SMART WASTE MANAGEMENT FOR METROPOLITAN CITIES

IBM PROJECT REPORT

Team ID - PNT2022TMID07372

SUBMITTED BY

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1.INTRODUCTION

a.Project Overview

In today's world hygiene had became one of the most imperative topic. The ineffectiveness of a proper disposal and collection of wastage is resulting in diseases which are easily prevalent in nature. Due to improper waste disposal we may face several problems like unpleasant odour and health problems to the mankind. The Smart waste management focusses on delivering a better hygiene by proper and a documented way of collection of garbage and disposal. It's main statement is to step towards a better future where one can resilient through with the garbage or disposal problems.The Internet of Things (IoT) is a concept in which surrounding objects are connected through wired and wireless networks without user intervention. In the field of IoT, the objects communicate and exchange information to provide advanced intelligent services for users.This project deals with the problem of waste management in smart cities, where the garbage collection system is not optimized. This project enables the organizations to meet their needs of smart garbage management systems. This system allows the user to know the fill level of each garbage bin in a locality or city at all times, to give a cost-effective and time-saving route to the truck drivers.

b.Purpose

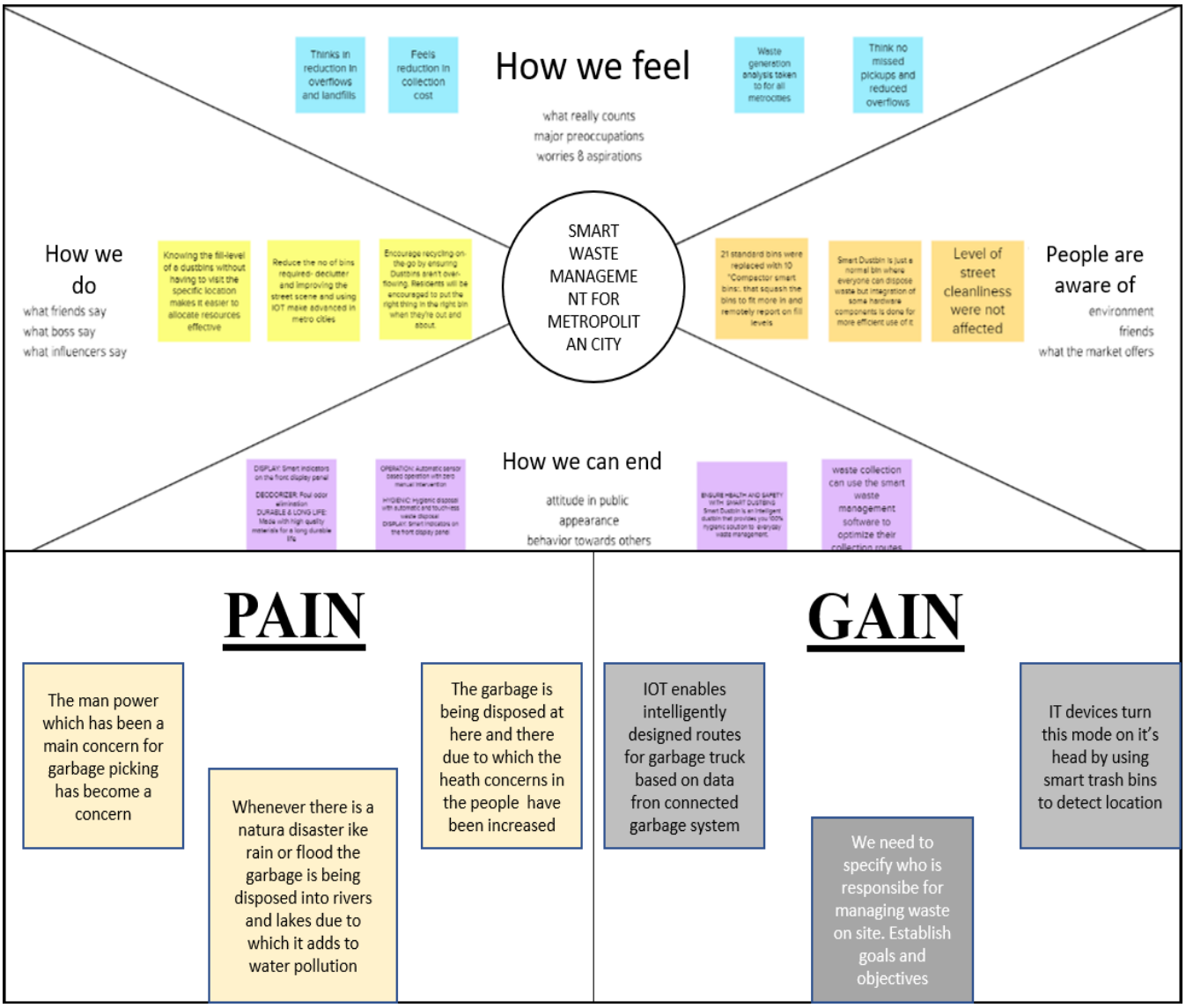
- Cleaning the environment is the key to existence and survival of life on planet earth.
- Maintaining a clean environment reduces pollution, preserves our biosphere, protects endangered species, and also helps preserve the earth's natural resources
- Disease free surrounding
- In society, the state of cleanliness of a society represents the mindset.

