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COLLEGE OF ENGINEERING
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SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITIAN CITIES-USING IOT

A PROJECT REPORT

Submitted by

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1. INTRODUCTION

Internet of Things is nothing but 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. Home automation industry and transportation industries are seeing rapid growth with IoT. The basic project idea is to design a smart waste detection system which would automatically notify the officials about the current status of various garbage bins inthe city, would have realtime monitoring capabilities, which would be remotely controlled using IoT techniques. This paper introduces you to the use of IoT on one such area, that is, Garbage Detection in smart ways using IoT and see how this can also be a major part of developing a city into a smart city.

1.1. Project Overview

A big challenge in the urban cities is that of waste management as there is a rapid growth in therate of urbanization and thus there is a need of sustainable urban development plans. As the concept of smart cities is very much trending these days and the smart cities cannot be complete without smart waste management system. There needs to be system that gives prior information of the filling of the bin that alerts the municipality so that they can clean the bin ontime and safeguard the environment. To avoid all such situations we intend to propose a solution for this problem "Smart Garbage Bin", which will alarm and inform the authorized person when the garbage bin is about to fill. Then message will be send to the authorized person to collect the garbage from the particular area. The authorized person will sends the message from his web application to the garbage collectors by sending a SMS .This system maintain a dry waste and a wet waste separately. This will help to reduce the

1.2. Purpose

This project helps the citizens to make their surroundings and environmentclean , pollution free and lead a healthy life throughout. It avoids the possibility garbage overflow, unhygienic environment, air-borne and water-borne disease , etc...

2. LITERATURE SURVEY

2.1 EXISTING PROBLEM

In the existing system garbage is collected by the corporation weekly once or twice. Sometimes the garbage stinks and overflows from the bin and spread over the roads and pollutes the environment. This also produces a heavy air pollution and routes to various air-borne diseases Many a times the street dogs and other animals eat these waste and scatter these waste aroundthe surroundings which creates the spread of various diseases and situation of unclean environment.

Disadvantages of existing system:

- Time consuming and less effective.
- Overflow of waste from the bin.
- Unhygienic Environment and look of the city.
- Stinky smell and unpleasant situations.

PROPOSED SYSTEM:

In this proposed system there will be no issues repeated that of previous system. In this systemthe 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 IDwill 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 ItsApplications to Non-destructive Evaluation.

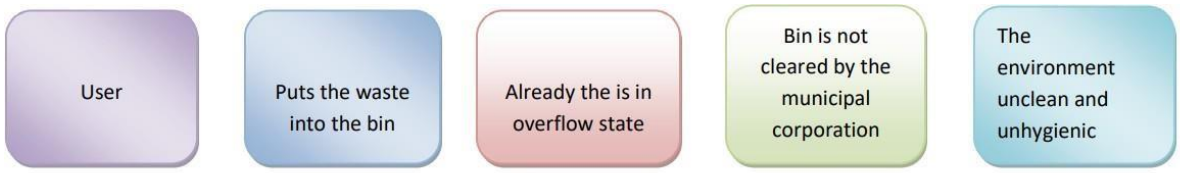
[2] Arduino, “Available at http://www.arduino.cc,” 2010.

[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 andComputation (ICECCO), 2014 11th International Conference on 29 Sept.-1 Oct. 2014.

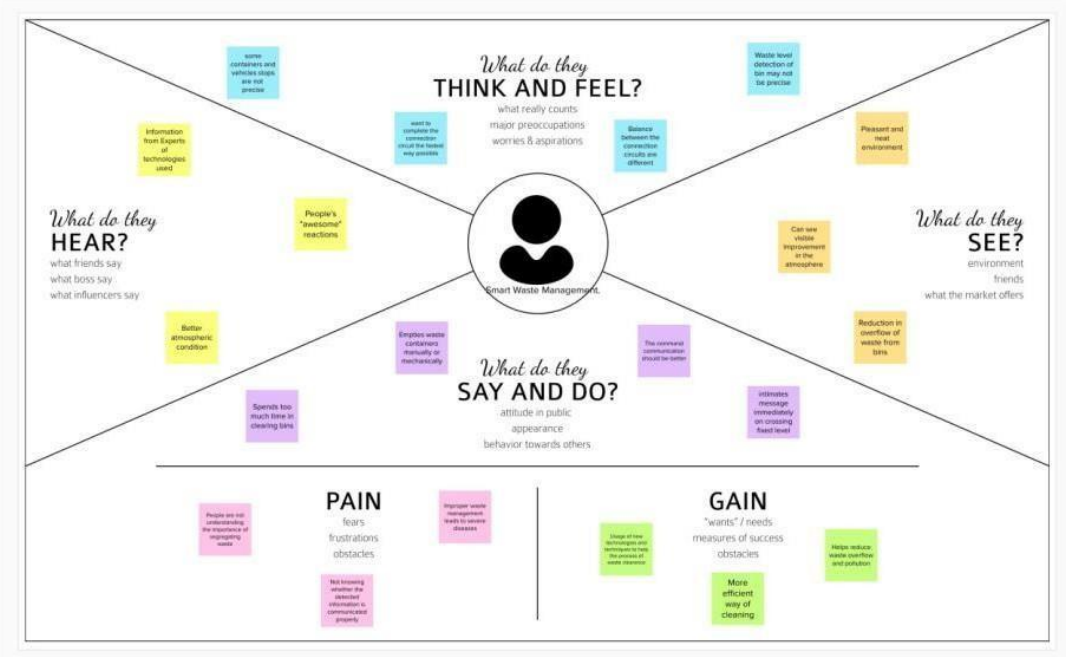
2.3. Problem Statement



Problem Statement (PS)	I'm (User)	I'm trying to	But	Because	Which makes me feel
PS - 1	Colony resident member	Put the waste into the waste bin	bin is already in the state of overflow	bin is not cleared by the corporation cleaners	So disgusting to see the spoiled area that stays as a major reason for many air-borne diseases.
PS - 2	Street Walkers	Throw the waste into the bin	There is no waste bin at all	Bin is not provided for the area	The main reason to make the surrounding unclean and unhygienic.

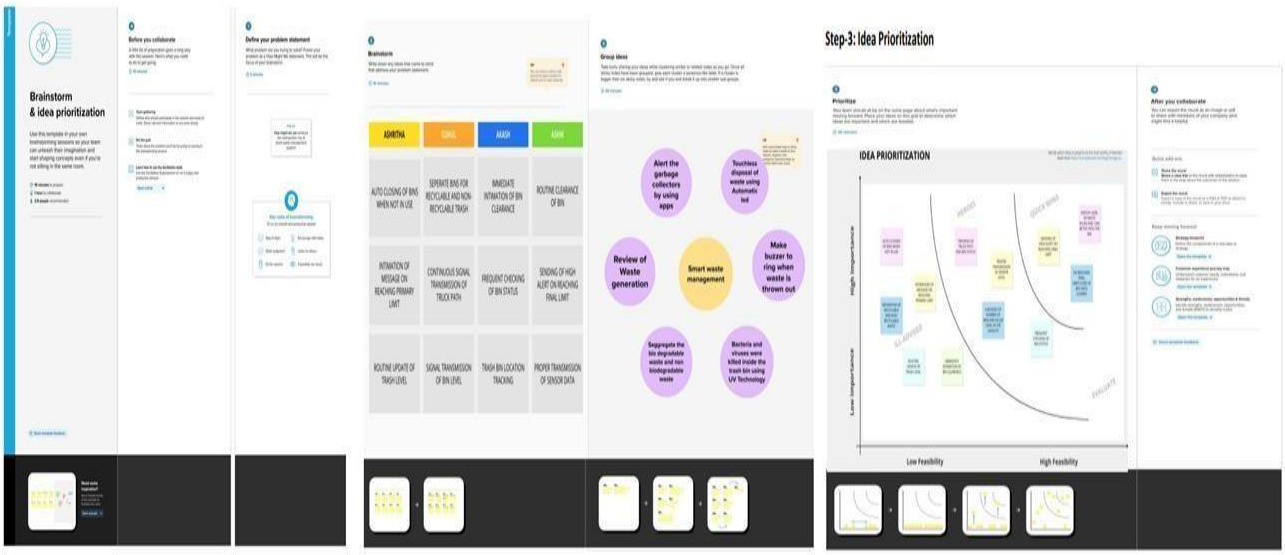
The waste management system provided earlier are not very reliable, efficient, cost effective and does not have any advanced processing features like automatic close of bin and alert intimations system .The following is a well articulated problem statementthat allows you to find the ideal solution for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

Empathy map on Smart waste Management System for Metropolitan cities.



