Project Report

Smart Waste Management System For Metropolitan Cities

1. INTRODUCTION

1.1 Project Overview :

To make the cities greener, safer, and more efficient, Internet of Things (IoT) can play an important role. Improvement in safety and quality of life can be achieved by connecting devices, vehicles and infrastructure all around in a city. We present a waste collection management solution based on providing intelligence to wastebins, using an IoT prototype with sensors. It can read, collect, and transmit huge volume of data over the Internet. Such data, when put into a spatio-temporal context and processed by intelligent and optimized algorithms, can be used to dynamically manage waste collection mechanism. Simulations for several cases are carried out to investigate the benefits of such system over a traditional system.Intelligent waste collection system t is responsible for measuring the waste level in the wastebins and later send this data (through Internet) to a server for storage and processing. This data helps to compute the optimized collection routes for the workers. In future, we would like to enhance the system for different kind of wastes, namely solid and liquid wastes.

1.2 Purpose :

A waste management system is an strategy an organization uses to dispose,reduse,reuse,and prevent waste.Possible waste disposal methods are recycling,composting,landfills,waste to energy and wate minimization.

2.LITERATURE SURVEY

2.1 Existing Problem :

The problem in the management of urban waste occurs due to the imbalance between the production and the capability to manage it; the waste volume continues to increase in line with the population growth, changes in the quality of life and the dynamics of community activities

2.2 References :

[1]Shyam, Gopal Kirshna, Sunilkumar S. Manvi, and Priyanka Bharti. "Smart waste management using Internet-of-Things (IoT)." IEEE Computing and Communications Technologies (ICCCT), (2017) pp. 199-203.

[2]Kurre, Vishesh Kumar. "Smart Garbage Collection Bin overflows Indicator using IOT." International Research Journal of Engineering and Technology (IRJET) (2016).

[3]Folianto, Fachmin, Yong Sheng Low, and Wai Leong Yeow. "Smartbin: Smart waste management system." Tenth IEEE International conference on Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), (2015).

[4]Vu, Dung, and Georges Kaddoum. "A waste city management system for smart cities applications." (2017).2017 Advances in Wireless and Optical Communications

[5]Kumar, S.Vinoth, T.Senthil Kumaran, A. Krishna Kumar, and MahanteshMathapati. "Smart garbage monitoring and clearance system using internet of things." IEEE Smart Technologies and Management for Computing, Communication, Controls, Energy and Materials, (2017).

[6]Swati Dewangan,IoT- Enabled Intelligent Solid Waste Management System for Smart City: A Survey, ISSN NO : 2249-7455

[7]Amoo OM, Fangbale RL (2013). Renewable municipal solid waste pathways for energy generation and sustainable development in the Nigerian context. International Journal of Energy and Environmental Engineering, 4(1): 42.J.H. Chuang.
Potential-Based Approach for Shape Matching and Recognition. Pattern Recognition, 29:463-470, 1996.

2.3 Problem Statement Definition :

Overflowing waste causes air pollution and respiratory diseases. One of the outcomes of overflowing garbage is air pollution, which causes various respiratory diseases and other adverse health effects as contaminants are absorbed from lungs into other parts of the body. One of the outcomes of overflowing garbage is **air pollution**, which causes various respiratory diseases and other adverse health effects as contaminants are absorbed from lungs into other parts of the body. The toxic substances in air contaminated by waste include carbon dioxide, nitrous oxide and methane.

3.IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas :

An empathy map canvas is a more in-depth version of the original empathy map, which helps identify and describe the user's needs and pain points. And this is valuable information for improving the user experience. An empathy map canvas helps brands provide a better experience for users by helping teams understand the perspectives and mindset of their customers. Using a template to create an empathy map canvas reduces the preparation time and standardises the process so you create empathy map canvases of similar quality.

THINK AND FEEL	Network connectivity	Hardware implementation	Expense
HEAR	Improving efciency	Difficult to implement	Time Saving
SAY AND DO	Good step towards digitlization	Requires skilled engineering	An effective way
SEE	Huge loads in Urban areas	Rural areas	Clean City In Automatically
PAIN	Lack of tech knowledge	Employee abandment	Disconnectivity
GAIN	Truck drivers and citizens are saving less time stuck in trafc jams	Reduce the cost of waste collection	Reduce the cost of waste collection

3.2 Ideation &Brainstorming :

Ideation is often closely related to the practice of brainstorming, a specific technique that is utilised to generate new ideas. A principal difference between ideation and brainstorming is that ideation is commonly more thought of as being an individual pursuit, while brainstorming is almost always a group activity.