2.LITERATURE SURVEY

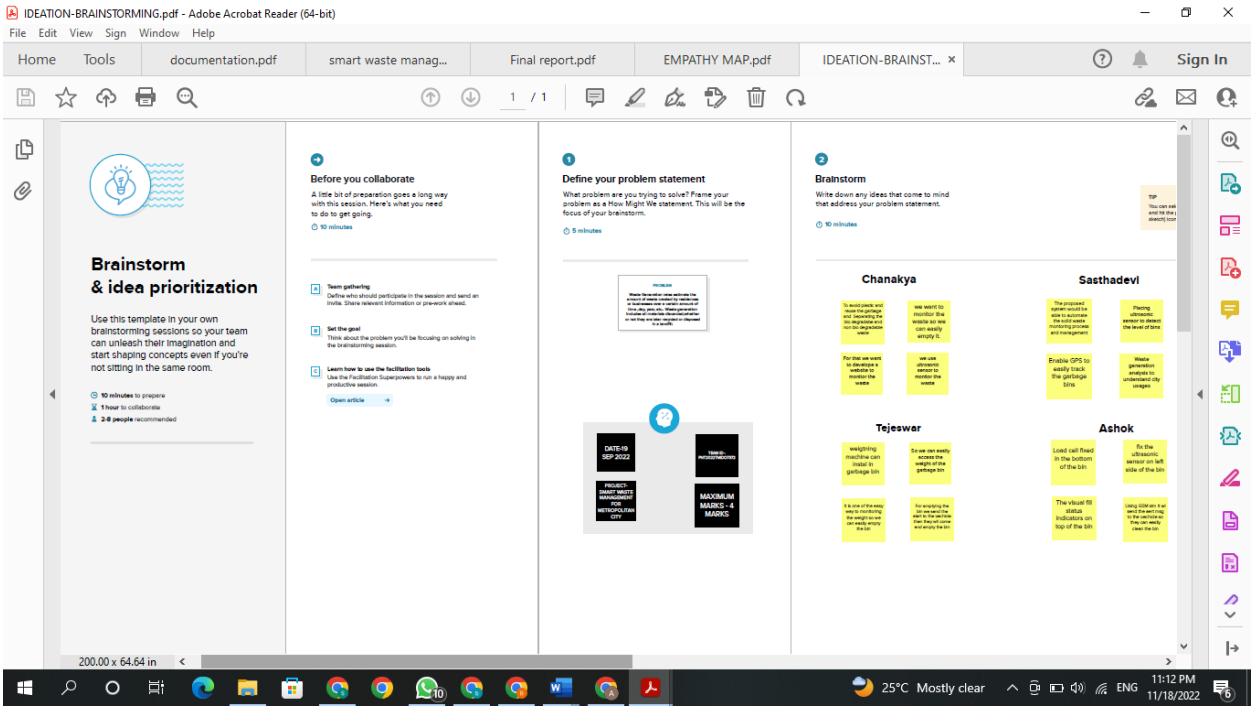
TITLE	AUTHOR	YEAR	FEATURES
Smart Bin for waste management system	S.Sreejith,R.Ramya,R.Roja,A.Sanjay Kumar	2019	Monitor the level of waste Easy to use and very cheap
Automatic waste segregation and management	V.P.Ajay,M.Bradeep Kumar,Kishanth,Vaishnavi Kumar,P.Santhiya Devi,K.Thenmozhi	2020	Metallic and non-metallic waste is stored Easy to use and stored
Blockchain for Waste Management in Smart Cities	Raja Wasim Ahmad	2021	Blockchain technology can be leveraged for managing waste within smart cities in a manner that is decentralized,temper-proof, transparent, traceable and trackable, auditable, secure and trustworthy.
Assessing the Adaptation of Internet of Things (IoT) Barriers for Smart Cities' Waste Management Using Fermatean Fuzzy Combined Compromise Solution Approach	Arunodaya R. Mishra	2022	To improve the quality of life and achieve sustainability It is flexible for solving MADM problems