Reference: https://www.mural.co/templates/empathy-map-canvas

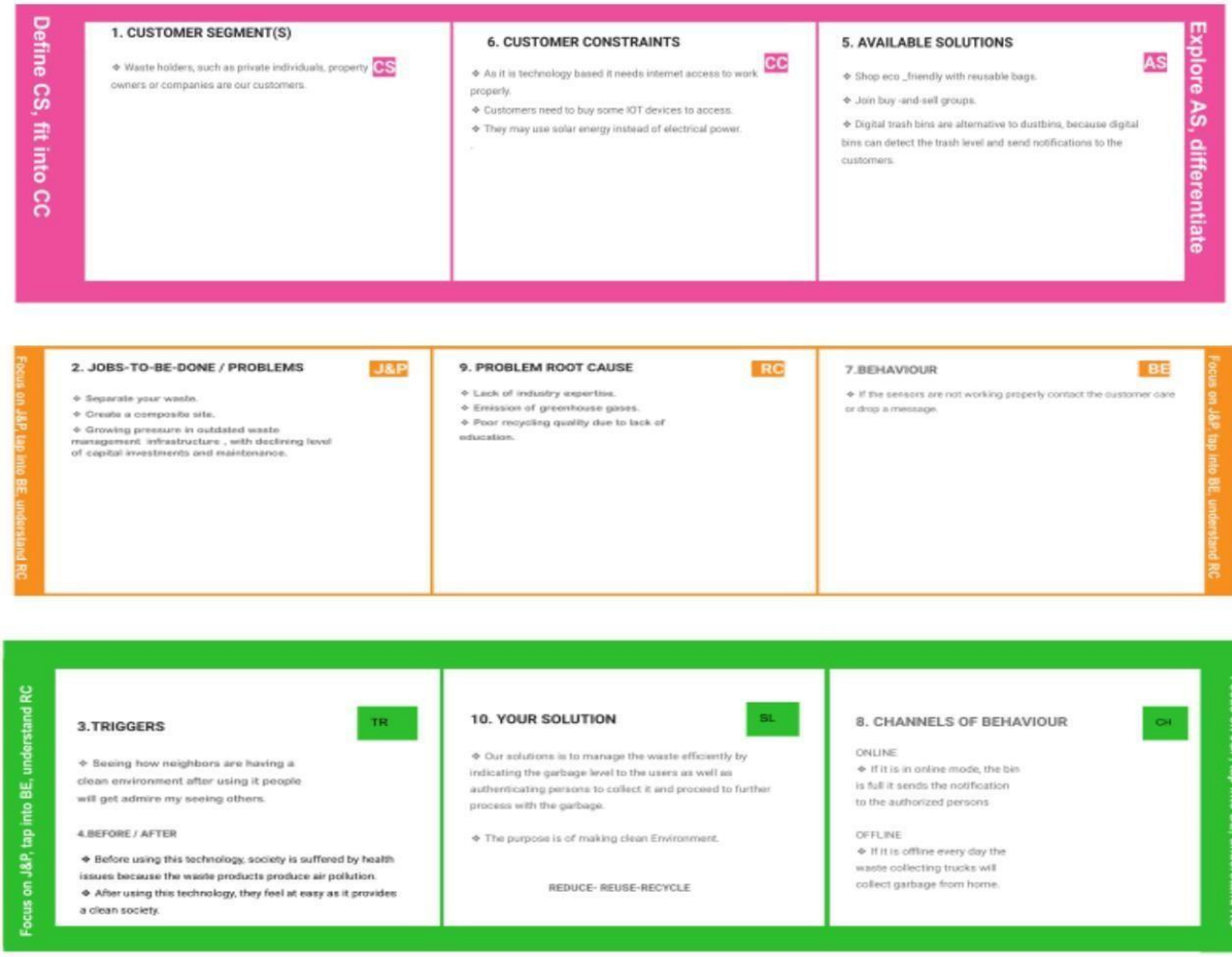
3.2. Ideation and Brainstorming



3.3. PROPOSED SOLUTION

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	➢ Ravage and waste can cause environmental pollution. ➢ Rotting garbage is the cause to produce harmful gases in the air and cause breathing problem to people. ➢ Due to improper waste disposal, we may face several problems like unpleasant odour and severe health issues.
2.	Idea / Solution description	➢ To solve this problem of waste disposal , we can design a smart garbage bin with inbuilt sensors and IOT devices such like Arduino UNO , Raspberry pi, etc.... ➢ Garbage level and location intimation mechanism . ➢ AI Recycling Robots.
3.	Novelty / Uniqueness	➢ Identify potential waste streams. ➢ Create a waste management-focused community outreach plane.
4.	Social Impact / Customer Satisfaction	➢ Neighbourhood of landfills to communities, breeding of pests and loss in property values. ➢ The IOT solution uses the data and intimates the information to the local area of management department when it reaches the initial boundary line .
5.	Business Model (Revenue Model)	➢ It generates revenue through the provision of various waste management and disposal services. ➢ Recycling solutions to residential , commercial , industrial, and municipal clients.
6.	Scalability of the Solution	➢ Installing separate bins for collecting recyclable and non-recyclable wastes. ➢ Recycling not only save energy but also prevent the material from going to landfills & Incineration and provides raw materials for new products.

3.4. PROBLEM SOLUTION FIT



4 . REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENT

Following are the functional requirements of the proposed solution.

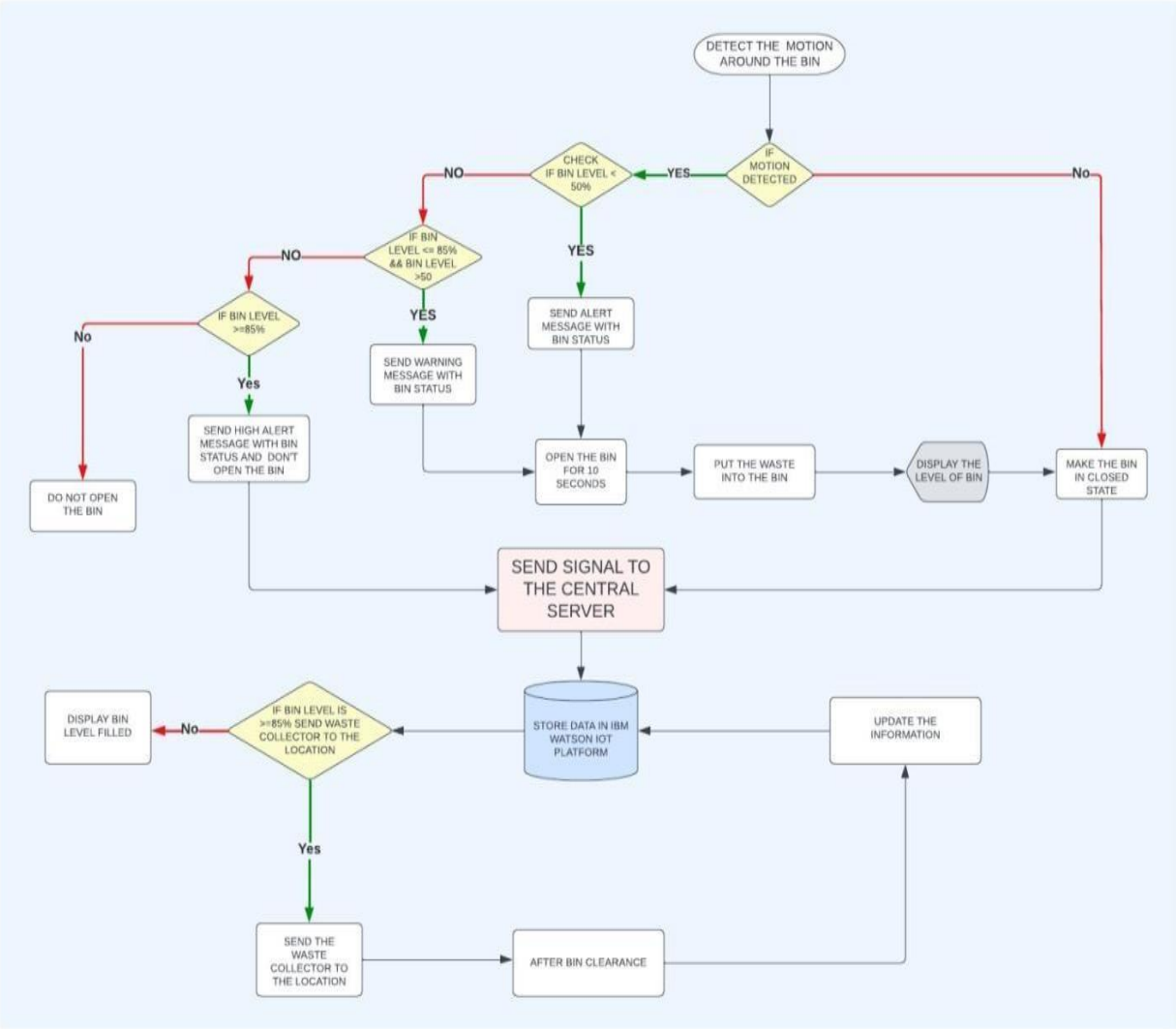
FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Authentication	Collecting data from the transmitted signal
FR-2	IBM Watson IOT Platform	Stores the sensed data and alerts.
FR-3	Node RED	Designs the wireframing and connection of user interface
FR-4	Web User Interface	Created by Node RED service connected to IBM Watson IOT platform
FR-5	Database	Fetched data is intimated and updated in the database
FR-6	Python script	Generates random data to the iot device and transmits to the Watson cloud.

