

**SMART WASTE MANAGEMENT SYSTEM**  
**FOR METROPOLITAN CITIES**  
**DOMAIN – INTERNET OF THINGS (IoT)**

**A PROJECT REPORT**

SUBMITTED BY

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In the partial fulfillment of the requirements for the award of a degree of  
BACHELOR OF ENGINEERING in ELECTRONICS AND COMMUNICATION  
ENGINEERING

**KONGU ENGINEERING COLLEGE**

**PERUNDURAI-ERODE**

**2022 – 2023**

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# **CHAPTER 1**

## **1.INTRODUCTION**

Internet of Things is the applications performing with the help of internet access. IoT Communication over the internet has grown from user - user interaction to device – device interactions these days. The IoT concepts were proposed years back but still it's in the initial stage of commercial deployment. Growth of IoT is been rapid in the home automation and transportation industries. The basic idea of the project is to design a smart waste detection system which would automatically notify the workers of the municipality, the current status of various garbage bins in the city, with the help of real-time monitoring capabilities, which would be remotely controlled using IoT techniques. This paper introduces you to the use of IoT in Garbage Detection and see how this can also be a major part of developing a city into a smart city.

### **1.1.Project Overview**

The rapid growth in the urbanization rate portrays the waste management in the urban cities as a big challenge and thus there is a need of sustainable urban development plans. In order to achieve this, the smart city plan is in the trend recent days and a huge role is played by the smart waste management system. There needs to be a system that gives prior information of filling of the bin that sends alert messages to the municipality so that they can clear the garbage when it is overflowed and safeguard the environment. To achieve a clean and

hygienic environment, a solution called "Smart Garbage Bin" is proposed, which will send alarm and inform the authorized person when the bin is about to fill. Then message will be sent to the authorized person who will be able to collect or assist to collect the garbage from the particular area. with the help of web application by sending a SMS. This system maintains the dry wastes and wet wastes separately. This will help to reduce the overflow of the garbage bin and thus keeping the environment clean.

## **1.2.Purpose**

This project helps the citizens to keep their surroundings and environment clean, pollution free and lead a healthy life throughout. It avoids the garbage overflow, which makes the environment unhygienic, paves way for air-borne and water- borne diseases , etc..

## **CHAPTER 2**

### **2. LITERATURE SURVEY**

#### **2.1.EXISTING PROBLEM**

Increasing waste generation has become a significant challenge in developing countries due to unprecedented population growth and urbanization. From the literature, many issues have been investigated that signify direct connection with the increase in waste material generation and related difficulties to handle it in a smart city. These issues are the resultants of an improper collection and disposal mechanism used for waste material, the increase in moving trends of peoples toward big cities and lack of intelligent technology used to support the municipal solid waste management system. Consequently, the management of waste material has become a challenge due to a large amount of waste littered everywhere. Furthermore, various problems also occur due to the existing systems that are not only inadequate and inefficient but also their non-scientific procedures involved in the solid waste management. In this paper, an IoT-based smart waste bin monitoring and municipal solid waste management system is proposed. This system helps to solve the problems associated with management of waste material and the IoT-based waste collection for the smart city as discussed above. The proposed system is capable in the collection of waste effectively, detection of fire in waste material and forecasting of the future waste generation. The IoT-based device performs the controlling and monitoring of the electric bins. These devices are wirelessly connected with the central hub to transmit the information about the bins filling level with the existing location. The significant advantage of the system is to collect waste material on time in order to avoid the overflow of bins that would help in saving the environment from pollution.

#### **Disadvantages of Existing System**

- Time Consuming and Less Effective.

- Overflow of Waste from the bin.
- Stinky smell and unpleasant situations.

## **PROPOSED SYSTEM:**

In this proposed system there will be no issues repeated that of previous system. In this system the bin is designed in such a way that when the waste level reaches the threshold limit it automatically closes the bin and intimates the alert to the admin . The bins are provided with low cost embedded device which helps in tracking the level of the garbage bins and a unique ID will be provided for every dustbin in the city .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 bin. The admin can monitor the level of the bin and can trace the location where it exists.

## **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 .

## **2.2.REFERENCES:**

- [1] Ikuo Ihara; Nagaoka University of Technology; Ultrasonic Sensing; Fundamentals and Its Applications to Non-destructive Evaluation.
- [2] Arduino, “Available at <http://www.arduino.cc>,” 2010.
- [3] M. Batty, “Smart Cities, Big Data,” Environment and Planning B: Planning and Design 2012, vol. 39, pp. 191– 93.
- [4] Xu Li, Student Member, IEEE, Performance Evaluation of Vehicle-Based Mobile Sensor Networks for Traffic Monitoring.

[5] Yusuf Abdullahi Badamasi, The Working Principle Of An Arduino, Electronics, Computer and Computation (ICECCO), 2014 11th International Conference on 29 Sept.-1 Oct. 2014.

### 2.3.Problem Statement

The waste management system provided earlier are not very reliable, efficient, cost effective and does not have any advanced processing features like automatic close of bin and alert intimations system. The following is a well-articulated problem statement that allows you to find the ideal solution for the challenges faced.