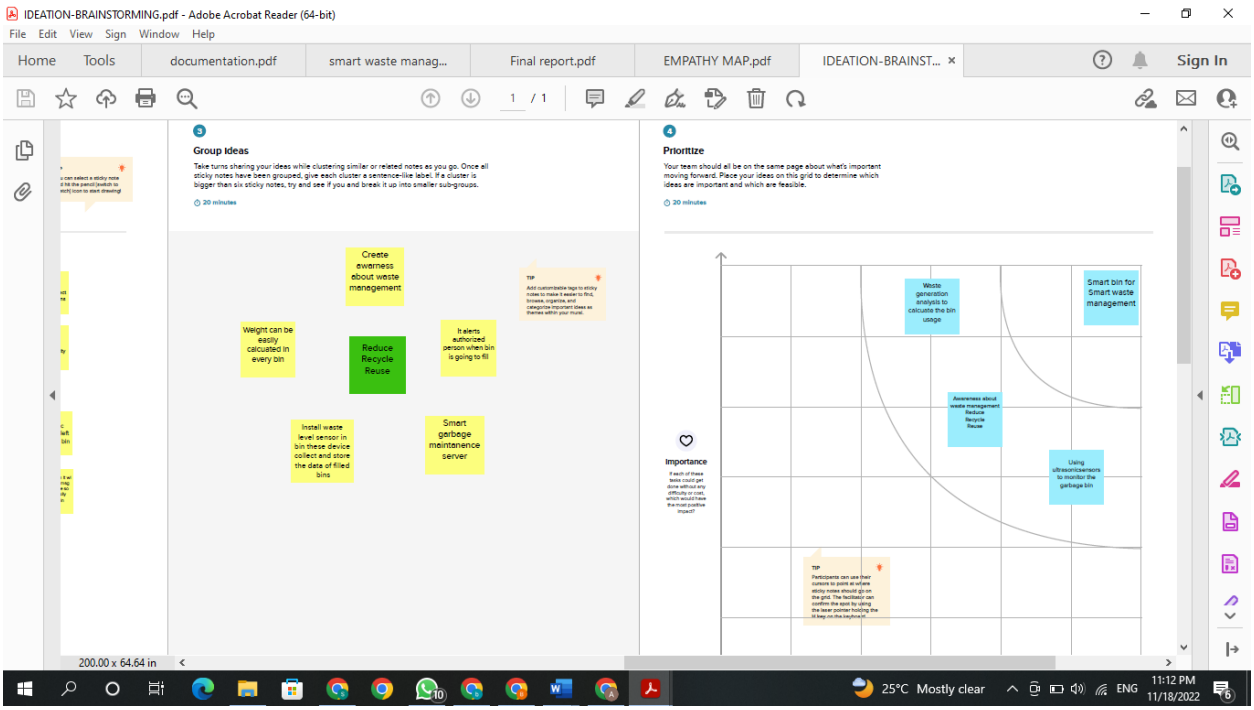
3.IDEATION AND PROPOSED SOLUTION

a.Empathy Map



b.Ideation And Brainstorming

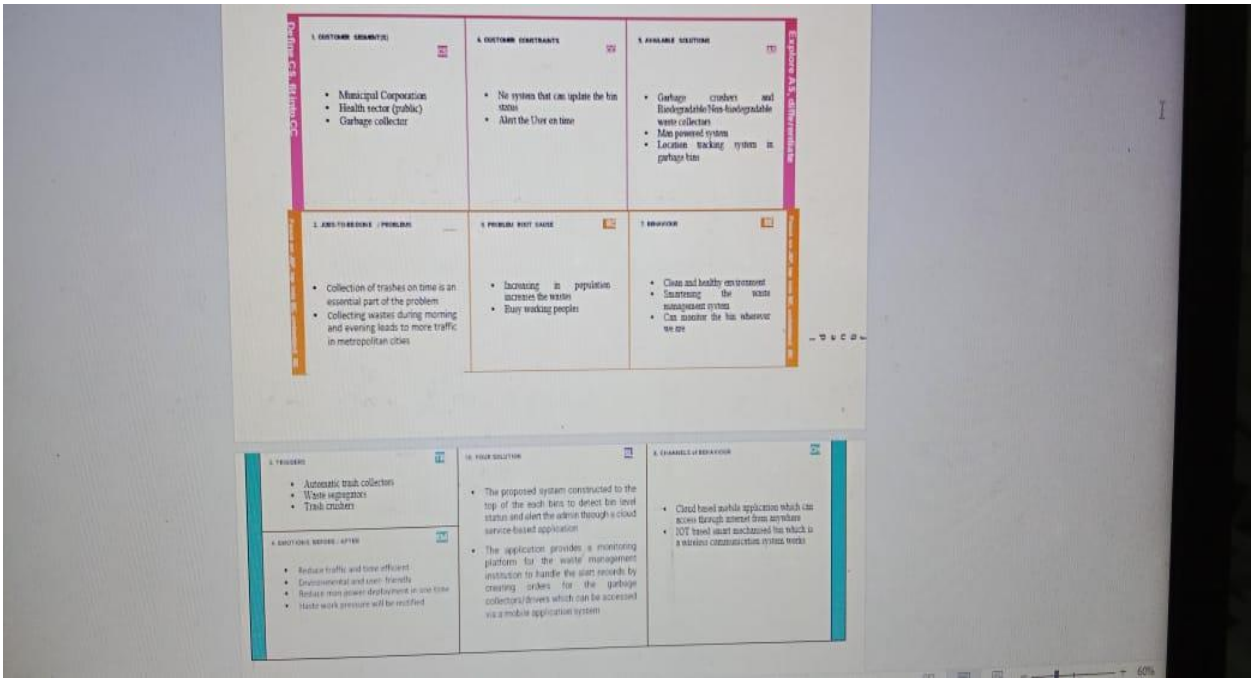




c.Proposed Solution

S.No.	Parameter	Description
	Problem Statement (Problem to be solved)	The problem of this project is waste management system in smart cities An inefficient waste management may cause the serious impacts on environment like infectious diseases, air and land pollution etc .. Due to improper waste disposal we may face several problems like unpleasant odour and health problems Collection of trashes on time is the essential part of the problem.
	Idea / Solution description	The proposed system constructed in the top of the garbage bin to detect the bin level and alert the authorized person by using the cloud service application . To solve this problem waste management here we use Technologies like ultrasonic sensor ,node MCU etc..
	Novelty / Uniqueness	To reduce the difficulty in collecting the garbage. Day and Night monitoring System. IOT based smart bin for waste management.
	Social Impact / Customer Satisfaction	Reduce the manpower. Clean and Healthy environment. Reduce traffic.
	Business Model (Revenue Model)	It generates revenue through the provision of various waste management and disposal service. This is intends to assist the municipal corporation.
	Scalability of the Solution	It can be updated to automated garbage collection through vehicles. The constant monitoring of garbage bins may save a lot of time. No need of new establishment.