Ideas :

M. ALHAZEENA	Waste management includes the processes and actions required to manage waste from its inception to its fnal disposal	In some cases waste can pose a threat to human health	A big part of this is deals with municipal solid waste
H.ASHIFA	Based on IOT technology smart waste management aims to optimize resource allocation	waste management deals with all types of waste ,includingindustrial,biological	proper management of waste is important for building sustainable and liveable cities
J.JEFFRINA SHIRLEY	cities and municipalities use IOT technology to handle sustainable waste management operation	Smart waste management is the solution for small cities	This system can help reduce extra spending and ensure a more intelligent budget

A.MAHIMA JENIFER	Smart waste management using IOT can reduce managerial time	It is also used to increase the maximum revenue generation	Eco -friendly waste management is the best example for this

3.3 Proposed Solution Template:

S.NO	PARAMETERS	DESCRIPTION
1.	Problem Statement (Problem to be solved)	World faces major environmental challenges associated with waste generation and inadequate waste collection, transport, treatment and disposal. Current systems cannot cope with the volumes of waste generated by an increasing urban population, and this impacts on the environment and public health.
2.	Idea / Solution description	The solution is a method in which waste management is automated. Waste management using IoT is an innovative way that will help to keep the cities clean and healthy.
3.	Novelty / Uniqueness	IoT enables companies to automate processes and reduce labor costs. It also cuts down on waste and improves service delivery, making it less expensive to manufacture and deliver goods, as well as offering transparency into customer transactions.
4.	Social Impact / Customer Satisfaction	IoT improves the total efficiency of waste collection and recycling. The most common use in waste management is route optimisation, which reduces fuel consumption.
5.	Business Model	Smart Waste Management generates revenue

	(Revenue Model)	through the provision of various waste management and disposal services and recycling solutions to residential, commercial, industrial, and municipal clients. They generate revenue by means of collecting fee.
6.	Scalability of the Solution	Scalability issues can be sorted out using IoT provided that the wireless network is wide range with high data speed and flexible software infrastructure.

3.4 Problem Solution fit :

1. CUSTOMER SEGMENT(S)

Residential Buildings Streets Commercial Buildings and College Campuses Homes Public Places Hospitals.

2.CUSTOMER CONSTRAINTS

Lack of Waste Collecting Points Irregularity of Waste Collection Inadequate Waste Collection Vehicles Inadequate Access to Waste Bins Alternatives to Final Waste Disposal (Burning and Illegal Dumping) Improper Waste Separation Facilities.

3. TRIGGERS

Real-time waste monitoring. Predictions for bin fullness. Detailed database of bins and stands. Interactive bin map including Street view. Route planning for waste collection.

4.JOBS TO-BE-DONE / PROBLEMS

The dumps are a source of complex pollution (air, water, soil, and biodiversity) which threatens the public health. Mixed waste fractions (municipal, agricultural, construction and demolition, WEEE, bulk items), including hazardous streams, are disposed in such sites causing serious public health issues.

5.ROOT CAUSES

Smart waste management is characterized by the usage of technology in order to be more efficient when it comes to managing waste. 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.

6.BEHAVIOUR

First, setup Smart Garbage Management System in the public places Take survey on the usage and drawbacks if any. If the people are

satisfied with the demo, then Setup the smart Waste Management system in all places.

7.SOLUTION

If in any area waste overloaded is detected the admins will be notified along with the location. In the web application, admins can view the sensor parameters. The parameters like hazardous waste levels and location data are published to the Watson IoT platform. The device will subscribe to the commands from the application and take decisions accordingly and sensor data is visualized in the Web Application.

4.REQUIREMENT ANALYSIS

4.1Functional requirement :

Following are the functional requirements of the proposed solution.