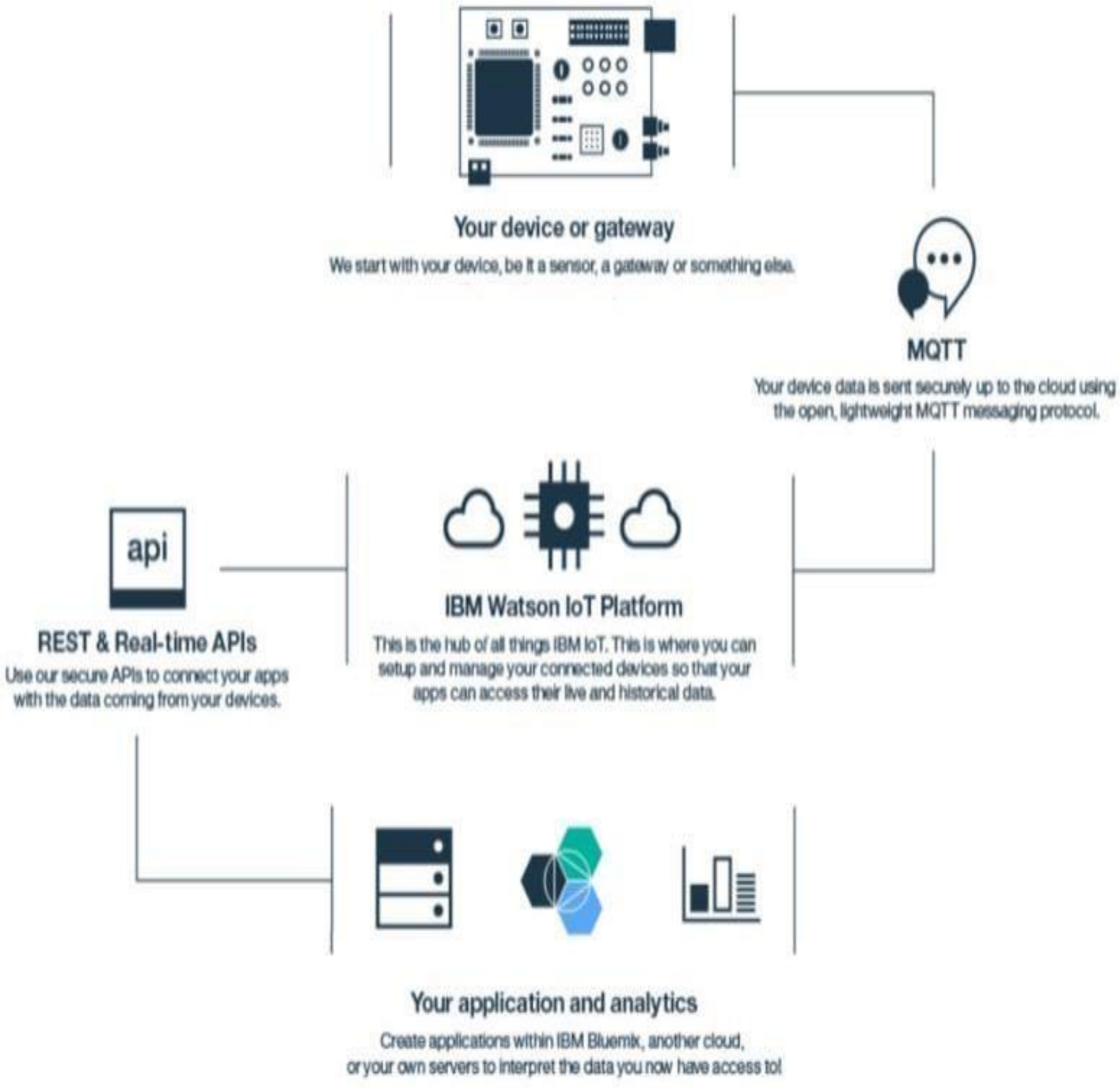
4.2 NON-FUNCTIONAL REQUIREMENT

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

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Separate bins for recyclable and non
NFR-2	**Security**	Data fetched can be only accessed by authorized user
NFR-3	**Reliability**	Accurate data and availabity is displayed
NFR-4	**Performance**	Detects and intimates alerts on reaching fixed limit.
NFR-5	**Availability**	Accessible through 24/7 by user and authorizer
NFR-6	**Scalability**	Holds vast accessibility by the user

5. PROJECT DESIGN
5.1. DATA FLOW DIAGRAM




Your device or gateway
We start with your device, be it a sensor, a gateway or something else.
MQTT
Your device data is sent securely up to the cloud using the open, lightweight MQTT messaging protocol.
api
REST & Real-time APIs
Use our secure APIs to connect your apps with the data coming from your devices.
IBM Watson IoT Platform
This is the hub of all things IBM IoT. This is where you can setup and manage your connected devices so that your apps can access their live and historical data.
Your application and analytics
Create applications within IBM Bluemix, another cloud, or your own servers to interpret the data you now have access to!

5.3 USER STORIES

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user / Web user)	Signup	USN-1	User can signup using their email and password and confirm the details.	I can access my account / dashboard	High	Sprint-1
		USN-2	A confirmation mail is sent to the user.	I can receive confirmation email & click confirm	High	Sprint-1
	Login	USN-3	User can login using login credentials	User can log on to the website	High	Sprint-1
	Dashboard	USN-4	User can specify the location and area to check the availability of bins.	User can access dashboard and search for bins in specified areas	High	Sprint-2
		USN-5	User can post the queries and grievances in the report section	Options are provided to solve user issues	Medium	Sprint-2

6. PROJECT PLANNING AND SCHEDULING

6.1 . SPRINT DEVELEVERY

TITLE	DESCRIPTION	RELEASE DATE
Literature Survey and Information Gathering	Surveying on the topic of selected project & gathering information by referring the, technical papers ,research publications etc.	23 SEPTEMBER 2022
Prepare Empathy Map	Prepare Empathy Map Canvas to capture the user pains & gains on particular issue.	25 SEPTEMBER 2022
Ideation	Jot down the ideas by organizing the brainstorming session and prioritize the top 3 ideas based on the feasibility & importance.	27 SEPTEMBER 2022
Proposed Solution	Prepare your proposed solution of the project which includes the novelty, feasibility of idea, business model, social impact, scalability of solution, etc.	28 SEPTEMBER 2022
Problem Solution Fit	Prepare problem - solution fit document.	28 SEPTEMBER 2022
Solution Architecture	Prepare solution architecture document.	30 SEPTEMBER 2022
Customer Journey Map	Prepare the customer journey maps to understand the user interactions & experiences with the application (entry to exit)	16 OCTOBER 2022
Functional Requirement	Prepare the functional requirement for the project.	18 OCTOBER 2022
Data Flow Diagrams	Draw the data flow diagrams to understand the flow of execution of the project.	18 OCTOBER 2022
Technology Architecture	Prepare the technology architecture diagram.	18 OCTOBER 2022
Milestone & Activity List	Prepare the milestones & activity list of the project.	28 OCTOBER 2022
Delivery of Sprints	Submit the coding development of the project and submit in sprints. Sprint -1 Sprint -2 Sprint -3 Sprint -4	 30 October 2022 5 November 2022 11 November 2022 17 November 2022