d.Problem Solution Fit



4.REQUIREMENT ANALYSIS

a.Funtional Requirement

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through email and mobile number
FR-2	User Confirmation	Confirmation via Email and Confirmation via OTP
FR-3	Web Application	Node Red Service
FR-4	Device Configuration	IBM Watson IOT platform
FR-4	Bin monitoring	The sensors monitor the garbage bins and it alert the authorized person when the bin will be filled based on the past data and capacity of the bin. Thesensor will know when the bin was last emptied .So we can eliminate overflowing bins and cease collecting the empty ones.

b.Non Funtional Requirement

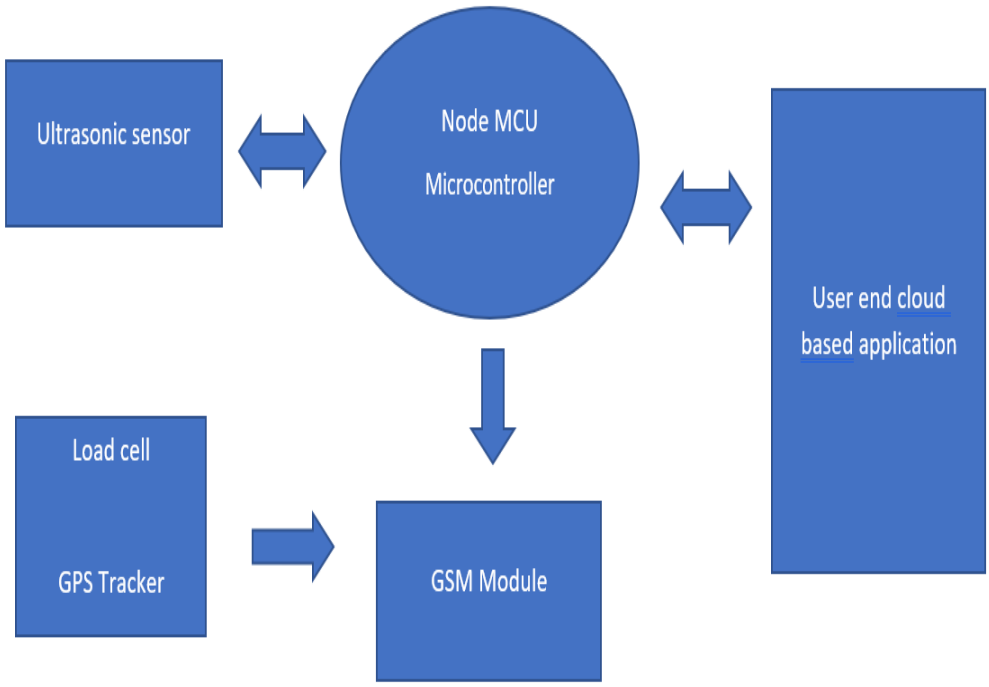
FR No.	Non-Functional Requirement	Description
NFR-1	Usability	Usability is a unique and significant perspective to examine user needs, which may further enhance the design quality, according to IOT devices.To study the customers product usability can help desiners to understand better
NFR-2	Security	Security is enhanced as the system has a secured login/registration page and even the data is stored in a secured manner
NFR-3	Reliability	This is also about creating better working conditions for waste collectors and drivers. The drivers can access the bin level and location of bin and update the status of each bin.
NFR-4	Performance	We use Sensors to measure the fill levels and other datas in bins several times a day

NFR-5	Availability	This system is avaiabe for al time so we can easily collect the garbage on time
NFR-6	Scalability	The scalability is very high because it reduces the number of bins and it is cost effective

5.PROJECT DESIGN

a.Data Flow Daigram

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



b.Solution And Technical Architechture

c.User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Admin	Login	USN-1	The admin manages all the details of Garbage bin and workers of each area.	Admin can access the account and dashboard	Medium	Sprint-1
		USN-2	If any wrong in the application co admin will take of it.	Authorized person is monitoring the qarbage bin	High	Sprint-1
Truck driver	Login	USN-3	The truck driver should follow the admin to view bin level data and empty them	Driver will go to the correct root where the bin is fil	High	Sprint-2
Garbage collector	Login	USN-4	After a collecting bin they can report on to the admin through application	Collector collect the garbage from the bin	High	Sprint-3
Municipality Corporation	Login	USN-5	In municipality, they will check if there is any issues in collectinq bin	Municipality manages all this task	Medium	Sprint-4