FR.NO	FUNCTIONAL REQUIREMENTS	SUB REQUIREMENTS
1	User Registration	Registration through Form Registration through Gmail Registration through LinkedIn
2	User Confirmation	Confirmation via Email Confirmation via OTP
3	Authentication	The system sends an approval request after the user enters personal information.
4	User Interface	It should be the connector between the various systems or between other part or unit of the system.
5	Software interface	This includes embedded application that will used in supporting the various functions of the system Eg: GPS, Web Server and Database

Non-functional Requirements:

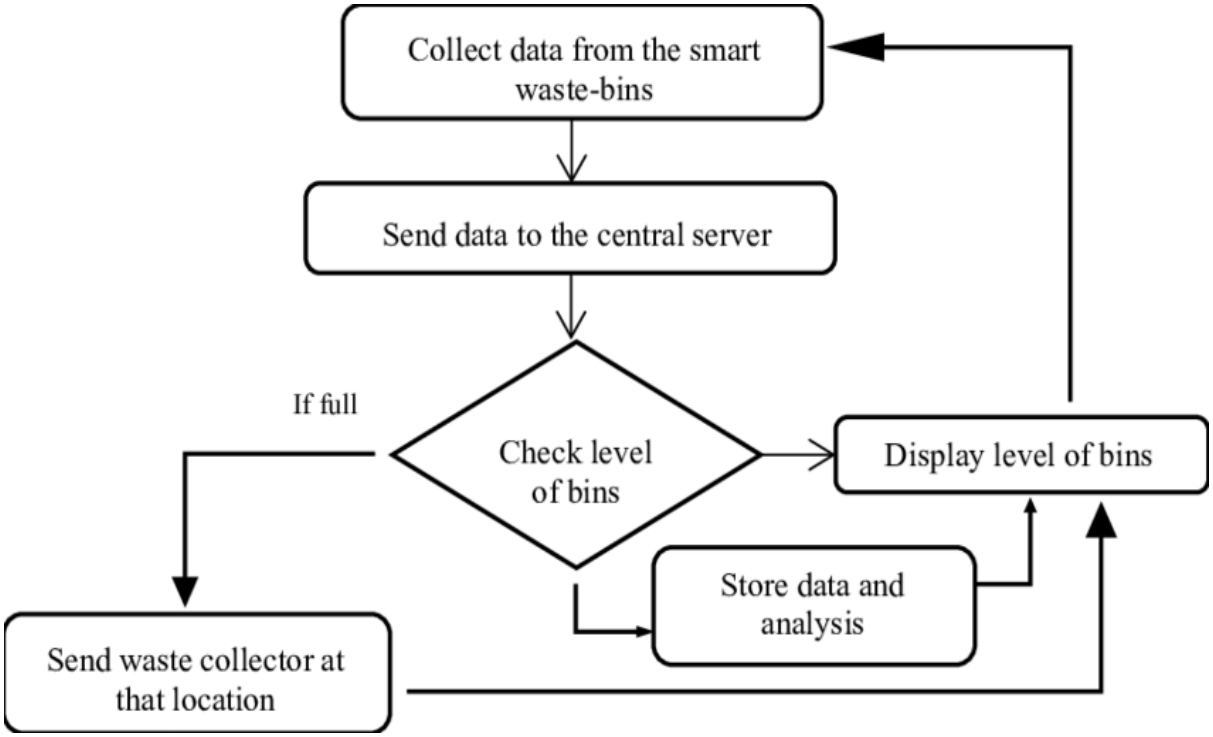
Following are the non-functional requirements of the proposed solution.

NFR.NO	NON FUNCTIONAL REQUIREMENTS	EXPLANATION
1	Usability	Ease with which the user is able to learn, operate and prepare inputs and interpret outputs through interaction with the system.
2	Security	Extend to which the system is safeguarded against deliberate and intrusive faults from internal and external sources.
3	Reliability	Extend to which the software systems consistently perform the specified functions without any failures.
4	Performance	System performance of handling capacity, throughput and response time.
5	Availability	Degree to which the users can depend on the system to be up during normal operating times.
5	Scalability	Degree to which the system is able to expand its processing capabilities upward and outward with business growth.

5.PROJECT DESIGN

5.1 Data Flow Diagram :

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.