6.2. SPRINT DELIVERY SCHEDULE

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Sign up / Sign in	USN - 1	User can signup using their email and password and confirm the details.	10	High	ASHRITHA H A
Sprint-1		USN - 2	A confirmation mail is sent to the user.	10	High	
Sprint-2	Login	USN - 3	User can login using login credentials and is authenticated.	20	Low	GOHUL J P
Sprint-3	Dashboard	USN - 4	User can view the previous login activities of the account and updates.	10	Medium	ASHIK SINHA J
Sprint - 4	Search Location	USN - 5	User can search for the bins available around the location.	10	High	ASHRITHA H A
Sprint - 4	Results / Grievances	USN - 6	User can post their grievances related to the bins and gets the results of bin status around the location from IBM Cloud.	10	High	AKASH K B

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

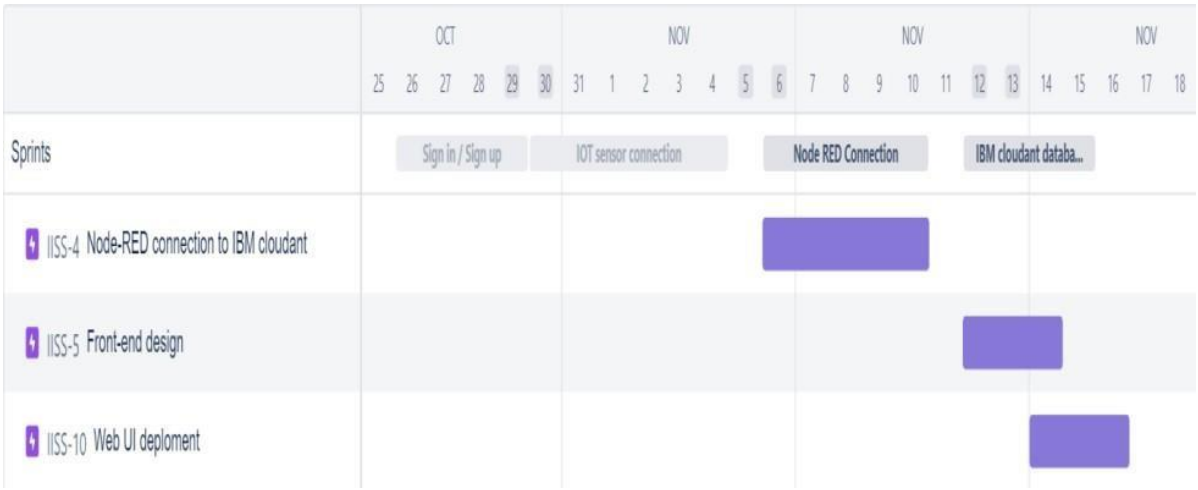
Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	4 Days	26 Oct 2022	29 Oct 2022	20	30 Oct 2022
Sprint-2	20	4 Days	31 Oct 2022	04 Nov 2022	20	05 Nov 2022
Sprint-3	20	4 Days	06 Nov 2022	10 Nov 2022	20	11 Nov 2022
Sprint-4	20	4 Days	12 Nov 2022	16 Nov 2022	20	17 Nov 2022

Velocity:

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

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

6.3. JIRA



REPORTS

SPRINT DELIVERY SCHEDULE:

DELIVERY OF SPRINT – 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/twi
  tter-bootstrap/4.5.2/css/bootstrap.min.css" />
  <!-- Fontawesome CSS CDN -->
  <link rely="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
  adddress 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>
<!-- 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:4
00,500,600,700,800,900&display=swap");


* { margin: 0;
   padding: 0;
   box-sizing:
```

```
   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
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;
}
```

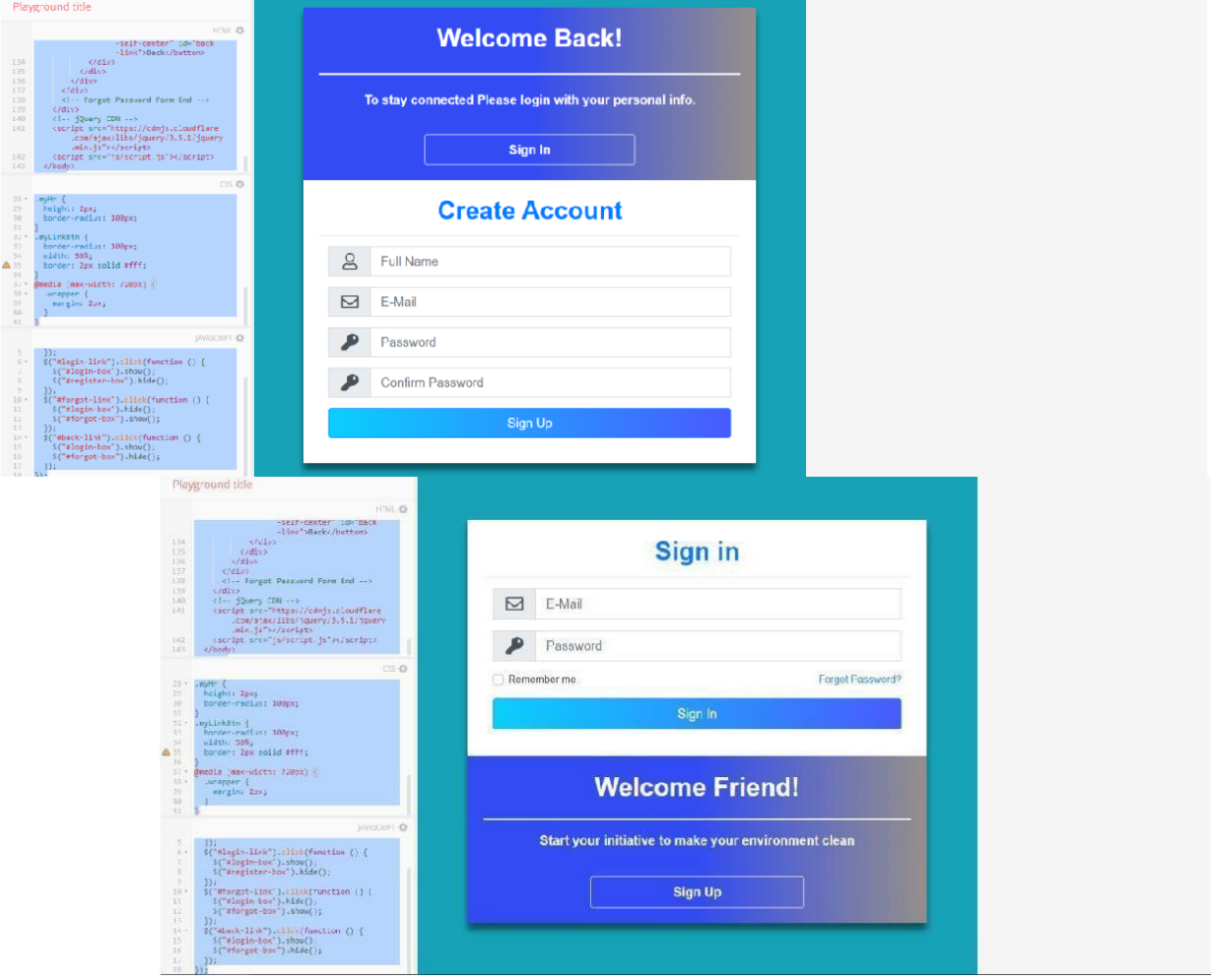
```
.myLinkBtn
{
borderrad
ius:
100px;
width:
50%;
   borde
r:
       2
px solid
#fff;
}
@media (max-width: 720px) {
 .wrap
 per
 {
 marg
 in:
 2px;
} }
```

JS CODE:

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

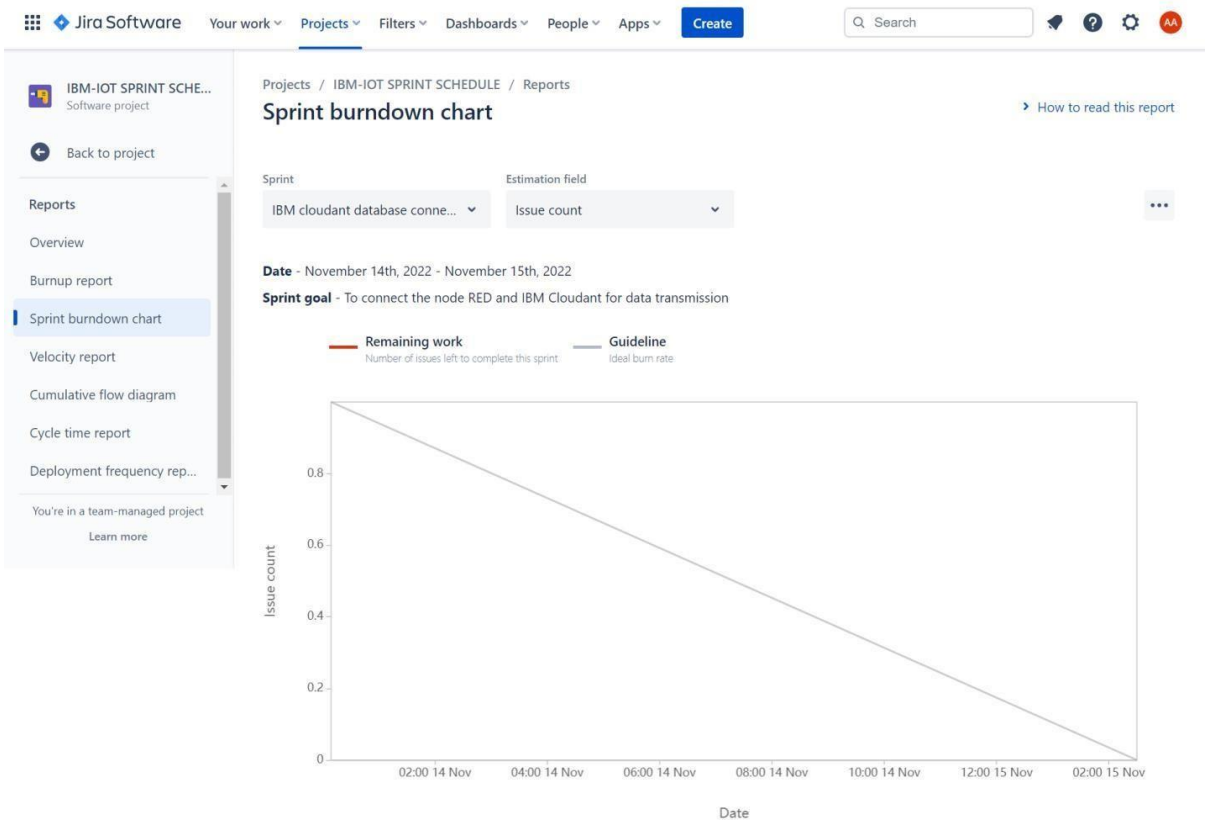
```
$("#register-box").show();