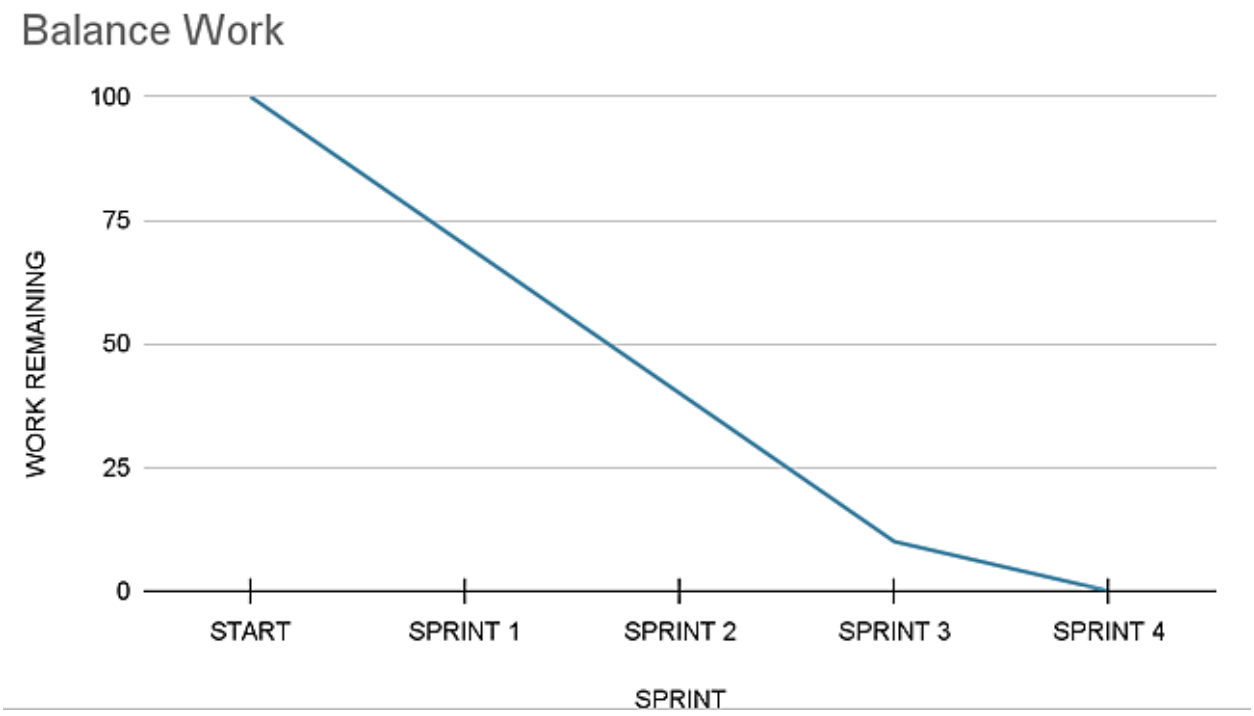
6.PROJECT PLANNING AND SCHEDULING

a.Sprint Planning and Estimation

Sprint	Functional Requirement (Epic)	User Story Number	User Story/ Task	Story Points	Priority	Team Members
Sprint-1	Admin	USN-1	Admin need to give the user id and workers in municipality and the monitor the bin	1	Medium	Pentakota Chanakya, Sasthadevi N Tejeswar Reddy, Ashokkumar
Sprint-2	Truck driver	USN-3	Truck driver need to follow the co admin and go to the place where the bin is filled	2	High	Pentakota Chanakya, Sasthadevi N Tejeswar Reddy, Ashok kumar
Sprint-3	Garbage Colector	USN-4	Collector need to coect the garbage in the bin on time	2	High	Pentakota Chanakya, Sasthadevi N Tejeswar Reddy, Ashok kumar
Sprint-4	Municipality Corporation	USN-5	Municipality peoples need to assure that the process is done correctly	2	Medium	Pentakota Chanakya, Sasthadevi N Tejeswar Reddy, Ashok kumar

b.Sprint Delivery Plan

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	1 Nov 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov2022	20	10 Nov2022
Sprint-3	20	6 Days	07 Nov2022	12 Nov2022	20	15 Nov2022
Sprint-4	20	6 Days	14 Nov2022	19 Nov2022	20	19 Nov



7.CODING AND SOLUTION

a.Feature Code

ULTRASONIC SENSOR CODE:

```
int LED = 12;
int LED1=13;
int LED2=11;
int obstaclePin = 8;
int obstaclePin1 = 9;
int obstaclePin2 = 10;
void setup()
{
  pinMode(LED, OUTPUT);
  pinMode(obstaclePin, INPUT);
  pinMode(LED1, OUTPUT);
  pinMode(obstaclePin1, INPUT);
  pinMode(LED2, OUTPUT);
  pinMode(obstaclePin2, INPUT);
    Serial.begin(9600);
}
void loop() {
  int hasObstacle = digitalRead(obstaclePin);
  int hasObstacle1= digitalRead(obstaclePin1);
  int hasObstacle2=digitalRead(obstaclePin2);
  Serial.println(hasObstacle);
  Serial.println(hasObstacle1);
  Serial.println(hasObstacle2);
  if (hasObstacle == HIGH)
  {
    digitalWrite(LED, HIGH);
  }
  else
  {
    digitalWrite(LED, LOW);
  }
  if (hasObstacle1 == HIGH)
  {
    digitalWrite(LED1, HIGH);
  }
  else
  {
    digitalWrite(LED1, LOW);
  }
  if (hasObstacle2 == HIGH)
  {
    digitalWrite(LED2, HIGH);
  }
  else
  {
```

```
    digitalWrite(LED2, LOW);
   }
   delay(1500);
}
```