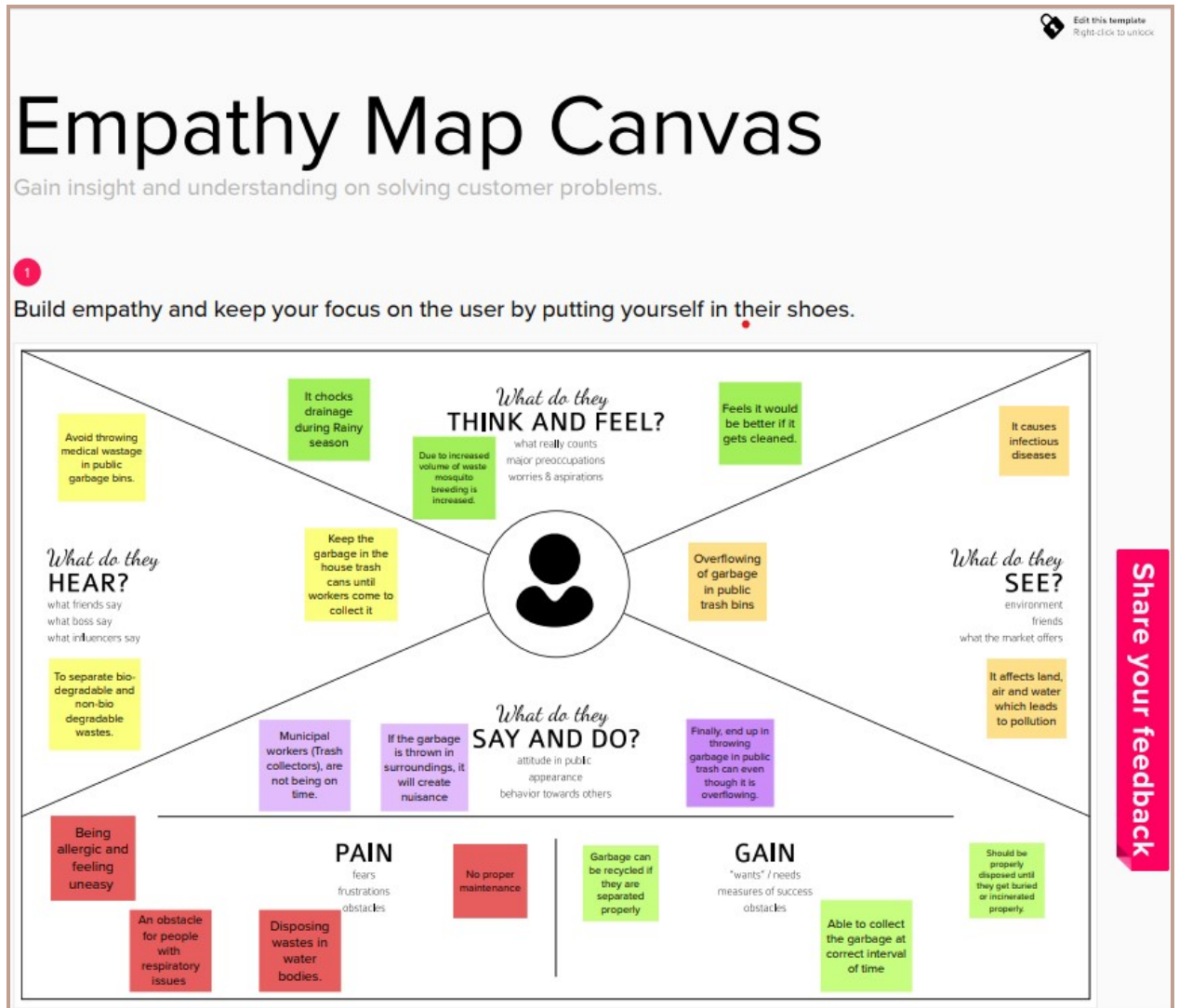




## CHAPTER 3

### 3.IDEATION & PROPOSED SOLUTION

#### 3.1.EMPATHY MAP CANVAS



## 3.2.IDEATION AND BRAINSTORMING

### Brainstorm & idea prioritization

Use this template in your own brainstorming sessions as your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

- 6 Minutes 1 person
- 2 Minutes 1 person
- 2 Minutes 1 person

Start template link

#### Before you collaborate

After all participants have signed up, add to the session from which you want to be going.

Start template

After all participants have signed up, add to the session from which you want to be going.

Start template

After all participants have signed up, add to the session from which you want to be going.

Start template

#### Define your problem statement

What problem are you trying to solve? Frame your problem as a clear, specific statement. This will be the focus of your brainstorm.

Start template

After all participants have signed up, add to the session from which you want to be going.

Start template

#### Brainstorm

Write down any ideas that come to mind. Don't edit or judge your ideas.

Start template

After all participants have signed up, add to the session from which you want to be going.

Start template

#### Group ideas

Discuss and group your ideas into clusters. Grouping ideas is a great way to see if you have a larger idea that is only one, or if you have a larger idea that is only one.

Start template

After all participants have signed up, add to the session from which you want to be going.

Start template

#### Prioritize

Now you should all be at the same page about which ideas are most important. Prioritize your ideas by placing them on the grid. Ideas are important and which are feasible.

Start template

After all participants have signed up, add to the session from which you want to be going.

Start template

#### After you collaborate

You can export the board as an image or PDF. It's a great way to share your ideas with your team and to keep track of your progress.

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Start template

### 3.3. PROPOSED SOLUTION

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Indiscriminate disposal of solid waste is a major issue in urban centers of most developing countries and it poses a serious threat to healthy living of the citizens. Access to reliable data on the state of solid waste at different locations within the city will help both the local authorities and the citizens to effectively manage the menace.
2.	Idea / Solution description	To develop the intelligent solid waste monitoring system using Internet of Things (IoT) and cloud computing technologies. The fill level of solid waste in each of the containers, which are strategically situated across the communities, is detected using ultrasonic sensors.
3.	Novelty / Uniqueness	Analysing the different type of waste.
4.	Social Impact / Customer Satisfaction	Customer satisfaction is an important goal. To meet this goal ,it is necessary to use an evaluation model for measuring the customer satisfaction level. Some important criteria such as, Quality of trash bin ,responsibility of municipal etc. are distinguished and used in the proposed model.

5.	Business Model (Revenue Model)	Smart waste management is one of the essential component of today's technology. It will reduce the waste in cities and reduce the man power.It help
		to calculate types of waste and amount of the waste. The waste management services take care of a healthy environment allowing optimization of the utilities and prevent overloading the carrier for waste disposal
6.	Scalability of the Solution	We can use the capacitance sensor in the bin continuously monitors the level of the bin in real time and communicates to the central cloud where the bins are connected. Ultrasonic sensor is used to open and close the lid of the bin whenever the persons are nearby the bin.

## 3.4.PROBLEM SOLUTION FIT:

Smart Waste Management			TEAM ID: PNT2022TMD04731
Define CS, fit into CC	<b>1. CUSTOMER SEGMENT(S)</b> Who is your customer? <u>working parents of 0-5 kids</u> <ul style="list-style-type: none"> <li>Public</li> <li>Garbage collection team, Municipalities.</li> </ul>	<b>6. CUSTOMER CONSTRAINTS</b> What constraints prevent your customers from taking action or limit their choices of solutions? <u>spending power, budget, no cash, network connection, available devices.</u> <ul style="list-style-type: none"> <li>Maintain clean environment.</li> <li>Lack of waste management.</li> <li>Automation of garbage bins.</li> </ul>	<b>5. AVAILABLE SOLUTIONS</b> Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros & cons do these solutions have? <u>pen and paper is an alternative to digital notetaking</u> <ul style="list-style-type: none"> <li>Separation of garbage into biodegradable and non-biodegradable.</li> <li>Recycling of waste and making a useful byproduct.</li> <li>Digital information should be made in order to collect the data to achieve efficiency, transparency and sustainability.</li> </ul>
	<b>2. JOBS-TO-BE-DONE / PROBLEMS</b> Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides. <ul style="list-style-type: none"> <li>To reduce the contamination of disease.</li> <li>To control the overflow of garbage.</li> <li>To intimate the Municipalities when the garbage limit is exceeded.</li> </ul>	<b>9. PROBLEM ROOT CAUSE</b> What is the real reason that this problem exists? What is the back story behind the need to do this job? <u>customers have to do it because of the change in regulations.</u> <ul style="list-style-type: none"> <li>The over flow of waste in garbage bins is not monitored regularly.</li> <li>Lack of proper waste management makes the environment unclean which may lead to various diseases.</li> </ul>	<b>7. BEHAVIOUR</b> What does your customer do to address the problem and get the job done? <u>directly related: find the right solar panel installer, calculate usage and benefits; indirectly associated: customers spend free time on volunteering work (i.e. Greenpeace)</u> <ul style="list-style-type: none"> <li>In order to control the overflow of garbage a sensor is to be inserted and thus the overflow of garbage is controlled leading to a clean environment.</li> </ul>
<b>3. TRIGGERS</b> ONLINE? <u>seeing their garbage, installing solar panels, reading about a more efficient solution in the news.</u> <ul style="list-style-type: none"> <li>By seeing the neighboring countries, <u>it makes us to do things and by come to know the startup ideas.</u></li> </ul>	<b>10. YOUR SOLUTION</b> If you are working on an existing business, write down your current solution first, fit it in the canvas, and check how much it fits reality. If you are working on a new business proposition, then keep it blank until you fit it in the canvas and come up with a solution that fits within customer limitations, <u>it solves problem and matches customer behaviour</u> <ul style="list-style-type: none"> <li>In the present situation, the garbage overflow is not collected regularly sometimes thus results in pollution.</li> <li>Here we use IOT based application in which the garbage management is automated.</li> <li>Sensors are used to note the garbage level and send alert messages accordingly along with there's a web portal shows the location of garbage for easier access.</li> </ul>	<b>8. CHANNELS of BEHAVIOUR</b> What kind of actions do customers take online? Extract online channels from #7 <ul style="list-style-type: none"> <li>With the results from the sensors and the corresponding location from the portal we can easily <u>identify the garbage location i.e., from where the alert messages are received.</u></li> </ul>	
<b>4. EMOTIONS: BEFORE / AFTER</b> How do customers feel when they face a problem or a job and afterwards? <u>lost, insecure &gt; confident, in control - use it in your communication strategy &amp; design</u> <ul style="list-style-type: none"> <li>Before solving the problem people feels more difficulties such as <u>unclean environment, bad odour due to overflowing and unattended waste.</u></li> <li>After solving the problem they feel comfortable than the previous system of the waste management and be <u>less worried about the contaminated diseases</u></li> </ul>		<b>OFFLINE</b> What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development. <ul style="list-style-type: none"> <li>The separated garbage on the basis of the given input were collected and the ones which could be recycled are converted into products.</li> </ul>	

