if(cm <= 120)
{
digitalWrite(22,HIGH);
String payload =
"{\"Warning\":";payload +=
cm ;
payload += " }";
Serial.print("\n");
Serial.print("Sending
payload: ");
Serial.println(payload);
if(client.publish(publishTopic, (char*) payload.c_str()))
{
Serial.println("Publish OK");
}
else
{
Serial.println("Publish FAILED");
}
}
else
{
Serial.println();
```

```
}

 float inches = (cm / 2.54);                    //print on
 lcdlcd.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();
}
```

CHAPTER - 8

8.TESTING:

8.1.TEST CASES:

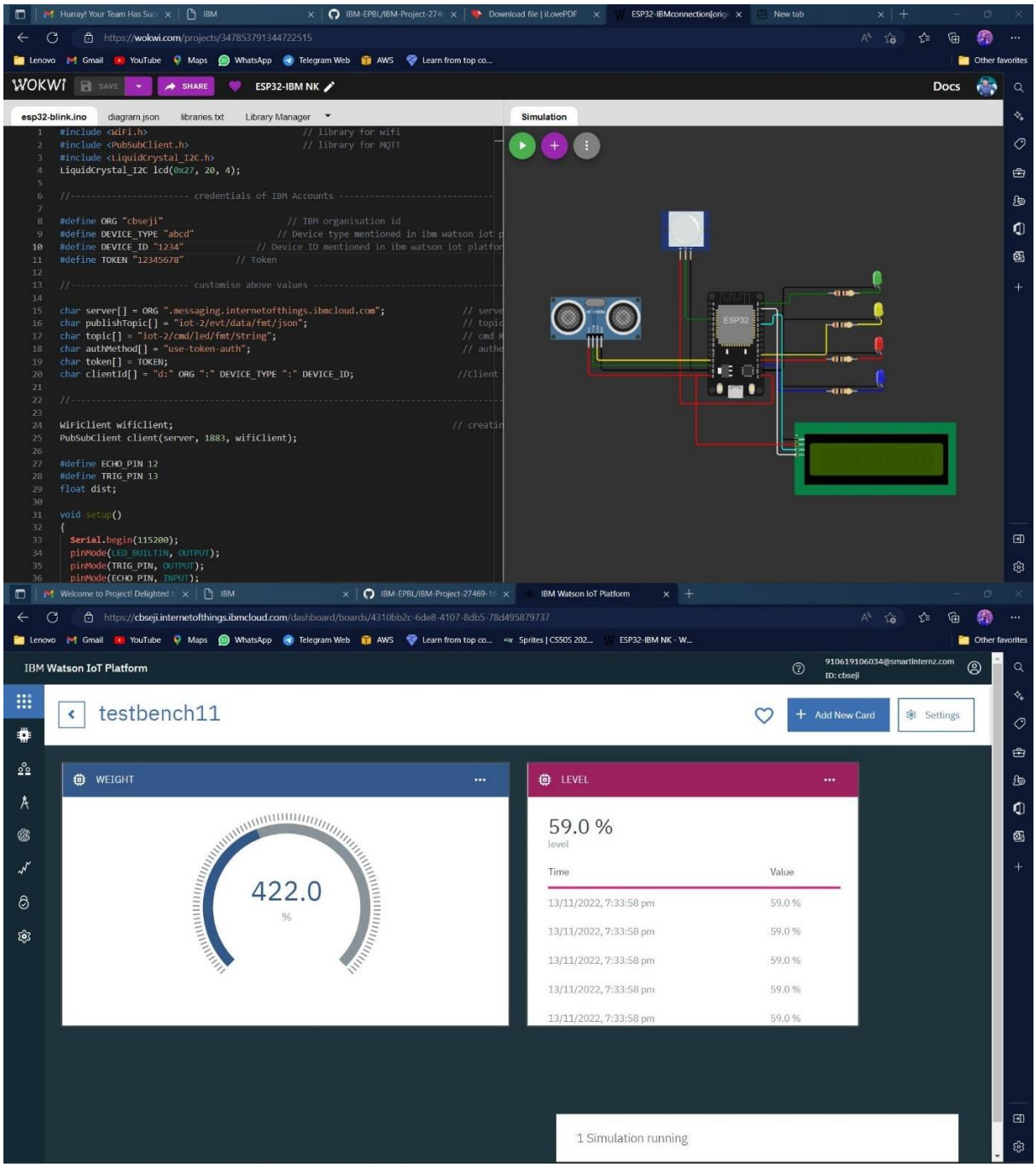

Figure 8.1

8.1.User Acceptance Testing:

Date	10 November 2022
Team ID	PNT2022TMID11512
Project Name	Smart Waste Management System for Metropolitan Cities - IOT
Maximum Marks	4 Marks

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 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 howthey were resolved

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	10	4	3	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	78

3.Test Case Analysis

This report shows the number of test cases that have passed ,failed ,and untested.