        });

        $("#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();

        });
    });
```

OUTPUT :


Playground title
Welcome Back!
To stay connected Please login with your personal info.
Sign In
Create Account
Full Name
E-Mail
Password
Confirm Password
Sign Up

Playground title
Sign in
E-Mail
Password
Remember me
Forgot Password?
Sign In
Welcome Friend!
Start your initiative to make your environment clean
Sign Up

SPRINT BURNDOWN CHART



7. CODING AND SOLUTION

7.1 Wokwi code for Sensor transmission

```
#include <WiFi.h> // library for wifi
#include <PubSubClient.h>
                    //
library for MQTT #include
<LiquidCrystal_I2C.h>
#include
<mjson.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 publishTopic[] = "iot-2/evt/data/fmt/json";
                                    // topic name and
```

```
type of event perform and format in which data to be
send
char topic[] = "iot-2/cmd/led/fmt/String"; // cmd
Represent type and command is test format of strings
char authMethod[] = "use-token-auth";
                                    //
authentication method char token[] =
TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
                                    //Client id

//

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

#define ECHO_PIN 12
#define
TRIG_PI
N 13
float
dist;
String data3;
bool
SealBin
= true;
void
setup()
{
 Serial.begi
 n(115200);
 pinMode(LED
 _BUILTIN,
```

```
OUTPUT);
pinMode(TRI
G_PIN,
OUTPUT);
pinMode(ECH
O_PIN,
INPUT);
//pir
pin
pinMode
(34,
INPUT);

//ledpin
s
pinMode(
23,
OUTPUT);
pinMode(
2,
OUTPUT);
pinMode(
4,
OUTPUT);
pinMode(
15,
OUTPUT);

lcd.init
();
lcd.back
```

```
 light();
 lcd.
 setCurso
 r(1, 0);
 lcd.prin
 t("");
 wifiConn
 ect();
 mqttConn
 ect();
}

float readcmCM()
{
 digitalWrit
 e(TRIG_PIN,
 LOW);
 delayMicros
 econds(2);
 digitalWrit
 e(TRIG_PIN,
 HIGH);
 delayMicros
 econds(10);
 digitalWrit
 e(TRIG_PIN,
 LOW);
 int duration =
 pulseIn(ECHO_PIN,
 HIGH); return
 duration * 0.034 /
```

```
void loop()
{

 lcd.clear();

 publi
 shDat
 a();
 delay
 (500)
 ;
 if (!client.loop())
  {
   mqttConnect();       // function call to connect to IBM
  }
}

/*               retrieving to cloud
                 */ void  wifiConnect()
{
 Serial.print("C
 onnecting to
 ");
 Serial.print("W
 ifi");
 WiFi.begin("Wok
 wi-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(5
      00);
     }
    initManagedDevice();
    Serial.println();
   }
 }
void initManagedDevice()
 {
  if (client.subscribe(topic))
   {
                                      }
   }                                 }
else
   {
```

```
Seri cribe to cmd OK");
al.p
rint
ln("
IBM
subs Serial.println("subscribe to cmd FAILED");
  void publishData()
  {
   float cm = readcmCM();

   if(digitalRead(34))  //pir motion detection
   {
    Serial.printl
    n("Motion
    Detected");
    Serial.printl
    n("Lid
    Opened");
    digitalWrite(
    15, HIGH);



  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.prin
 tln("Lid
 Closed");
 lcd.print("
 Full!  Don't
 use");
 delay(2000)
 ;
 lcd.clea
 r();
 digitalW
 rite(4,
 LOW);
 digitalW
 rite(23,
 LOW);
}
else if(cm > 100 && cm < 180)
{
 digitalWrite(4, HIGH);
 Serial.println("Warning!!,Trash
 is about to cross 50% of bin
 level"); digitalWrite(2,  LOW);
 digitalWrite(23, LOW);

}
else if(cm > 180)
{
 digitalWrite(2
 3, 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(1
 5, LOW);
 digitalWrite(4
 , LOW);
 digitalWrite(2
 3, LOW);
}

}
 else
 {
 digitalWrite(15, LOW);

 }
```

```
 if(cm <= 100)
{
digitalWrite(21,HIGH);
String payload
=
"{\"High_Alert
\":"; payload
+= cm;
payload += "
}";
Serial.print(
"\n");
Serial.print(
"Sending
payload: ");
Serial.printl
n(payload);

if (client.publish(publishTopic, (char*)
payload.c_str()))          // if data is uploaded to
cloud successfully,prints publish ok else prints
publish failed
{
Serial.println("Publish OK");
}
}
else if(cm <= 180)
{
digitalWrite(22,HIGH);
String
payload =
```