Problem-Solution fit canvas is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 license  
 Created by Daria [www.amaltama.com](https://www.amaltama.com) / Amaltama.com

**AMALTAMA**

## CHAPTER 4

### 4. REQUIREMENT ANALYSIS

#### 4.1.FUNCTIONAL REQUIREMENT

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Fitting IoT device in the trashcans.	The IoT device need to be fixed in the dustbin with water proof safety. The IoT device consists Ultrasonic sensor,level sensor,Servo motor,LCD. To send data to the cloud GSM/GPRS is used.
FR-2	Connecting to the cloud.	The device should configure to connect to the cloud. The data of sensors need to be received and processed.
FR-3	Predictions for bin fulness.	In this system, a 24×7 monitoring system is designed for monitoring dumpsters, A smart and organized system is designed for selective clearing the ultrasonic sensor is used for measuring the level of waste in the dustbin, DC motor powered platform is to open the lid of the dustbin.Level sensor is used to the dustbin to be indicated full or not.If either of the containers is full then an alert message is sent from the dustbin to employees and the cloud. In turn, employees can clear the corresponding dumpster.
FR-4	Real-time waste monitoring	Trash and recycling containers can be outfitted or produced with low-cost sensors that monitor everything from the amount and types of material in a container to temperature, odour and location of the bin.
FR-5	Do not miss a pick	For periodically picked bins, we provide Pick evaluation. The tool records picks (sensor) and compares them to the schedule. Authorized person can immediately identify any missed, or off-schedule picks.

FR-6	Routes to the dumpsters	Based on current bin fill-levels and predictions of reaching full capacity, you are ready to respond and schedule waste collection driver can compare planned vs. executed routes to identify any inconsistencies.
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## 4.2.NON-FUNCTIONAL REQUIREMENT

FR No.	Non-Functional Requirement	Description
NFR-1	<b>Usability</b>	IoT solutions for waste management problems offer municipalities data intelligence and real- time insights. In that regard, 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.
NFR-2	<b>Security</b>	Building and deploying IoT-based smart waste management in cities can be a complex, time- consuming and resource- intensive process. Many municipal IT departments will not have the resources or in-house skills to support such a project internally.

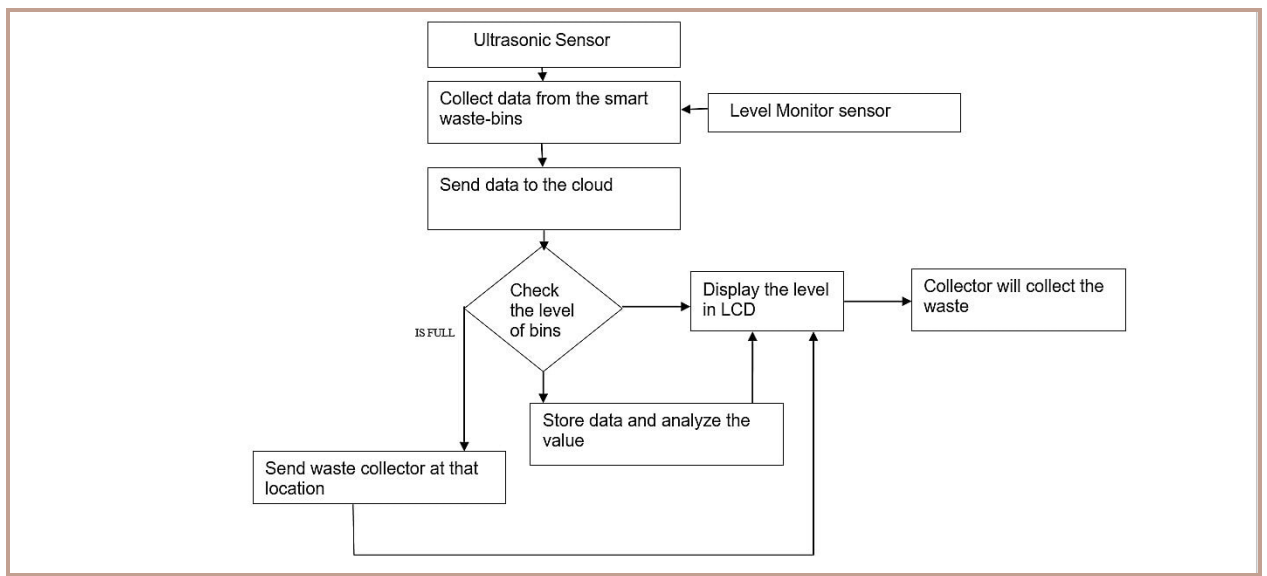
NFR-3	<b>Reliability</b>	One of the difficult operational problems of municipal and local authorities are facing is the collection of municipal solid waste. In recent years, due to environmental concerns and number of costs, most of the municipalities have been forced for assessing their solid waste management and examining their cost- effectiveness and environmental impact, for example, designing the collection of routes. During the past 15 years
NFR-4	<b>Performance</b>	An integrated Arduino program is developed to synchronize the identification system, automated lid system, micro-controller, display system, and communication system. An ultrasonic sensor is attached to the front side of the garbage bin. The transmitter of the ultrasonic sensor emits an ultrasonic sound that is beyond the human ear listening range, and the receiver receives the reflected sound waves by the solid objects.
NFR-5	<b>Availability</b>	Another purpose of this project is to make the proposed waste management system as cheap as possible. A cost in BDT is presented in the following Table 3 needs for the construction of the proposed smart bin.
NFR-6	<b>Scalability</b>	The city diverts about 80% of its waste from landfills and hopes to go “zero waste” by the end of 2020. Besides strict regulations and high waste management fees for end consumers and businesses.