5.2 Solution & Technical Architecture :

Table -1: Components & Technologies

S.No	Components	Description	Technology
1.	User Interface	Web Portal	HTML,CSS,NodeRed, Javascript.
2.	Application Logic-1	Tocalculatethedistance of dreck and show the real time level in web portal , information getting via ultra sonic sensor and the alert message activate with python script to web portal.	Ultrasonic sensor/ Python.
3.	Application Logic-2	To calculate the weight of the garbage and show the real time weight in web portal, this info getting via load cell and the alert message activate with python to web portal.	Loadcell/Python
4.	Application Logic-3	GettinglocationoftheGarbage.	GSM/GPS.

5.	Cloud Database	Database Service on cloud.	IBM DB2, IBM Cloudant etc..
6.	File Storage	File Storage requirements.	GitHub, Local file System.
7.	External API-1	Firebase is a set of hosting services for any type of application	Firebox.
		It offers NoSQL and real-time hosting of databases, content, social authentication, and notifications, or services, such as a realtime communication server.	
8.	Ultrasonic Sensor.	To throw alert message when garbage is getting full. Distance Recognition Model.	Distance Recognition Model.
9.	Infrastructure (Server/Cloud).	Application Deployment on Local System / Cloud Local Server Configuration: localhost Cloud Server Configuration: localhost, Firebox	Localhost, Web portal.

Table-2: Application Characteristics:

S No	Characteristics	Description	Technology
1.	Open -Source Framework	NodeRed**,**Python**,**IBMSimulator**.**	Iot.

2.	Security Implementation	Raspberry Pi is connected to the internet and for example used to broadcast live data, further security measures are recommended and use the UFW(uncomplicated Firewall).	Iot.
3.	Scalable Architecture	Raspberry pi:Specifications Soc: rspi ZERO W CPU: 32-bit computer with a 1 GHz ARMv6 RAM: 512MB	Iot.
		Networking: Wi-Fi Bluetooth: Bluetooth 5.0, Bluetooth Low Energy (BLE). Storage: MicroSD GPIO: 40-pin GPIO header, populated Ports: micro HDMI 2.0, 3.5mm analogue audiovideo jack, 2x USB 2.0, 2x USB 3.0, Ethernet Dimensions: 88mm x 58mm x 19.5mm, 46g	
4.	Availability	These smart bins use sensors like ultrasonic and load cell to send alert message about the trash level recognition technology, and artificial intelligence, enabling them to automatically sort and categorize recycling litter into one of its smaller bin.	Iot.

5.	Performance	Number of request:RPI manages to execute 129-139 read requests per second.Use of Cache:512mb Use of CDN's:Real time	Iot/web portal.

5.3 Customer Journey:

Use the below template to create product backlog and sprint schedule

User Type	**Functional Requirement (Epic)**	**User Story Number**	**User Storey Or Task**	**Acceptance Criteria**	**Priority**	**Release**
Customer	Registration	USN-1	As a user I can register for the product through mail.	I can access my account	High	Spirit-1
		USN-2	As a user I can say demerits of product		Medium	Spirit-1
		USN-3	As a user I can access procedure to use product		High	Spirit-1
		USN-4	As a user I	I can register &	Low	Spirit-2

			can register via face book and whatsap p	access the dashboard with Face book Login		
		USN-5	As a user i can get my own passwor d to access dashboar d	I can receive confirmati on email & click confirm	High	Spirit-1
Customer (Web User)						
Customer Care Executive						
Administrat or						

6.PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation:

Estimation is done by the entire team during Sprint Planning Meeting. The objective of the Estimation would be to consider the User Stories for the Sprint by Priority and by the Ability of the team to deliver during the Time Box of the Sprint.