```
"{\"Warning\"
:"; payload
+= cm ;
payload += "
}";
Serial.print(
"\n");
Serial.print(
"Sending
payload: ");
Serial.printl
n(payload);
if(client.publish(publishTopic, (char*) payload.c_str()))
{
Serial.println("Publish OK");
}
else
```

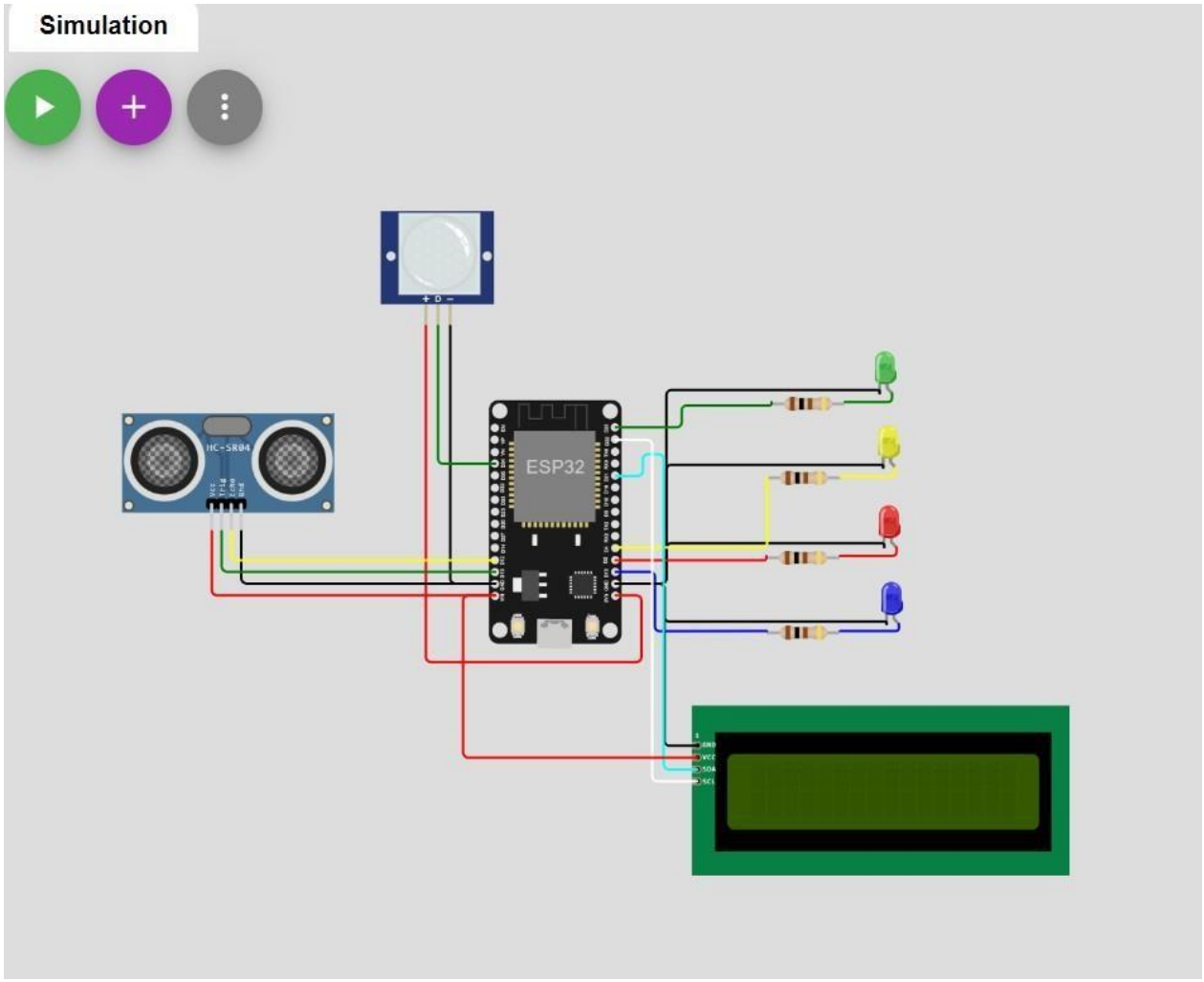
```
{
Serial.println("Publish FAILED");
}
}
else if(cm > 180)
{
digitalWr
ite(23,HI
GH);
String
payload =
"{";
payload
+= cm;
payload += "
}";
Serial.print(
"\n");
Serial.print(
"Sending
payload: ");
Serial.printl
n(payload);

if (client.publish(publishTopic, (char*)
payload.c_str()))          // if data is uploaded to
cloud successfully,prints publish ok else prints
publish failed
{
Serial.println("Publish OK");
}
```

```
}

 float inches = (cm / 2.54);
                                //pri
 nt on lcd lcd.setCursor(0,0);
 lcd.prin
 t("Inche
 s");
 lcd.setC
 ursor(4,
 0);
 lcd.setr
 sor(12,0
 );
 lcd.prin
 t("cm");
 lcd.setC
 ursor(1,
 1);
 lcd.prin
 t(inches
 , 1);
 lcd.setC
 ursor(11
 ,1);
 lcd.prin
 t(cm,
 1);
 lcd.setC
 ursor(14
 ,1);
```

```
 delay(10
 00);
 lcd.clea
 r();
}

//handles commands from user side

void callback(char* subscribetopic, byte* payload, unsigned
int payloadLength)
{

 Serial.print("callback invoked for topic: ");
 Serial.println(subscribetopic);
 for (int i = 0; i < payloadLength; i++) {

  data3 += (char)payload[i];
 }
 Serial.println("data: "+ data3);

 const char *s
 =(char*)
 data3.c_str();
 double pincode
 = 0;


    const
    char
    *buf;
    int
    len;
```

```
    if (mjson_find(s, strlen(s), "$.command", &buf, &len)) //
    And print it
    {
     String
     command(buf,le
     n);
     if(command=="\
     "SealBin\"")
     {
      SealBin = true;