WEIGHT DETECTION CODING (LOAD CELL):

```
#include <Arduino.h>
#include "HX711.h"
const int LOADCELL_DOUT_PIN = 2;
const int LOADCELL_SCK_PIN  = 3;

HX711 scale;

void setup() {
  Serial.begin(57600);
  Serial.println("HX711 LOAD AMPLIFIER");
  Serial.println("INITIALIZING SCALE");

  scale.begin(LOADCELL_DOUT_PIN, LOADCELL_SCK_PIN);

  Serial.println("BEFORE SETTING UP THE SCALE :");
  Serial.print("READ : \t\t ");
  Serial.println(scale.read());
  Serial.print("READ AVERAGE : \t\t ");
  Serial.println(scale.read_average(20));
  Serial.print("GET VALUE : \t\t ");
  Serial.println(scale.get_value(5));

  Serial.print("GET UNITS : \t\t ");
  Serial.println(scale.get_units(5), 1);
  scale.set_scale(36.059);
  scale.tare();
  Serial.println("AFTER SETTING UP SCALE :");

  Serial.print("READ : \t\t ");
  Serial.println(scale.read());

  Serial.print("READ AVERAGE : \t\t ");
  Serial.println(scale.read_average(20));
  Serial.print("GET VALUE : \t\t ");
  Serial.println(scale.get_value(5));
  Serial.print("GET UNITS : \t\t ");
  Serial.println(scale.get_units(5), 1);
  Serial.println("READINGS : ");
}

void loop() {
  Serial.print("WEIGHT IN KG : \t ");
```

```
        Serial.print(scale.get_units()/1000, 1);
        Serial.print("\t AVERAGE : \t ");
        Serial.println(scale.get_units(10), 5);

        delay(5000);
}
```

b.Feature Code 2

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 For Metropolitan Cities</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 the initiate 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.</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>
   <!-- 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; 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 { borderradius:
 100px; width:
    50%;
    border:
    2px
 solid #fff;
}
@media (max-width: 720px) {
 .wrapper
  { margin:
  2px;
```

```
    } }
```

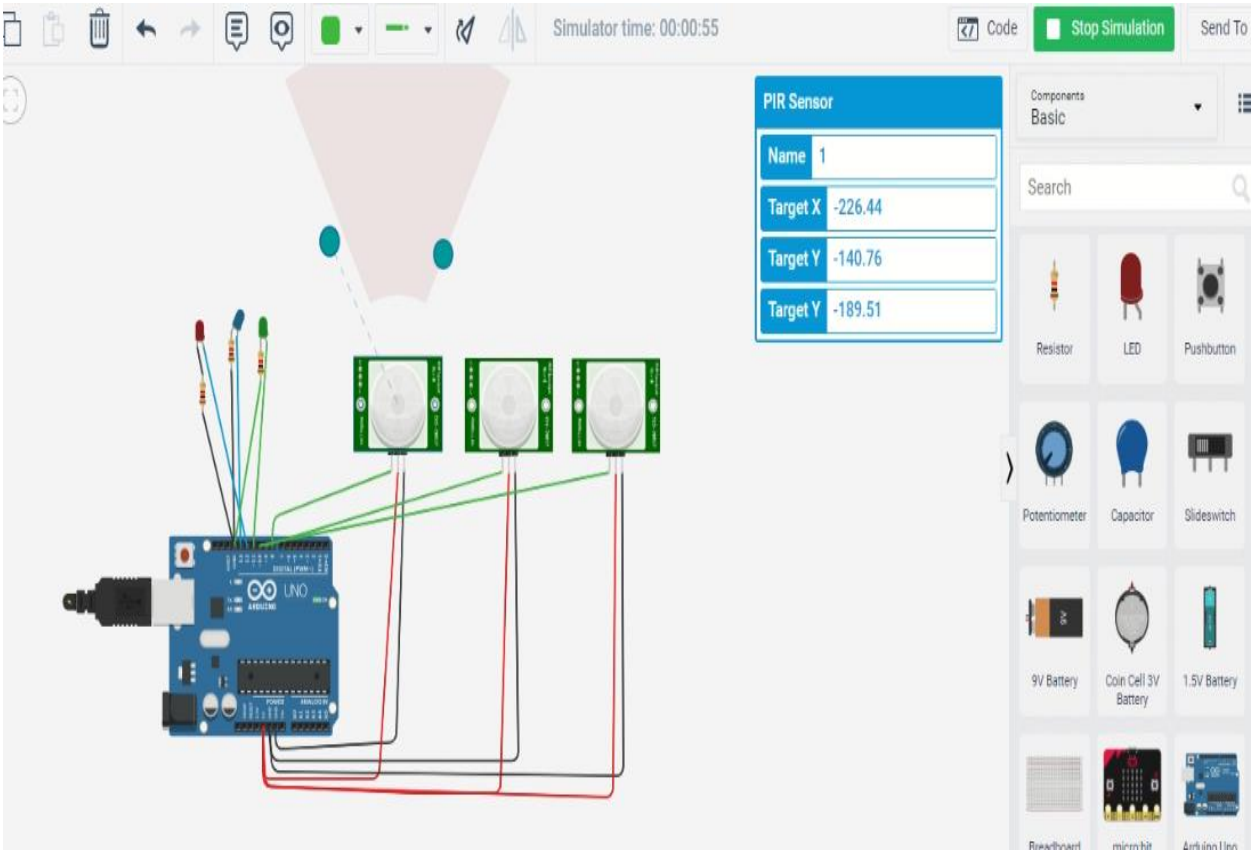
JS CODE:

```
  $(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();
  });
});
```

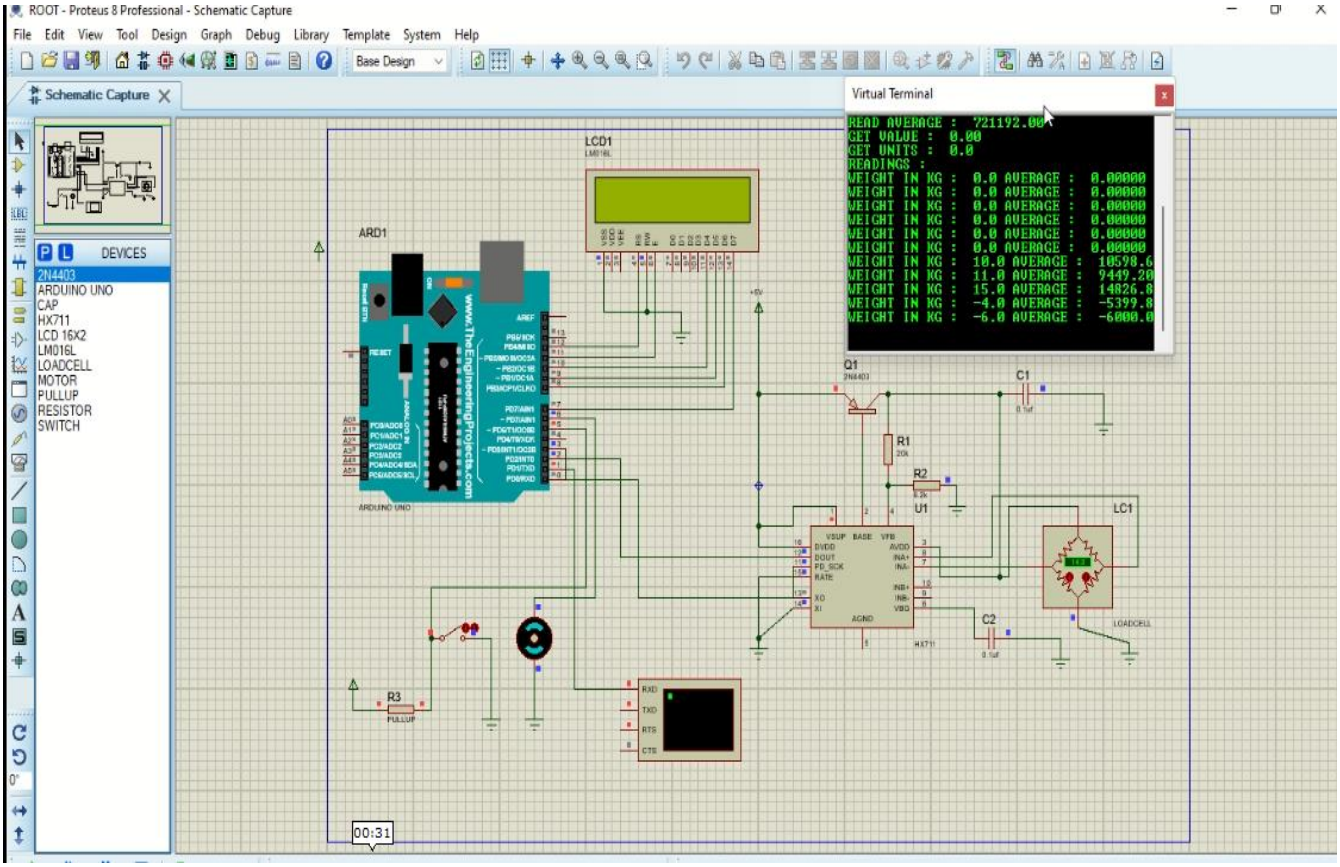
8.TESTING

a.Simulation daigram

Ultrasonic sensor simulation

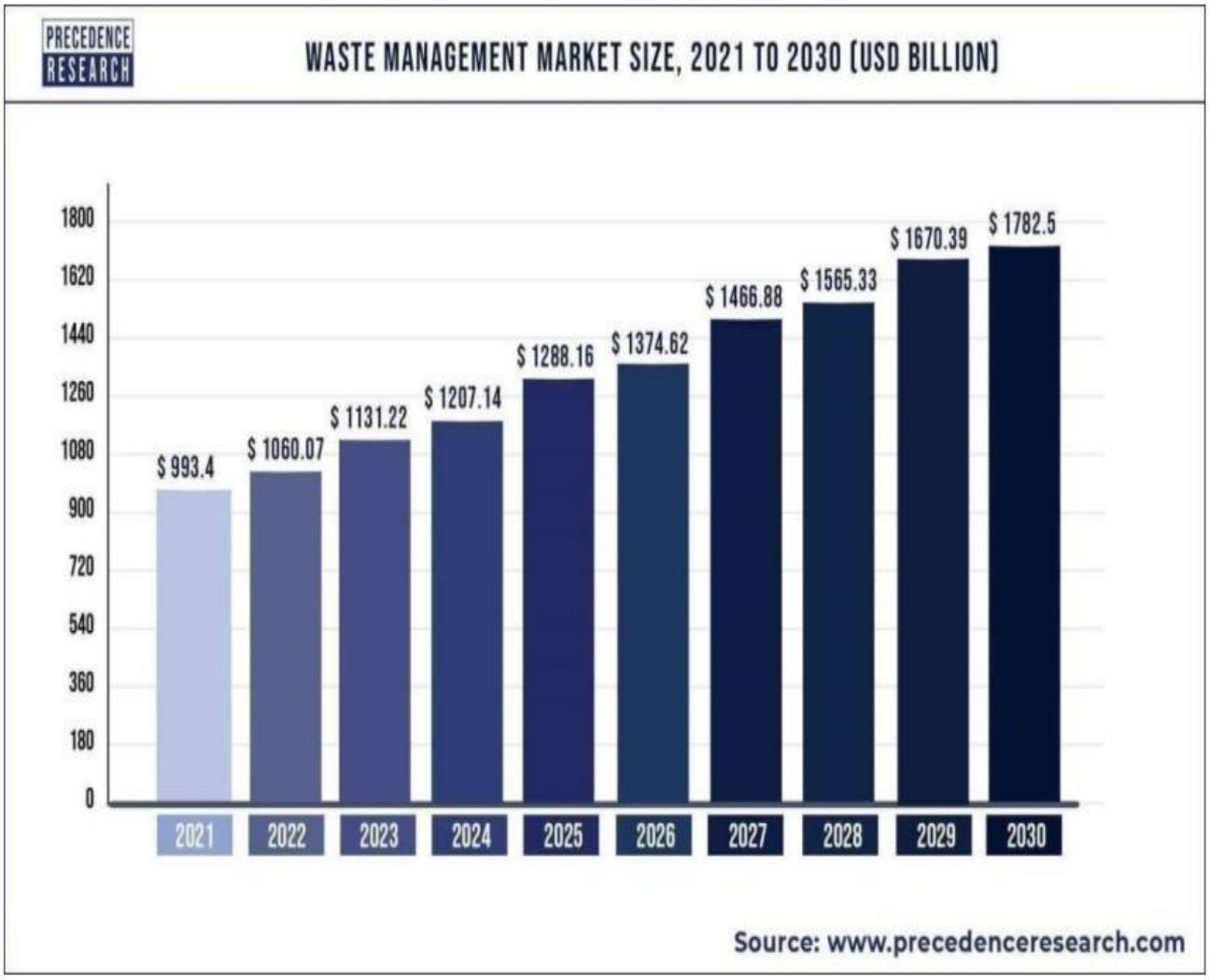


loadcell simulation



9.RESULTS

a.Performance Metrix



10.ADVANTAGES AND DISADVANTAGES

Advantages

- Reduction in Collection Cost
- Waste Generation Analysis
- Clean and Healthy Environment
- Disease Free Cities

Disadvantages

- System requires a greater number of waste bins for separate waste collection as per population 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

The behaviour of generating garbage is too dangerous not only for today's generation, but also for future generations. It is critical to educate people and encourage them to practise Recycle, Reuse, and Reduce instead of producing waste. Waste disposal should be a priority for municipalities and governments.

12.FUTURE SCOPE

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 ‘Swach 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.

13.APPENDIX

a.Source code