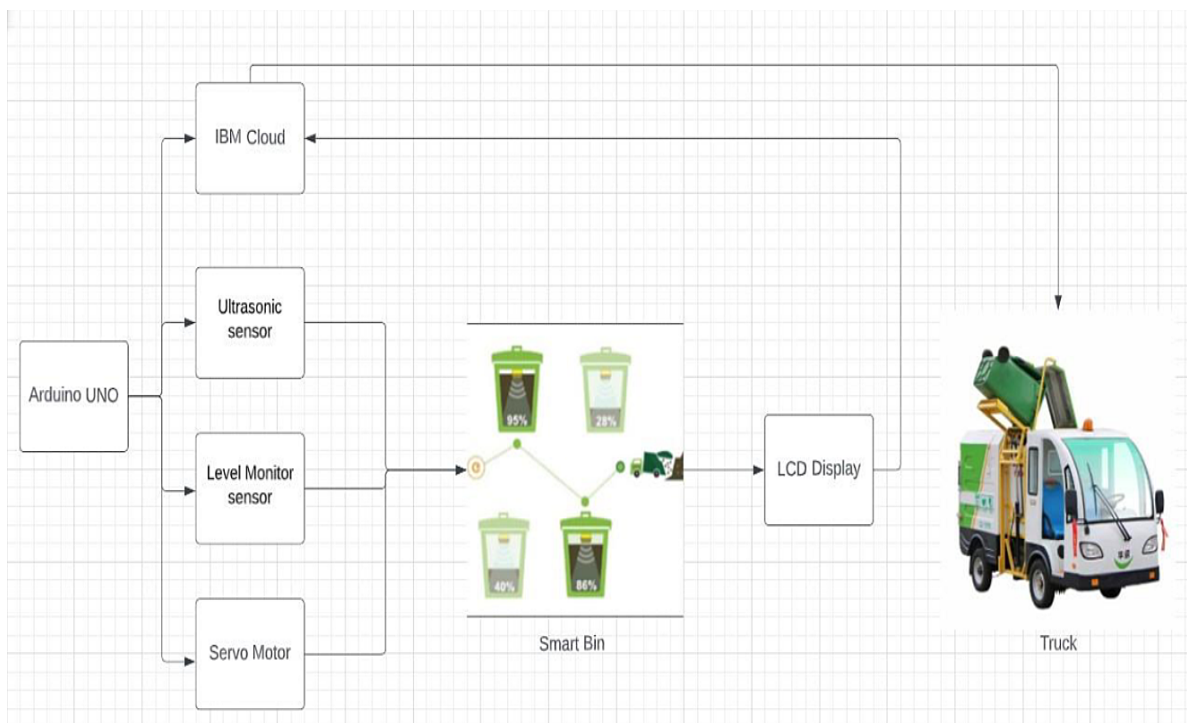
## CHAPTER 5

### 5.PROJECT DESIGN

#### 5.1.DATA FLOW DIAGRAM



#### 5.2.SOLUTION ARCHITECTURE AND TECHNICAL ARCHITECTURE



### 5.3.USER STORIES

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Admin	Registration	USN-1	As an admin, I give user id and password to every worker and manage them	I can manage account/dashboard	Medium	Sprint-1
Co admin	Supervision	USN-2	As a Co Admin , I'll manage the garbage level monitor, If the garbage <u>get</u> filled alert I will post location and garbage id to trash truck	I can manage garbage monitoring	High	Sprint-1
Truck Driver	Maintenance	USN-3	As truck driver , I'll follow the route send by Co Admin to reach the filled garbage	I can drive to reach the garbage filled route in shortest route given	Medium	Sprint-1
Local Garbage Collector	Maintenance	USN-4	As a Waste Collector , I'll collect all the trash from garbage and load into garbage truck and send them to landfill	I can collect trash and pulled to truck and send off	Medium	Sprint-1
Municipality	Maintenance	USN-5	As a Municipality , I'll check the process are happening in discipline manner without any issues	I can manage all these processes going good	High	Sprint-1

## CHAPTER 6

### 6. PROJECT PLANNING AND SCHEDULING

#### 6.1. SPRINT PLANNING AND ESTIMATION

TITLE	DESCRIPTION	DATE
Literature Survey & Information Gathering	Literature survey on the selected project & gathering information by referring the, <u>technical papers, research publications etc.</u>	10 SEPTEMBER 2022
Prepare Empathy Map	Prepare Empathy Map Canvas to capture the user Pains & Gains, Prepare list of problem statements	15 SEPTEMBER 2022
Ideation	List the by organizing the brainstorming session and prioritize the top 3 ideas based on the feasibility & importance.	26 SEPTEMBER 2022
Proposed Solution	Prepare the proposed solution document, which includes the novelty, feasibility of idea, business model, social impact, scalability of solution, etc.	21 OCTOBER 2022
Problem Solution Fit	Prepare problem - solution fit document.	26 OCTOBER 2022

<b>Solution Architecture</b>	Prepare solution architecture document.	19 OCTOBER 2022
<b>Customer Journey</b>	Prepare the customer journey maps to understand the user interactions & experiences with the application.	31 OCTOBER 2022
<b>Functional Requirement</b>	Prepare the functional requirement document.	7 NOVEMBER 2022
<b>Data Flow Diagrams</b>	Draw the data flow diagrams and submit for review.	31 OCTOBER 2022
<b>Technology Architecture</b>	Prepare the technology architecture diagram.	7 NOVEMBER 2022
<b>Prepare Milestone &amp; Activity List</b>	Prepare the milestones & activity list of the project.	13 NOVEMBER 2022
<b>Project Development - Delivery of Sprint-1, 2, 3 &amp; 4</b>	Develop & submit the developed code by testing it.	IN <u>PROGRESS..</u>

## 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	As an admin,I give user id and password to every worker and manage them	10	High	Subhashree M
Sprint-1	Login	USN-2	As a Co Admin , I'll manage the garbage level monitor.If the garbage get filled alert I will post location and garbage id to trash truck	10	High	Subhashree M
Sprint-2	Dashboard	USN-3	As truck driver , I'll follow the route send by Co Admin to reach the filled garbage	20	Low	Subhashini G
Sprint-3	Dashboard	USN-4	As a Waste Collector , I'll collect all the trash from garbage and load into garbage truck and send them to landfill	20	Medium	Subiksha P
Sprint-4	Dashboard	USN-5	As a Municipality , I'll check the process are happening in discipline manner without any issues	20	High	Sethurajan S

### 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	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

#### 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)

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

## 6.3 JIRA

### REPORTS



## CHAPTER 7

### 7.CODING AND SOLUTION

#### 7.1.FEATURES

- IOT DEVICE
- WOKWI SOFTWARE
- IOT WATSON PLATFORM
- NODE RED
- WEB UI
- CLOUDANT DB

#### 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 "9gbe4w" // IBM organisation id
#define DEVICE_TYPE "SWMSMC" // Device type mentioned in ibm watson iot platform
#define DEVICE_ID "ibmproject" // Device ID mentioned in ibm watson iot platform#define
TOKEN "sUNA41tG6-Pq)0rk5X" // Token
// customise above values
charserver[] = 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
ofstrings
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))
  {
  }
  else
  {
    Serial.println("IBM subscribe to cmd OK");
    Serial.p
rintln("s
ubscrib
e to

```

```

cmd
FAILE
D"
);
}
}
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");

```

## 7.2 FEATURE 2

- REGISTRATION
- LOGIN
- VERIFICATION
- SELECT THE CITY
- DISPLAY THE STATUS OF BIN
- ADD QUERY

### CODE:

Functional Requirement – Sign in / Sign up User story : USN –1

HTML CODE :

```

<!DOCTYPE html>
<html lang="en">
<head>
<meta charset="UTF-8" />
<meta name="viewport" content="width=device-width, initial-scale=1.0" />
<title>Smart Waste Management System</title>
<!-- Bootstrap 4 CSS CDN -->
<link rel="stylesheet" href="https://cdnjs.cloudflare.com/ajax/libs/twitter-
bootstrap/4.5.2/css/bootstrap.min.css" />
<!-- Fontawesome CSS CDN -->
<link rel="stylesheet" href="https://cdnjs.cloudflare.com/ajax/libs/font-
awesome/5.14.0/css/all.min.css" />
<link rel="stylesheet" href="css/style.css" />
</head>

```

```

<body class="bg-info">
<div class="container">
<!-- Login Form Start -->
<div class="row justify-content-center wrapper" id="login-box">
<div class="col-lg-10 my-auto myShadow">
<div class="row">
<div class="col-lg-7 bg-white p-4">
<h1 class="text-center font-weight-bold text-primary">Sign in</h1>
<hr class="my-3" />
<form action="#" method="post" class="px-3" id="login-form">
<div class="input-group input-group-lg form-group">
<div class="input-group-prepend">
<span class="input-group-text rounded-0"><i class="far fa-envelope fa-lg fa-fw"></i></span>
</div>
<input type="email" id="email" name="email" class="form-control rounded-0" placeholder="E-Mail" required />
</div>
<div class="input-group input-group-lg form-group">
<div class="input-group-prepend">
<span class="input-group-text rounded-0"><i class="fas fa-key fa-lg fa-fw"></i></span>
</div>
<input type="password" id="password" name="password" class="form-control rounded-0" minlength="5"
placeholder="Password" required autocomplete="off" />
</div>
<div class="form-group clearfix">
<div class="custom-control custom-checkbox float-left">
<input type="checkbox" class="custom-control-input" id="customCheck" name="rem" />
<label class="custom-control-label" for="customCheck">Remember me</label>
</div>
<div class="forgot float-right">
<a href="#" id="forgot-link">Forgot Password?</a>
</div>
</div>
<div class="form-group">
<input type="submit" id="login-btn" value="Sign In" class="btn btn-primary btn-lg btn-block myBtn" />
</div>
</form>
</div>
<div class="col-lg-5 d-flex flex-column justify-content-center myColor p-4">

```