     }


     }

 data3="";
}
```

7.2 . Sensor Connection Setup

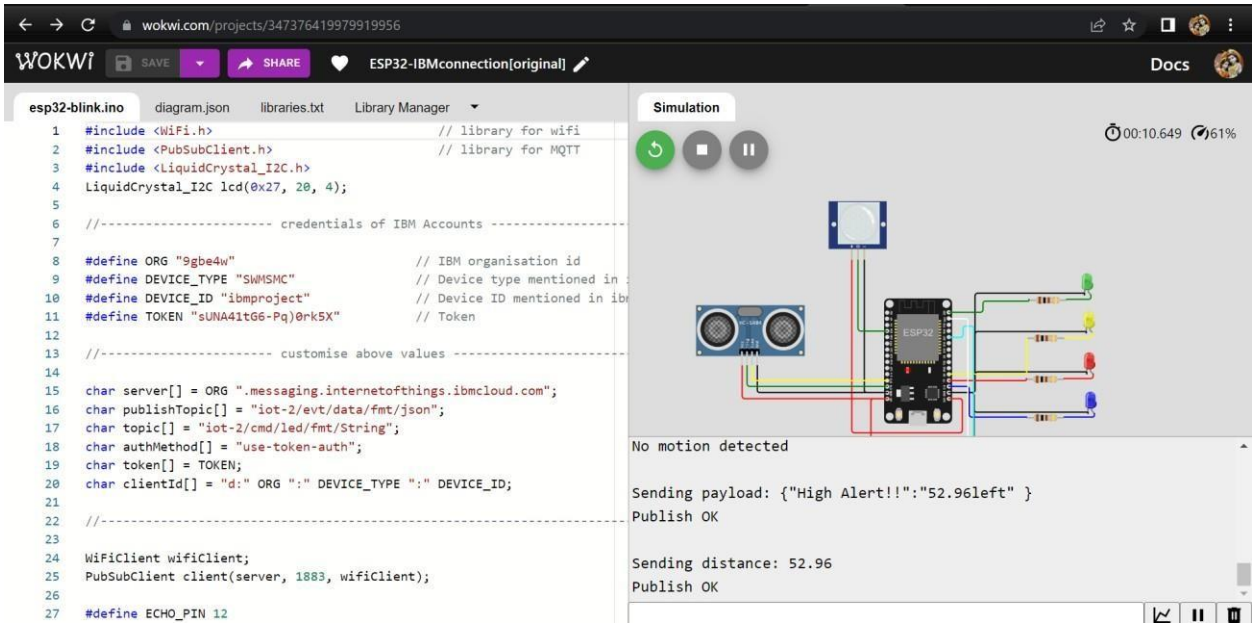


PHYSICAL COMPONENTS:

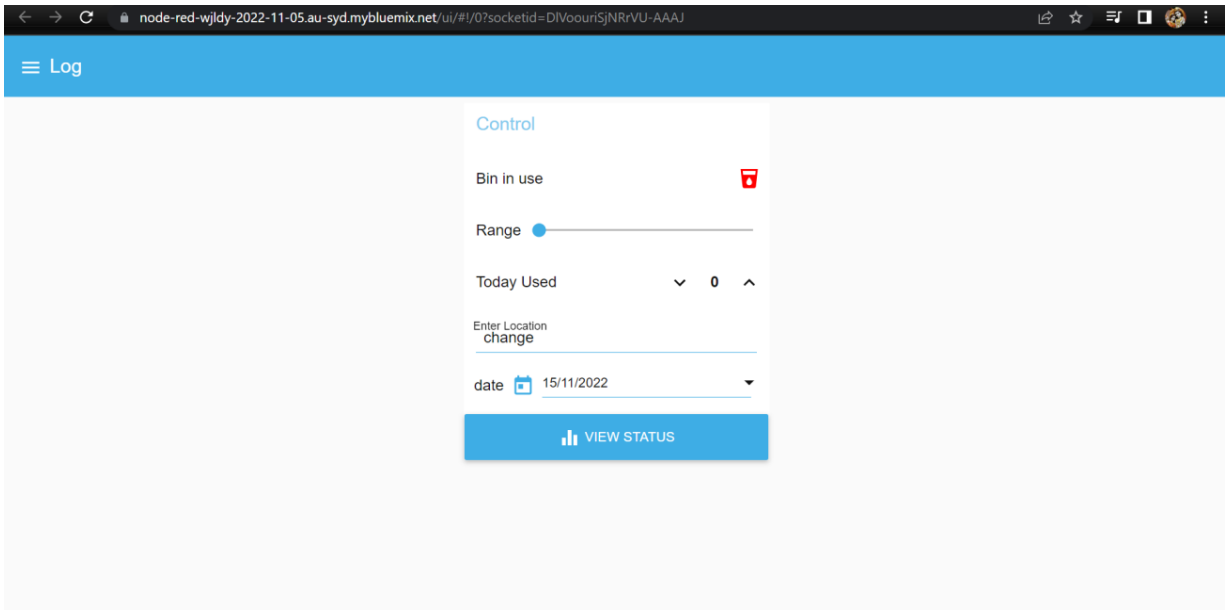
- PIR MOTION SENSOR
- ULTRASONIC DISTANCE SENSOR
- ESP32-ARDUINO MICROCONTROLLER

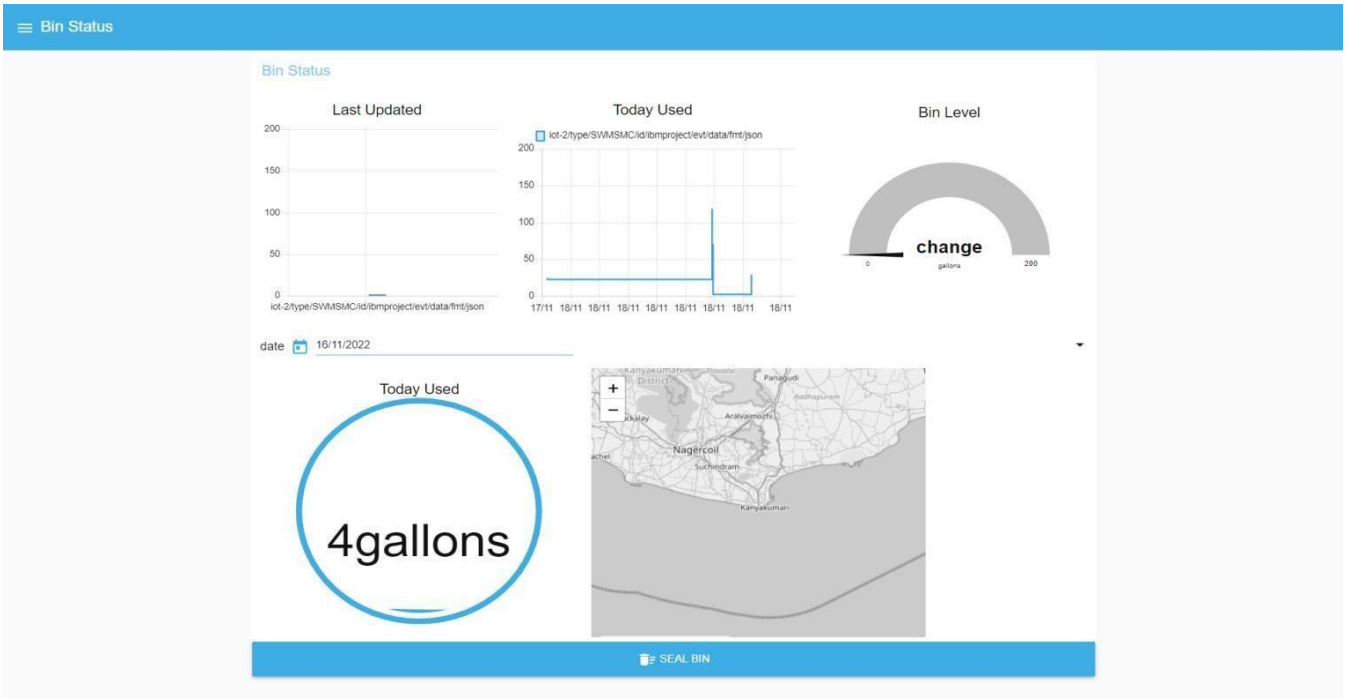
OUTPUT:

WOKWI


wokwi.com/projects/347376419979919956
WOKWI
SAVE
SHARE
ESP32-IBMconnection[original]
Docs
esp32-blink.ino
diagram.json
libraries.txt
Library Manager
#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
#define DEVICE_ID "ibmproject" // Device ID mentioned in ib
#define TOKEN "sUNA41tG6-Pq)0rk5X" // Token
//---------- customise above values ----------
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";
char publishTopic[] = "iot-2/evt/data/fmt/json";
char topic[] = "iot-2/cmd/led/fmt/String";
char authMethod[] = "use-token-auth";
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
//---------- ----------
WiFiClient wifiClient;
PubSubClient client(server, 1883, wifiClient);
#define ECHO_PIN 12
Simulation
00:10.649
61%
ESP32
No motion detected
Sending payload: {"High Alert!!":"52.96left" }
Publish OK
Sending distance: 52.96
Publish OK

WEB UI


node-red-wjldy-2022-11-05.au-syd.mybluemix.net/ui/#!/0?socketid=DlVoouriSjNRrVU-AAAJ
Log
Control
Bin in use
Range
Today Used
0
Enter Location
change
date
15/11/2022
VIEW STATUS



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 Highalert and closes the bin. If the admin wants to seal the bin the admin can command seal bin until it is accessed for cleaning.

Test Case:

Maximum Size of Bin : 200 cm Safe limit: below 100 cmMinimum 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*	*Kanyakumariri*
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	*19 5*	*High_Al e rt*	*Neyveli*
20	*80*	*Safe*	*Krishnagiri*

USER ACCEPTANCE TESTING

1.Purpose of Document

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

2.Defect Analysis

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

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

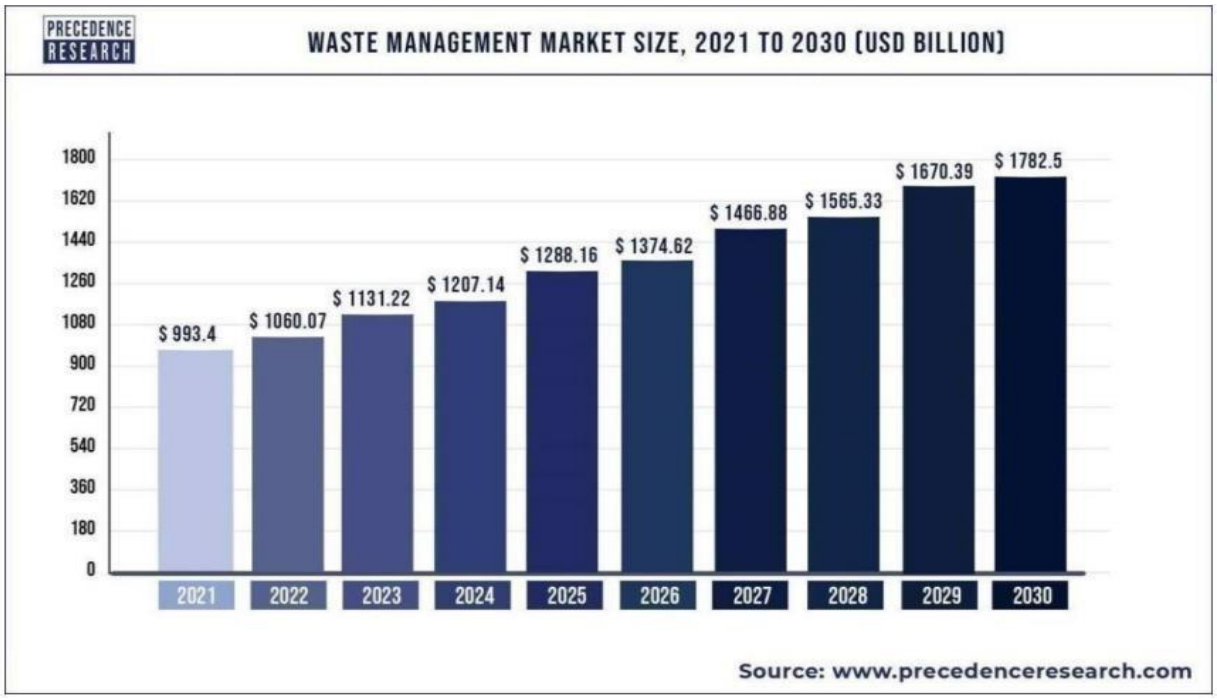
1. TEST CASE ANALYSIS

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

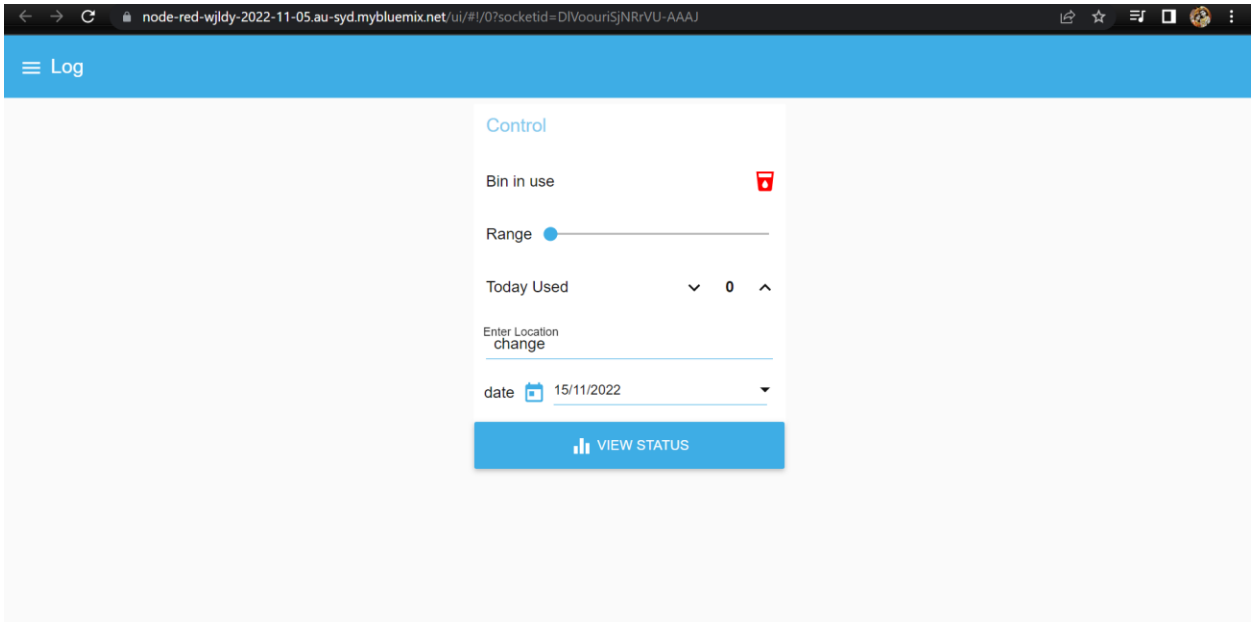
Section	Total Cases	Not Tested	Fail	Pass
Print Engine	7	0	0	7
Client Application	51	0	0	51
Security	2	0	0	2
Outsource Shipping	3	0	0	3
Exception Reporting	9	0	0	9
Final Report Output	4	0	0	4
Version Control	2	0	0	2

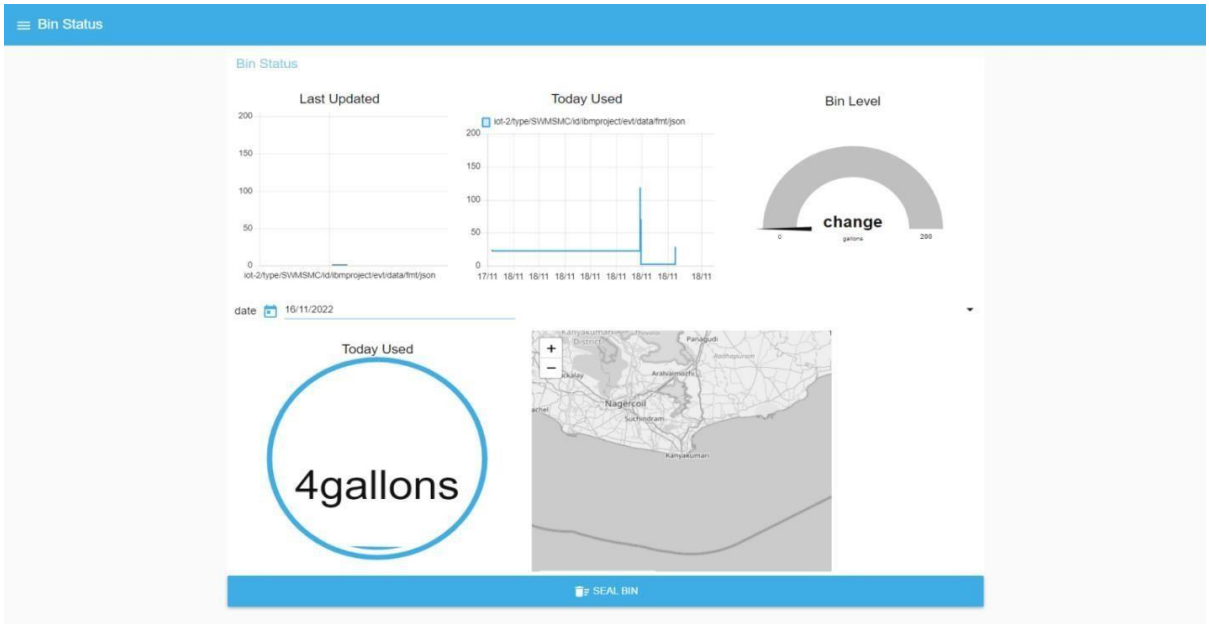
9. RESULTS

9.1. Performance Metrics


PRECEDENCE RESEARCH
WASTE MANAGEMENT MARKET SIZE, 2021 TO 2030 (USD BILLION)
1800
1620
1440
1260
1080
900
720
540
360