6.2 Sprint Delivery Schedule:

Sprint	**Functional Requirement (Epic)**	**User Story Number**	**User Story / Tas**
Sprint-1	Registration	USN-1	As a user, I can r email, password,

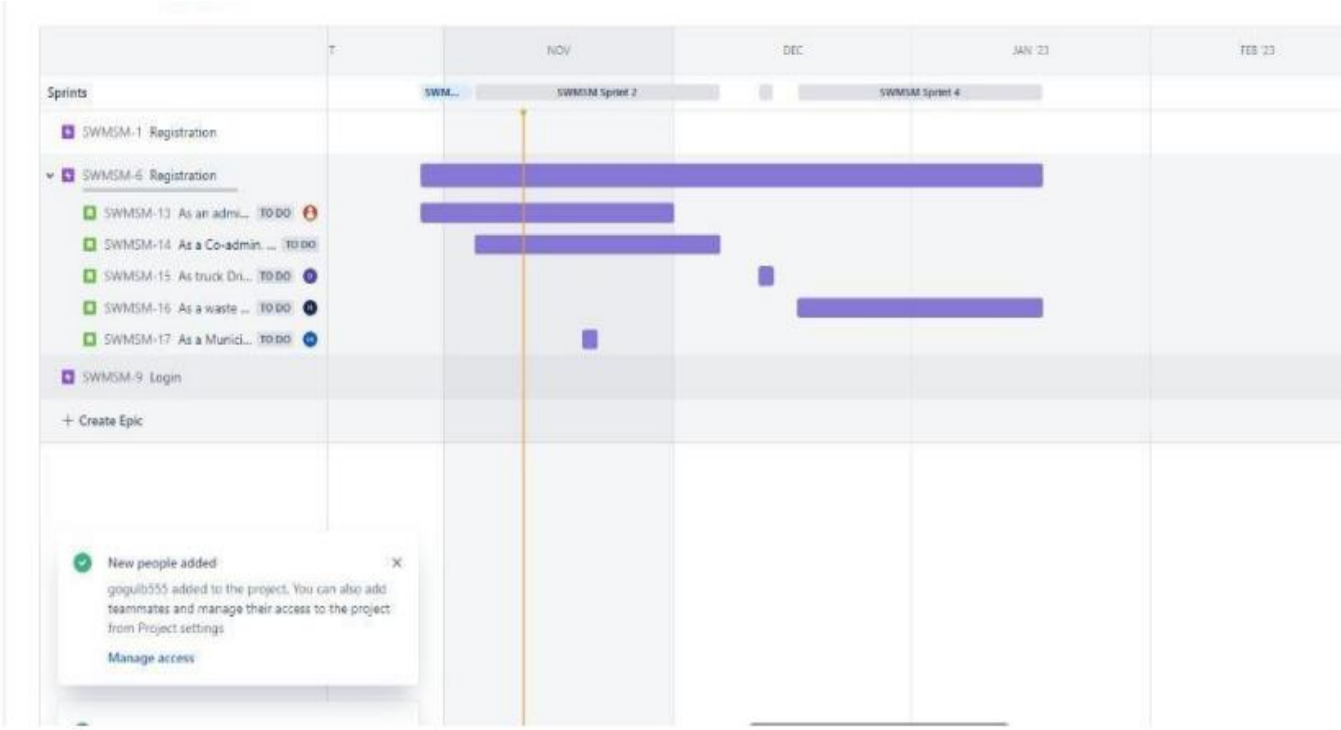
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Tas
Sprint-1		USN-2	As a user, I will registered for the
Sprint-2		USN-3	As a user, I can Facebook.
Sprint-1		USN-4	As a user, I can
Sprint-1	Login	USN-5	As a user, I can password.
Sprint-1	Dashboard	USN-6	As a user, I can use the dashboar use the app
Sprint-1	Login and Dashboard	USN-7	As a web app us email and passw mobile users.
Sprint-1	Login	CCE1	As a CCE I can can interact with
Sprint-1	Dashboard	CCE2	As a CCE I can I can see all user queries.
Sprint-1	Login and Dashboard	A1	As an administra manage and dire

Project Tracker, Velocity & Burndown Chart:

Sprint	Total Story Points	Duration	Sprint Start Date
Sprint-1	20	6 Days	24 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022
Sprint-3	20	6 Days	07 Nov 2022

Sprint	Total Story Points	Duration	Sprint Start Date
Sprint-4	20	6 Days	12 Nov 2022