```

<h1 class="text-center font-weight-bold text-white">Welcome Friend!</h1>
<hr class="my-3 bg-light myHr" />
<p class="text-center font-weight-bolder text-light lead">Start your initiative to make your
environment clean</p>
<button class="btn btn-outline-light btn-lg align-self-center font-weight-bolder mt-4 myLinkBtn"
id="register-link">Sign
Up</button>
</div>
</div>
</div>
</div>
<!-- Login Form End -->
<!-- Registration Form Start -->
<div class="row justify-content-center wrapper" id="register-box" style="display: none;">
<div class="col-lg-10 my-auto myShadow">
<div class="row">
<div class="col-lg-5 d-flex flex-column justify-content-center myColor p-4">
<h1 class="text-center font-weight-bold text-white">Welcome Back!</h1>
<hr class="my-4 bg-light myHr" />
<p class="text-center font-weight-bolder text-light lead">To stay connected Please login with
your personal info.</p>
<button class="btn btn-outline-light btn-lg font-weight-bolder mt-4 align-self-center myLinkBtn"
id="login-link">Sign In</button>
</div>
<div class="col-lg-7 bg-white p-4">
<h1 class="text-center font-weight-bold text-primary">Create Account</h1>
<hr class="my-3" />
<form action="#" method="post" class="px-3" id="register-form">
<div class="input-group input-group-lg form-group">
<div class="input-group-prepend">
<span class="input-group-text rounded-0"><i class="far fa-user fa-lg fa-fw"></i></span>
</div>
<input type="text" id="name" name="name" class="form-control rounded-0" placeholder="Full
Name" required />
</div>
<div class="input-group input-group-lg form-group">
<div class="input-group-prepend">
<span class="input-group-text rounded-0"><i class="far fa-envelope fa-lg fa-fw"></i></span>
</div>
<input type="email" id="remail" name="email" class="form-control rounded-0" placeholder="E-
Mail" required />

```

```

</div>
<div class="input-group input-group-lg form-group">
<div class="input-group-prepend">
<span class="input-group-text rounded-0"><i class="fas fa-key fa-lg fa-fw"></i></span>
</div>
<input type="password" id="rpassword" name="password" class="form-control rounded-0"
minlength="5"
placeholder="Password" required />
</div>
<div class="input-group input-group-lg form-group">
<div class="input-group-prepend">
<span class="input-group-text rounded-0"><i class="fas fa-key fa-lg fa-fw"></i></span>
</div>
<input type="password" id="cpassword" name="cpassword" class="form-control rounded-0"
minlength="5"
placeholder="Confirm Password" required />
</div>
<div class="form-group">
<div id="passError" class="text-danger font-weight-bolder"></div>
</div>
<div class="form-group">
<input type="submit" id="register-btn" value="Sign Up" class="btn btn-primary btn-lg btn-block
myBtn" />
</div>
</form>
</div>
</div>
</div>
</div>
<!-- Registration Form End -->
<!-- Forgot Password Form Start -->
<div class="row justify-content-center wrapper" id="forgot-box" style="display: none;">
<div class="col-lg-10 my-auto myShadow">
<div class="row">
<div class="col-lg-7 bg-white p-4">
<h1 class="text-center font-weight-bold text-primary">Forgot Your Password?</h1>
<hr class="my-3" />
<p class="lead text-center text-secondary">To reset your password, enter the registered e-mail
address and we
will send you password reset instructions on your e-mail!</p>
<form action="#" method="post" class="px-3" id="forgot-form">

```

```

<div id="forgotAlert"></div>
<div class="input-group input-group-lg form-group">
<div class="input-group-prepend">
<span class="input-group-text rounded-0"><i class="far fa-envelope fa-lg"></i></span>
</div>
<input type="email" id="femail" name="email" class="form-control rounded-0" placeholder="E-Mail" required />
</div>
<div class="form-group">
<input type="submit" id="forgot-btn" value="Reset Password" class="btn btn-primary btn-lg btn-block myBtn" />
</div>
</form>
</div>
<div class="col-lg-5 d-flex flex-column justify-content-center myColor p-4">
<h1 class="text-center font-weight-bold text-white">Reset Password!</h1>
<hr class="my-4 bg-light myHr" />
<button class="btn btn-outline-light btn-lg font-weight-bolder myLinkBtn align-self-center" id="back link">Back</button>
</div>
</div>
</div>
</div>
</div>
<!-- Forgot Password Form End -->
</div>
<!-- jQuery CDN -->
<script src="https://cdnjs.cloudflare.com/ajax/libs/jquery/3.5.1/jquery.min.js"></script>
<script src="js/script.js"></script>
</body>
</html>

```

CSS CODE :

```

@import
url("https://fonts.googleapis.com/css?family=Maven+Pro:400,500,600,700,800,900&display=swap");
* {
margin: 0; padding: 0; boxsizing: border-box; font-family:
"Maven Pro", sans-serif;
}
.wrapper
{ height: 100vh;}
.myColor

```

```

{
background-image: linear-gradient(to right, #324bf3 50%, #f9d423 150%);
}
.myShadow {
box-shadow: 0 10px 10px rgba(0, 0, 0, 0.5);
}
.myBtn { border-radius: 50px; font-weight: bold; font-size: 20px;
background-image: linear-gradient(to right, #0acffe 0%, #495aff
100%); border: none;
}
.myBtn:hover { background-image: linear-gradient(to right,
#495aff 0%, #0acffe 100%);
}
.myHr { height: 2px;
border-radius:
100px;
}
.myLinkBtn {
border- radius:
100px; width: 50%;
border: 2px solid
#fff;
}
@media (max-width: 720px) {
.wrapper {
margin: 2px;
}
}

```

JS CODE:

```

$(function () {
$("#register-link").click(function () {
$("#login-box").hide();
$("#register-box").show();
});
$("#login-link").click(function () {
$("#login-box").show();
$("#register-box").hide();
});
$("#forgot-link").click(function () {
$("#login-box").hide();
$("#forgot-box").show();
});

```



```
});
$("#back-link").click(function () {
$("#login-box").show();
$("#forgot-box").hide();
});
});
```

## 7.3 DATABASE SCHEMA