180
0
$ 993.4
$ 1060.07
$ 1131.22
$ 1207.14
$ 1288.16
$ 1374.62
$ 1466.88
$ 1565.33
$ 1670.39
$ 1782.5
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
Source: www.precedenceresearch.com

9.2 . Admin Web UI





10. ADVANTAGES AND DISADVANTAGES

10.1. ADVANTAGES

- Reduction in Collection Cost
- No Missed Pickups
- Reduced Overflows
- Waste Generation Analysis
- CO2 Emission Reduction

10.2 DISADVANTAGES

- System requires a greater number of waste bins for separate waste collection as perpopulation in the city.
- 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.

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 enoughsolid trash for a single unit. But these may price bit high.

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 inprotecting 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

14. APPENDIX

- **Esp32 - Microcontroller** :

  ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi anddual-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 sensemotion, 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 thetarget by measuring the time between the emission and reception.
- An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e. the sound that humans can hear).

13.2 . GITHUB LINK

LINK : *https://github.com/IBM-EPBL/IBM-Project-44798-1660726828*

VIDEO DEMO LINK:

https://drive.google.com/file/d/1A1oM4rRle6-0_Rrn7WhPUpV8bLnpPLoC/view?usp=share_link

Smart Waste Management System

- Home
- Features
- Our Team
- Services
- Products Details
- Contact Us
- For Details

Menu

SWMS

Real-time data & Easy-to-integrate

Call For Quote

01 Automating waste collection in factories
02 Digitalization of post-consumer recycling process
03 Monitoring Street Bins at University Campus, Park or City Center
04 Waste Monitoring of Semi-Underground and Underground Bins

80%Real-time data
95Easy-to-integrate
90%Digital database
80%Monitoring

Our Team

We *are most* interested & in research work

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(610819205025)

Discover Proucts

Our Services

Discover What We Do & Offer To Our *Clients*

1Real-time waste monitoring Predictions for

2.bin fulness

3.Detailed database of bins and stands Interactive bin

4.map including Street viewRoute planning for waste

5.collection Overview of scheduled and executed routesn

database of citizen reports.

6.Fire and tilt alarm

CREATE ACCOUNT

SIGN IN

DEVELOPMENT

WASTE MANAGEMENT

Node-RED Connection

MAIN

FLOW DIAGRAM

LOCATION TRACK

Contact Us

Fill Out The Form Below To Get In *Touch* With Us

Send Message Now

- info@swmsworld.com

- +91 63808 90185