6.3 Reports from JIRA:



7.CODING & SOLUTIONING

7.1 Feature 1 :

Code for Data Transfer from Sensors:

```
#include //library for wifi
#include //library for MQTT
#include LiquidCrystal_I2C
lcd(0x27, 20, 4); // credentials of IBM Accounts –
#define ORG "el2iyd" //IBM organisation id
#define DEVICE_TYPE "NodeMUC" // Device type mentioned in
ibmwatsoniot platform
#define DEVICE_ID "12345" // Device ID mentioned in ibmwatsoniot 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"; 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
WiFiClientwifiClient; // creating instance for wificlient
PubSubClientclient(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();
```

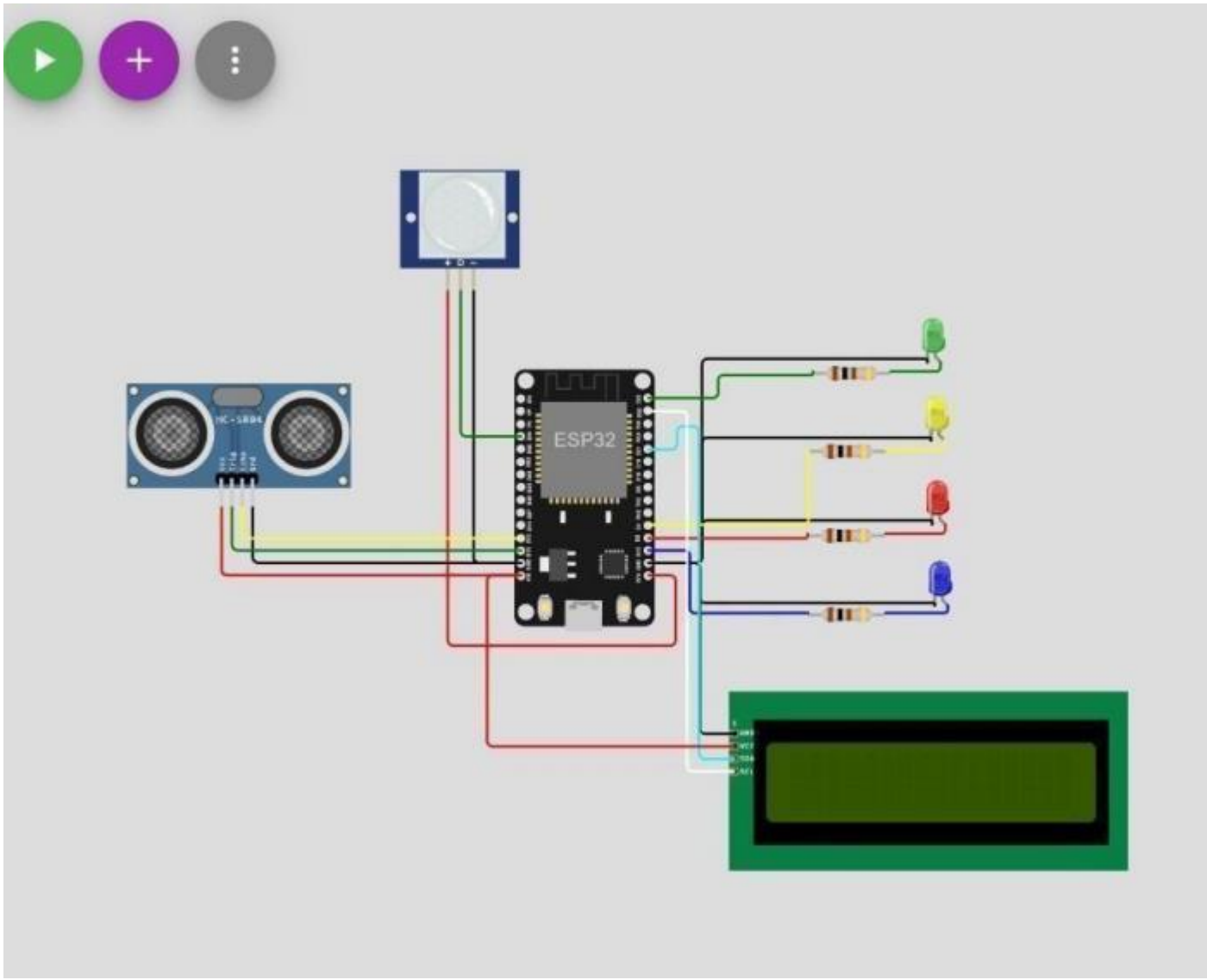
```
delay(500);
if (!client.loop())
 {
mqttConnect(); //function call to connect to IBM
}
 } /* -retrieving to cloud */
 void wifiConnect()
 {
Serial.print("Connecting to ");
Serial.print("Wifi");
WiFi.begin("Wokwi-GUEST", "", 6);
while (WiFi.status() != WL_CONNECTED)
 {
delay(500);
Serial.print(".");
 }
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 Detected");
Serial.println("Lid 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!!!,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 > 150 && cm < 250)
 {
digitalWrite(4, HIGH);
```

```
Serial.println("Warning!!,Trash 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("Lid Closed");
 }
 else { Serial.println("No motion 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();
 }
```