```
int LED = 12;
int LED1=13;
int LED2=11;
int obstaclePin = 8;
int obstaclePin1 = 9;
int obstaclePin2 = 10;
void setup()
{
  pinMode(LED, OUTPUT);
  pinMode(obstaclePin, INPUT);
  pinMode(LED1, OUTPUT);
  pinMode(obstaclePin1, INPUT);
  pinMode(LED2, OUTPUT);
  pinMode(obstaclePin2, INPUT);
    Serial.begin(9600);
}
void loop() {
  int hasObstacle = digitalRead(obstaclePin);
  int hasObstacle1= digitalRead(obstaclePin1);
  int hasObstacle2=digitalRead(obstaclePin2);
  Serial.println(hasObstacle);
  Serial.println(hasObstacle1);
  Serial.println(hasObstacle2);
  if (hasObstacle == HIGH)
  {
    digitalWrite(LED, HIGH);
  }
  else
  {
    digitalWrite(LED, LOW);
  }
  if (hasObstacle1 == HIGH)
  {
    digitalWrite(LED1, HIGH);
  }
  else
  {
    digitalWrite(LED1, LOW);
  }
  if (hasObstacle2 == HIGH)
  {
    digitalWrite(LED2, HIGH);
  }
  else
  {
    digitalWrite(LED2, LOW);
  }
  delay(1500); }
```

b.Gitrepo and Demo link

Gitrepo

link - https://github.com/IBM-EPBL/IBM-Project-44741-1660726563

Demo link

https://drive.google.com/file/d/1YC6BbtWpeMb9UgSfbVXLMyE1rOMTSQhQ/view?usp=drivesdk

Node Red Link

https://node-red-wjldy-2022-11-05.au-syd.mybluemix.net/ui/#!/0?socketid=PyqH93j_A9ODVDSLAAAB