```
labl_0 = Label(base, text="Registration form",width=20,font=("bold",20))
labl_0.place(x=90,y=53)
lb1= Label(base, text="Enter Name", width=10, font=("arial",12))
lb1.place(x=20, y=120)
en1= Entry(base) en1.place(x=200, y=120)
lb3= Label(base, text="Enter Email", width=10, font=("arial",12))
lb3.place(x=19, y=160)
en3= Entry(base) en3.place(x=200, y=160)
lb4= Label(base, text="Contact Number", width=13,font=("arial",12))
lb4.place(x=19, y=200)
en4= Entry(base) en4.place(x=200, y=200)
lb5= Label(base, text="Select Gender", width=15, font=("arial",12))
lb5.place(x=5, y=240)
var = IntVar()
Radiobutton(base, text="Male", padx=5,variable=var, value=1).place(x=180, y=240)
Radiobutton(base, text="Female", padx =10,variable=var, value=2).
place(x=240,y=240)
Radiobutton(base, text="others", padx=15, variable=var,
value=3).place(x=310,y=240)
list_of_cntry = ("United States", "India", "Nepal",
"Germany") cv =StringVar()
drplist= OptionMenu(base, cv, *list_of_cntry) drplist.config(width=15)
cv.set("United States")
lb2= Label(base, text="Select Country", width=13,font=("arial",12))
lb2.place(x=14,y=280)
drplist.place(x=200, y=275)
lb6= Label(base, text="Enter Password", width=13,font=("arial",12))
lb6.place(x=19, y=320)
en6= Entry(base, show="*") en6.place(x=200, y=320)
lb7= Label(base, text="Re-Enter Password", width=15,font=("arial",12))
lb7.place(x=21, y=360)
```

```

en7 = Entry(base, show=False, text="Register", width=10).place(x=200, y=400)
base.mainloop()

def generateOTP():
    # Declare a digits variable # which stores all digits
    digits = "0123456789"
    OTP = ""
    # length of password can be changed # by changing value in range
    for i in range(4):
        OTP += digits[math.floor(random.random() * 10)]
    return OTP

# Driver code
if __name__ == "__main__":
    print("OTP of 4 digits:", generateOTP())
    digits = "0123456789"
    OTP = ""
    for i in range(6):
        OTP += digits[math.floor(random.random() * 10)]
    otp = OTP + " is your OTP"
    msg = otp
    s = smtplib.SMTP('smtp.gmail.com', 587)
    s.starttls()
    s.login("Your Gmail Account", "Your app password")
    emailid = input("Enter your email: ")
    s.sendmail(emailid, msg)
    a = input("Enter Your OTP >>>: ")
    if a == OTP:
        print("Verified")
    else:
        print("Please Check your OTP again")

```

## **Sensor Connection Setup**

### **PHYSICAL COMPONENTS:**

- i.* PIR MOTION SENSOR
- ii. ULTRASONIC DISTANCE SENSOR
- iii. ESP32-ARDUINO MICROCONTROLLER

### **OUTPUT: WOKWI SETUP**

#### **WEB UI**

The admin gets notification when the bin detects motion and if the bin level crosses 50 percent it indicates warning and if it crosses 90 percent it gives a High alert and closes the bin. If the admin wants to seal the bin the admin can command seal bin until it is accessed for cleaning

## CHAPTER 8

### 8.TESTING

#### 8.1.Test Case:

Maximum Size of Bin : 200 cm

Safelimit: below 100 cm

Minimum threshold limit of bin: 100 cm

Maximum threshold limit of bin: 180 cm

S.no	Bin Level (cm filled)	Bin Status	Location
1	45	Safe	Kanyakumari
2	78	Safe	Coimbatore
3	112	Warning	Trichy
4	169	Warning	Chennai
5	186	Warning	Ooty
6	193	High_Alert	Tirunelveli
8	0	Safe	Chengalpattu
9	35	Safe	Madurai
10	101	Warning	Salem
11	132	Warning	Thanjavore
12	158	Warning	Vellore
13	93	High_Alert	Erode
14	93	High_Alert	Karur
15	93	High_Alert	Cuddalore

16	30	Safe	Kumbakonam
17	110	Warning	Ambur
18	180	Warning	Sivakasi
19	195	High_Alert	Neyveli
20	80	Safe	Krishnagiri

**Note:** The bin location provided above is default. When the user access the bin , the location and status of the bin displayed to the admin.

## 8.2.USER ACCEPTANCE TESTING

### 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).

### Defect Analysis

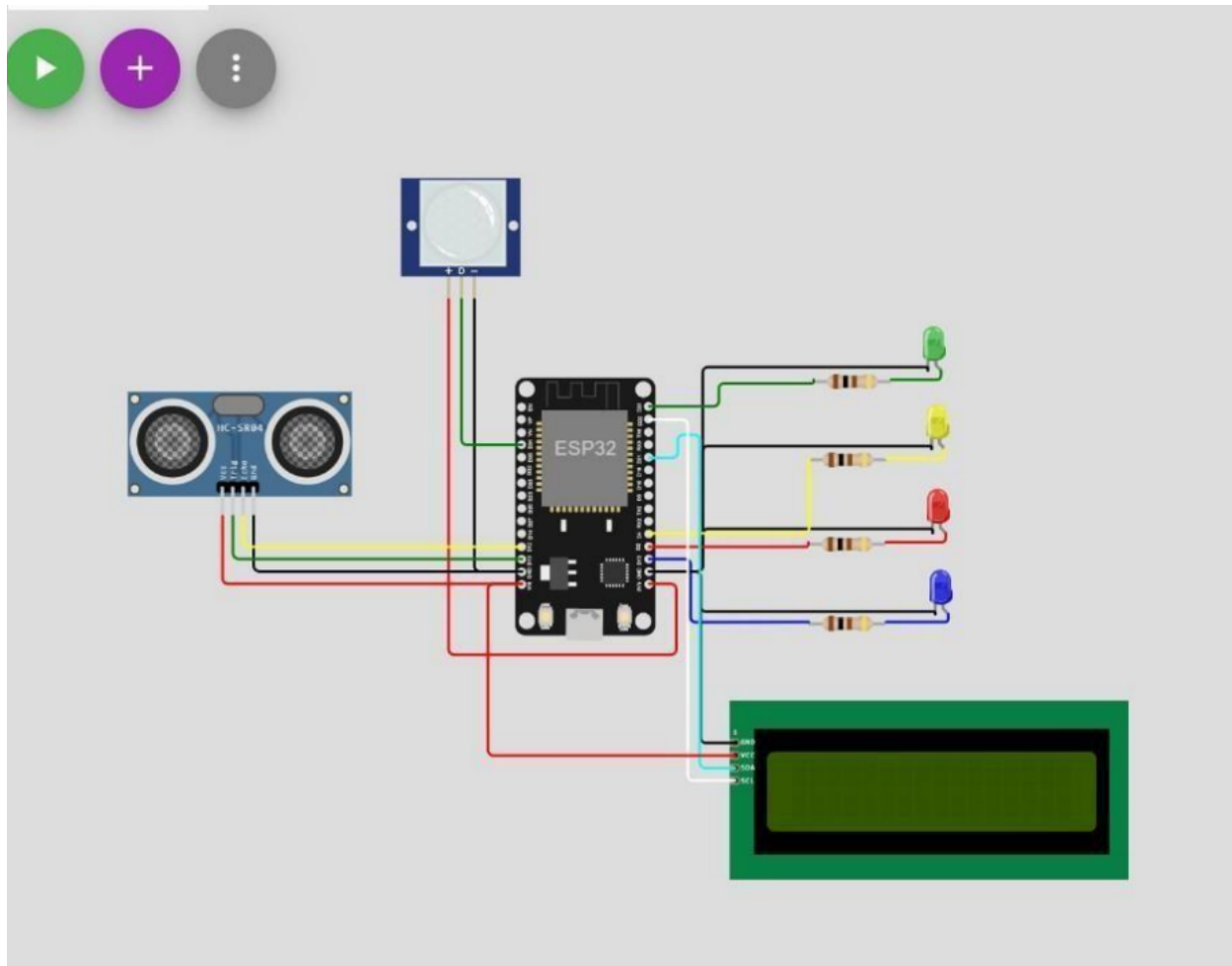
This report shows the number of resolved or closed bugs at each severity level, and how they were resolved.

## CHAPTER 9

### 9.RESULTS

#### 9.1Performance Metrics

Circuit Diagram:



## Workwi Simulation:

The screenshot displays the Workwi simulation interface. On the left, the 'esp32-blink.ino' code editor shows the following code:

```
177 f
178
179
180
181
182 if(cm <= 25)
183 {
184 digitalWrite(21,HIGH);
185 String payload = "{\"High_Alert\":\"";
186 payload += cm;
187 payload += " }";
188 Serial.print("\n");
189 Serial.print("Sending payload: ");
190 Serial.println(payload);
191
192 if (client.publish(publishTopic, (char*) payload.c_str())) // if
193 {
194 Serial.println("Publish OK");
195 }
196 }
197 if(cm <= 50)
198 {
199 digitalWrite(22,HIGH);
200 String payload = "{\"Warning\":\"";
201 payload += cm ;
202 payload += " }";
203 Serial.print("\n");
```

On the right, the 'Simulation' window shows a hardware diagram of an ESP32 board connected to a PIR Motion Sensor, a buzzer, and an LCD screen. Below the diagram, the simulation log displays the following output:

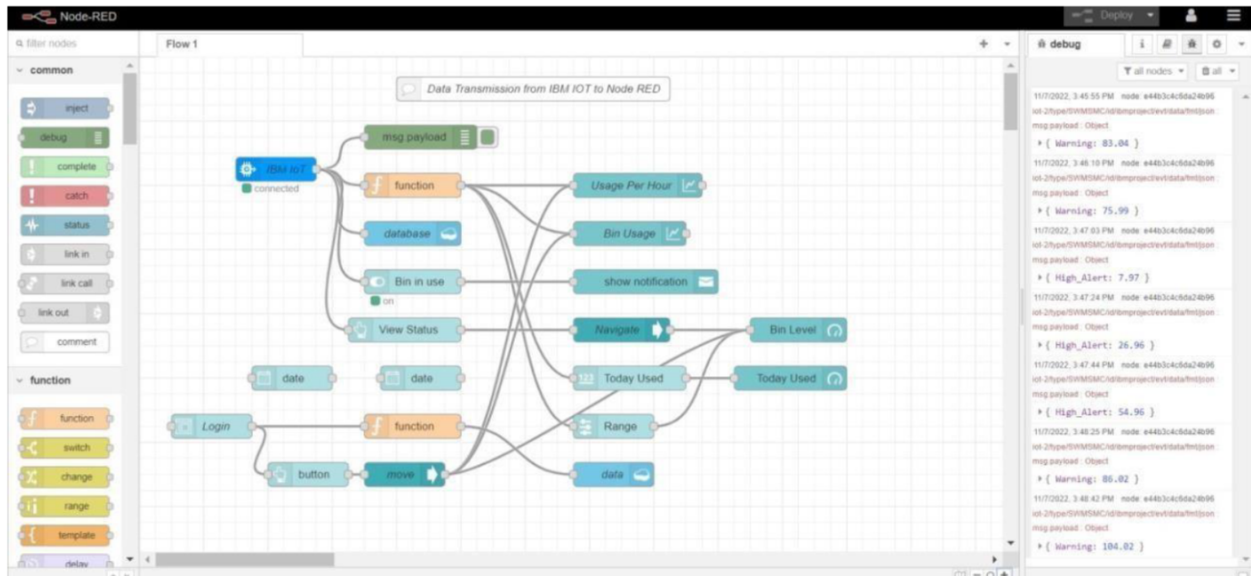
```
Sending distance: 26.94
Publish OK
Motion Detected
Lid Opened
High Alert!!!,Trash bin is about to be full
Lid Closed
```

## Data transfer to Watson IoT platform :

The screenshot shows the Watson IoT platform interface. The top navigation bar includes 'Browse', 'Action', 'Device Types', and 'Interfaces'. A sidebar on the left contains various icons. The main content area displays a table of recent events with the following data:

Event	Value	Format	Last Received
data	{"Warning":28.95}	json	a few seconds ago
data	{"Warning":28.95}	json	a few seconds ago
data	{"Warning":49.98}	json	a minute ago
data	{"Warning":49.98}	json	a minute ago
data	{"Warning":11.03}	json	a minute ago

## Node-RED Connection setup for data transmission from IBM Watson IOTplatform to Node-RED dashboard:



## Storing database in IBM cloudant DB:

Databases					Database name	Create Database	{ } JSON		
Your Databases									
Name	Size	# of Docs	Partitioned	Actions					
login_credentials	13.7 KB	111	No						
noderedwjldy20221105	37.4 KB	4	No						
sample	59.4 KB	351	No						
sensor_data	15.7 KB	90	No						

Showing 1-4 of 4 databases. Databases per page 20



<div> <div>↔</div> <div>←</div> <div>sensor_data</div> <div>⋮</div> </div> <div> <div>📊</div> <div>📄</div> <div>🔍</div> <div>🔗</div> <div>📋</div> <div>👤</div> <div>🔊</div> <div>📖</div> <div>🏠</div> </div> <div>Log Out</div>	<div> <div>All Documents</div> <div>+</div> </div> <div>Query</div> <div>Permissions</div> <div>Changes</div> <div>Design Documents</div> <div>+</div>	<div> <div>Document ID</div> <div>Options</div> <div>{ } JSON</div> <div>🔔</div> </div> <div> <div>Table</div> <div>Metadata</div> <div>{ } JSON</div> <div>🔖</div> <div>Create Document</div> </div> <table> <thead> <tr> <th>id</th><th>key</th><th>value</th></tr> </thead> <tbody> <tr><td><input type="checkbox"/></td><td>0198213c192cb2c244cc2433f1...</td><td>0198213c192cb2c244cc2433f1... { "rev": "1-cde2dd17c519394df...</td></tr> <tr><td><input type="checkbox"/></td><td>0198213c192cb2c244cc2433f1...</td><td>0198213c192cb2c244cc2433f1... { "rev": "1-d26c5b40891e13c6c...</td></tr> <tr><td><input type="checkbox"/></td><td>0198213c192cb2c244cc2433f1...</td><td>0198213c192cb2c244cc2433f1... { "rev": "1-cde2dd17c519394df...</td></tr> <tr><td><input type="checkbox"/></td><td>0198213c192cb2c244cc2433f1...</td><td>0198213c192cb2c244cc2433f1... { "rev": "1-f96eb0460bc16cfab0...</td></tr> <tr><td><input type="checkbox"/></td><td>1a921f21cbe229b86f599acb45...</td><td>1a921f21cbe229b86f599acb45... { "rev": "1-7226f08794cd47b7c...</td></tr> <tr><td><input type="checkbox"/></td><td>1a921f21cbe229b86f599acb45...</td><td>1a921f21cbe229b86f599acb45... { "rev": "1-1bdd9a985bd56cf9...</td></tr> <tr><td><input type="checkbox"/></td><td>20a854e5445fa818e6c1de049...</td><td>20a854e5445fa818e6c1de049... { "rev": "1-7226f08794cd47b7c...</td></tr> <tr><td><input type="checkbox"/></td><td>20a854e5445fa818e6c1de049...</td><td>20a854e5445fa818e6c1de049... { "rev": "1-3ad288ecad57f039e...</td></tr> <tr><td><input type="checkbox"/></td><td>20a854e5445fa818e6c1de049...</td><td>20a854e5445fa818e6c1de049... { "rev": "1-1bdd9a985bd56cf9...</td></tr> <tr><td><input type="checkbox"/></td><td>298ed6fhd9h3b815f5ac7c061e...</td><td>298ed6fhd9h3b815f5ac7c061e... { "rev": "1-4e7240f6e5307a1b9...</td></tr> </tbody> </table> <div>Showing document 1 - 20. Documents per page: 20</div>	id	key	value	<input type="checkbox"/>	0198213c192cb2c244cc2433f1...	0198213c192cb2c244cc2433f1... { "rev": "1-cde2dd17c519394df...	<input type="checkbox"/>	0198213c192cb2c244cc2433f1...	0198213c192cb2c244cc2433f1... { "rev": "1-d26c5b40891e13c6c...	<input type="checkbox"/>	0198213c192cb2c244cc2433f1...	0198213c192cb2c244cc2433f1... { "rev": "1-cde2dd17c519394df...	<input type="checkbox"/>	0198213c192cb2c244cc2433f1...	0198213c192cb2c244cc2433f1... { "rev": "1-f96eb0460bc16cfab0...	<input type="checkbox"/>	1a921f21cbe229b86f599acb45...	1a921f21cbe229b86f599acb45... { "rev": "1-7226f08794cd47b7c...	<input type="checkbox"/>	1a921f21cbe229b86f599acb45...	1a921f21cbe229b86f599acb45... { "rev": "1-1bdd9a985bd56cf9...	<input type="checkbox"/>	20a854e5445fa818e6c1de049...	20a854e5445fa818e6c1de049... { "rev": "1-7226f08794cd47b7c...	<input type="checkbox"/>	20a854e5445fa818e6c1de049...	20a854e5445fa818e6c1de049... { "rev": "1-3ad288ecad57f039e...	<input type="checkbox"/>	20a854e5445fa818e6c1de049...	20a854e5445fa818e6c1de049... { "rev": "1-1bdd9a985bd56cf9...	<input type="checkbox"/>	298ed6fhd9h3b815f5ac7c061e...	298ed6fhd9h3b815f5ac7c061e... { "rev": "1-4e7240f6e5307a1b9...
id	key	value																																	
<input type="checkbox"/>	0198213c192cb2c244cc2433f1...	0198213c192cb2c244cc2433f1... { "rev": "1-cde2dd17c519394df...																																	