OUTPUT:



8. TESTING

8.1Test Cases

Test case description	Required input	Information and relat requirements
The user or concerned service provider should register with the required details	User input details for registration	User Name, Email ID Phone Number, and Secu Password
The user or concerned service provider tried to log in to the monitoring portal with registered details	User login details	User Name, Security Password
Monitoring website portal indicating home, user, SGB status	User monitoring home screen should be display	The developed prototype Smart Garbage Bin mus kept 'ON.'

8.2User Acceptance Testing:

How to prepare for user acceptance testing

User acceptance testing validates changes you make to your software stack so that business is unhindered and continues to run as usual. Successful UAT testing requires careful planning, scoping, and execution.

Planning:

Start by gathering the information needed to create a comprehensive test. A dedicated testing application instead of spreadsheets providesqualitative data and reportable metrics. Using spreadsheets for testing presents many challenges for test managers and testers.

Planning, implementing, monitoring, and evaluating the UAT results requires constant input from multiple stakeholders. Test managers try to meet this challenge with Excel spreadsheets that serve as planning and evaluation tools. However, spreadsheets are not an application dedicated to testing.

Opt for a dedicated testing management solution that reports and monitors project progress in real time, including standard reports that track tests and defects by cycle and business process.

Scoping:

Not all business processes need to be tested, so you must define your project's scope beforehand. What to test is the million dollar question. Too much to test, and you run out of time. Too little, and you risk not testing enough. Input from key business users is essential when determining the scope of your project.

However, it's troublesome to repeatedly ask your users to list the most critical business processes to be tested and the problems that arise for each new feature. When opting for a UAT management solution, focus on key user adoption. The solution should be intuitive, easy to use, and offer easy onboarding that accelerates self-directed learning.

A testing management solution can also automatically record tests for documentation and play them back for scripting. Eliminating the overhead associated with realigning each project encourages users to focus on testing activities and increases productivity.

Execution, evaluation, and monitoring:

An automated execution process helps troubleshoot and decide whether it's possible to proceed with production. Most businesses think of "automation" first to make testing easier. The formula for user acceptance testing has not yet been fully cracked. Due to the high reliance on visual user interface elements, most companies do not automate UAT.

However, aspects of UAT related to workflows, business processes, collaboration, and error management can certainly be automated. Automated execution processes offer the ease and convenience of automation and the precision and understanding of manual testing.

UAT also needs to be managed along with your entire testing project so you can see the complete picture from kickoff to change delivery.

9. RESULTS

9.1Performance Metrics:

- **OPERATION:** Automatic sensor based operation with zero manual intervention
- **HYGIENIC:** Hygienic disposal with automatic and touch-less waste disposal
- **GERM KILLING:** UVC technology kills germs and bacteria inside the bin

- **DISPLAY:** Smart indicators on the front display panel
- **DEODORIZER:** Foul odour elimination
- **DURABLE & LONG LIFE:** Made with high quality materials for a long durable life
- **ENERGY EFFICIENT:** Low power consumption; lesser than a light bulb!
- **SLEEK & COMPACT DESIGN:** Designed to fit in small spaces and add to the aesthetics of your premises
- **SUITABLE FOR:** Paper waste, plastic waste, food waste, and other commonly generated waste
- **WIDELY USED IN:** Restaurants, food courts, hotels, offices, ships, trains, airports, adventure parks and other premium places.
- **REMOTE WASTE LEVEL MONITORING:** Inbuilt with RecycloBinUltraEye waste level sensors and integrated with smart IoT app, RecycloBin Smart Assist.