Section	Total Cases	Not Tested	Fail	Pass
Python installation	7	0	0	7
Launch IBM Watson	45	0	5	40
IBM Watson and python integration	2	0	0	2
Install Node red	13	0	7	6
Interconnecting IBM Watson and Node red	19	0	10	9
Web UI dashboard	14	0	0	14
MIT app design	30	1	4	25
To View the Values in mobile Application	20	0	7	13
Totals	150	1	33	116

CHAPTER - 9

9.1.RESULTS:

We have implemented real time waste management system by using smart dustbins to check the fill level of smart dustbins whether the dustbin are full or not. In this system the information of all smart dustbins can be accessed from anywhere and anytime by the concern person and he/she can take a decision accordingly.

9.1.1.ADVANTAGES:

- Real time information on the fill level of the dustbin.
- Deployment of dustbin based on the actual needs.
- Cost Reduction and resource optimization.
- Improves Environment quality
- Fewer smells
- Cleaner cities
- Intelligent management of the server.
- Effective usage of dustbins.

9.1.2.DISADVANTAGES:

- Time consuming and less effective: trucks go and empty containers whether they are full or not.
- High costs.
- Unhygienic Environment and look of the city.
- Bad smell spreads and may cause illness to human beings.

9.2.CONCLUSION:

By implementing this proposed system the cost reduction, resource optimization, effective usage of smart dustbins can be done. This system indirectly reducing traffic in the city. In major cities the garbage collection vehicle visit the area's everyday twice or thrice depends on the population of the particular area and sometimes these dustbins may not be full. Our System will informthe status of each and every dust bin in real time so that the concerned authority can send the garbage collection vehicle only when the dustbin is full. The scope for the future work is this system can be implemented with time stamp in which real-time clock shown to the concern person at what time dust bin is full and at what time the waste is collected from the smart dustbins.

9.3.FUTURE SCOPE:

The key motivation is in achieving efficiency in the waste management sector at the national level. Issues in the waste management Waste truck drivers need a navigation system and reporting problem system. Citizens want to have better service, lower cost and having easily accessible reports. Inorder to maintain a clean and hygienic environment in the area around us, we are using the technology for the better garbage monitoring system. In big institutions or a city under a municipal corporation where there are extensive quantities of garbage bins deployed and workers are kept specifically for this task, the antiquated technique for physically hunting down filled garbage bins is wasteful and does not run well with the technological era we are in. Routine checks for cleaning the garbage bins which depend on time crevices are wasteful in light of the fact that a dustbin may get filled early or may get tampered and might require prompt consideration or there might not be any need of a routine check for a drawn out stretch of time. Likewise, to save fuel and time and make the entire

process more effective and convenient, the workers going on routine check should know the shortest route consisting of all the filled garbage bins.

GITHUB : **IBM-EPBL/IBM-Project-27469-1660057502: Smart Waste Management System For Metropolitan Cities (github.com)**

WOWKI : **ESP32-IBM NK - Wokwi Arduino and ESP32 Simulator**