<input type="checkbox"/>	0198213c192cb2c244cc2433f1...	0198213c192cb2c244cc2433f1... { "rev": "1-d26c5b40891e13c6c...																																	
<input type="checkbox"/>	0198213c192cb2c244cc2433f1...	0198213c192cb2c244cc2433f1... { "rev": "1-cde2dd17c519394df...																																	
<input type="checkbox"/>	0198213c192cb2c244cc2433f1...	0198213c192cb2c244cc2433f1... { "rev": "1-f96eb0460bc16cfab0...																																	
<input type="checkbox"/>	1a921f21cbe229b86f599acb45...	1a921f21cbe229b86f599acb45... { "rev": "1-7226f08794cd47b7c...																																	
<input type="checkbox"/>	1a921f21cbe229b86f599acb45...	1a921f21cbe229b86f599acb45... { "rev": "1-1bdd9a985bd56cf9...																																	
<input type="checkbox"/>	20a854e5445fa818e6c1de049...	20a854e5445fa818e6c1de049... { "rev": "1-7226f08794cd47b7c...																																	
<input type="checkbox"/>	20a854e5445fa818e6c1de049...	20a854e5445fa818e6c1de049... { "rev": "1-3ad288ecad57f039e...																																	
<input type="checkbox"/>	20a854e5445fa818e6c1de049...	20a854e5445fa818e6c1de049... { "rev": "1-1bdd9a985bd56cf9...																																	
<input type="checkbox"/>	298ed6fhd9h3b815f5ac7c061e...	298ed6fhd9h3b815f5ac7c061e... { "rev": "1-4e7240f6e5307a1b9...																																	

Data is stored in JSON format:

<div> <div>↔</div> <div>←</div> <div>sensor_data</div> <div>➤</div> <div>0198213c192cb2c244cc2433f1802b91</div> <div>⋮</div> </div> <div> <div>📊</div> <div>📄</div> <div>🔍</div> <div>🔗</div> <div>📋</div> <div>👤</div> <div>🔊</div> <div>📖</div> <div>🏠</div> </div> <div>Log Out</div>	<div> <div>{ } JSON</div> <div>🔔</div> </div> <div> <div>Save Changes</div> <div>Cancel</div> <div>Upload Attachment</div> <div>Clone Document</div> <div>Delete</div> </div> <pre> 1 { 2   "_id": "0198213c192cb2c244cc2433f1802b91", 3   "_rev": "1-cde2dd17c519394df774730c495f8b", 4   "topic": "iot-2/type/SWMSMC/id/ibmproject/evt/data/fmt/json", 5   "payload": { 6     "Warning!!": "244.97left" 7   }, 8   "deviceId": "ibmproject", 9   "deviceType": "SWMSMC", 10  "eventType": "data", 11  "format": "json" 12 } </pre>
--	--

## **CHAPTER 10**

### **10.ADVANTAGES AND DISADVANTAGES**

#### **10.1.ADVANTAGES**

1. Reduction in Collection Cost
2. No Missed Pickups
3. Reduced Overflows
4. Waste Generation Analysis
5. CO<sub>2</sub> Emission Reduction

#### **10.2.DISADVANTAGES**

- a. System requires a greater number of waste bins for separate waste collection as per population in the city.
- b. This results into high initial cost due to expensive smart dustbins compare to other methods. Sensor nodes used in the dustbins have limited memory size.

## **CHAPTER 11**

### **11.CONCLUSION :**

A Smart Waste Management system that is more effective than the one in use now is achievable by using sensors to monitor the filling of bins. Our conception of a "smart waste management system" focuses on monitoring waste management, offering intelligent technology for waste systems, eliminating human intervention, minimizing human time and effort, and producing a healthy and trash- free environment. The suggested approach can be implemented in smart cities where residents have busy schedules that provide little time for garbage management. If desired, the bins might be put into place in a metropolis where a sizable container would be able to hold enough solid trash for a single unit. But these may price bit high.

## CHAPTER 12

### 12.FUTURE SCOPE:

There are several future works and improvements for the proposed system, including the following:

- Changes the system of user authentication and atomic lock of bins, which would aid in protecting the bin from damage or theft.
- The concept of green points would encourage the involvement of residents or end users, making the idea successful and aiding in the achievement of collaborative waste management efforts, thus fulfilling the idea of '[Swachh Bharath](#)'.
- Having case study or data analytics on the type and times waste is collected on different days or seasons, making the bin level predictable and remove the reliance on electronic components, and fixing the coordinates.
- Improving the Server's and Android's graphical interfaces

## CHAPTER 13

### 13.APPENDIX

- **Esp32 - Microcontroller :**

ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth.

- Memory: 320 KiB
- SRAM CPU: Tensilica Xtensa LX6 microprocessor @ 160 or 240 MHz
- Power: 3.3 V DC
- Manufacturer: Espressif Systems
- Predecessor: ESP8266

- **Sensors :**

- PIR motion sensor: PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range.
- Ultrasonic Distance Sensor : Ultrasonic Sensors measure the distance to the target by measuring the time between the emission and reception.

#### 13.1. Source 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 "9gbe4w" // IBM organisation id
#define DEVICE_TYPE "SWMSMC" // Device type mentioned in ibm watson iot platform
#define DEVICE_ID "ibmproject" // Device ID mentioned in ibm watson iot
platform#define
TOKEN "sUNA41tG6-Pq)0rk5X" // Token
// customise above values
char server[] = ORG ".messaging.internetofthings.ibmcloud.com"; // server name char
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 wifi client
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);
  // led pins 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))
  {
  }
  else
  {
    Serial.println("IBM subscribe to cmd OK");
    Serial.p
rintln("s
ubscrib
e to
cmd
FAILE
D"
);
  }
}
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");
}

```

## 13.2 . GITHUB LINK

**LINK :** <https://github.com/IBM-EPBL/IBM-Project-39181-1660399380>