10. ADVANTAGES & DISADVANTAGES

ADVANTAGES:

*Improve Productivity and Performance.

*Increase Profitability.

*Boost Sustainability.

*Superior Customer Engagement.

*Become a Smart City.

*Enhance Safety.

DISADVANTAGES:

*Misunderstanding of the operations of smart sensors: Because this is a new and emerging technology, there is a general misunderstanding of its operations

*Setting up the smart sensor

*Non-optimized truck routes

*Recycling

*Non-uniform waste distribution of waste in bins.

11. CONCLUSION:

The behaviour of generating garbage is too dangerous not only for today's generation, but also for future generations. It is critical to educate

people and encourage them to practise Recycle, Reuse, and Reduce instead of producing waste. Waste disposal should be a priority for municipalities and governments.

12. FUTURE SCOPE:

Total of approximately 143,449 MT of municipal waste is generated daily. However, only 35,062 tons of waste is treated. A report from MNRE says that waste generation is expected to reach 300 million tons annually by the year 2047.There are four tiers to waste management to reduce its environmental impact: pollution prevention and source reduction; reuse or redistribution of unwanted, surplus materials; treatment, reclamation, and recycling of materials within the waste; and disposal through incineration, treatment, or land burial.

13. APPENDIX

Source Code

database.js:

```
const cap_status = document.getElementById('cap_status');
const alert_msg = document.getElementById('alert_msg');

var ref = firebase.database().ref();

ref.on("value", function(snapshot)
 {
snapshot.forEach(function (childSnapshot) {
      var value = childSnapshot.val();

            const alert_msg_val = value.alert;
            const cap_status_val = value.distance_status;
```

```
                    alert_msg.innerHTML= `${alert_msg_val}`;
                });
            }, function (error) {
            console.log("Error: " + error.code);
            });
```

index.html

```
<!DOCTYPE html>
<html>
<head>
<link rel="stylesheet"
href="https://cdn.jsdelivr.net/npm/bootstrap@4.3.1/dist/css/bootstrap.min.css"
integrity="sha384-
ggOyR0iXCbMQv3Xipma34MD+dH/1fQ784/j6cY/iJTQUOhcWr7x9JvoRxT2
MZw1T" crossorigin="anonymous">
<meta charset="utf-8">
<meta name="viewport" content="width=device-width">
<title>Garbage Management System</title>
<link rel="icon" type="image/x-icon" href="/Images/DUMPSTER.png">
<link href="style.css" rel="stylesheet" type="text/css" />
<script src="https://www.gstatic.com/firebasejs/8.10.1/firebase-
app.js"></script>
<script src="https://www.gstatic.com/firebasejs/8.10.1/firebase-
database.js"></script>
<script>
var firebaseConfig =
{
apiKey: "AIzaSyB9ysbnaWc3IyeCioh-aJQT_UCMd5CBFeU",
authDomain: "fir-test-923b4.firebaseapp.com",
databaseURL: "https://fir-test-923b4-default-rtdb.firebaseio.com",
```

```
projectId: "fir-test-923b4",
storageBucket: "fir-test-923b4.appspot.com",
messagingSenderId: "943542145393",
appId: "1:943542145393:web:9b5ec7593e6a3cbd7966d0",
measurementId: "G-BN7JNX1Q7B"
};
firebase.initializeApp(firebaseConfig)
</script>
<script defer src="database.js"></script>
</head>
<body style="background-color:#1F1B24;">
<script src="map.js"></script>
<div id="map_container">
<h1 id="live_location_heading" >LIVE LOCATION</h1>
<div id="map"></div>
<div id="alert_msg">ALERT MESSAGE!</div>
</div>
</div>
<center><a href="https://goo.gl/maps/G9XET5mzSw1ynHQ18"
type="button" class="btnbtn-dark">DUMPSTER</a></center>
<script
src="https://maps.googleapis.com/maps/api/js?key=AIzaSyBBLyWj-
3FWtCbCXGW3ysEiI2fDfrv2v0Q&callback=myMap"></script></div>
</body>
</html>
```

GitHub Link: https://github.com/IBM-EPBL/IBM-Project-26023-1659980047