**Project Report**

### **Smart Waste Management System For Metropolitan Cities**

**1. INTRODUCTION**

**1.1 Project Overview :**

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

**1.2 Purpose :**

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

**2.LITERATURE SURVEY**

**2.1 Existing Problem :**

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

**2.2 References :**

[1] Shyam, Gopal Kirshna, Sunilkumar S. Manvi, and Priyanka Bharti. "Smart waste management using Internet-of-Things

(IoT)." IEEE Computing and Communications Technologies (ICCCT), (2017) pp. 199-203.

[2] Kurre, Vishesh Kumar. "Smart Garbage Collection Bin overflows Indicator using IOT." International Research Journal

of Engineering and Technology (IRJET) (2016).

[3] Folianto, Fachmin, Yong Sheng Low, and Wai Leong Yeow. "Smartbin: Smart waste management system." Tenth IEEE

International conference on Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), (2015).

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

Wireless and Optical Communications

[5] Kumar, S. Vinoth, T. Senthil Kumaran, A. Krishna Kumar, and MahanteshMathapati. "Smart garbage monitoring and

clearance system using internet of things." IEEE Smart Technologies and Management for Computing, Communication,

Controls, Energy and Materials, (2017).

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

[7] Amoo OM, Fangbale RL (2013). Renewable municipal solid waste pathways for energy generation and sustainable

development in the Nigerian context. International Journal of Energy and Environmental Engineering, 4(1): 42.J.H. Chuang.

Potential-Based Approach for Shape Matching and Recognition. Pattern Recognition, 29:463-470, 1996.

**2.3 Problem Statement Definition :**

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

**3.IDEATION & PROPOSED SOLUTION**

**3.1 Empathy Map Canvas :**

An empathy map canvas is a more in-depth version of the original empathy map, which helps identify and describe the user’s needs and pain points. And this is valuable information for improving the user experience.

An empathy map canvas helps brands provide a better experience for users by helping teams understand the perspectives and mindset of their customers. Using a template to create an empathy map canvas reduces the preparation time and standardises the process so you create empathy map canvases of similar quality.

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

**3.2 Ideation & Brainstorming :**

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

Ideas :

|  |  |  |  |
| --- | --- | --- | --- |
| **K.Pavithra** | Waste management includes the processes and actions required to manage waste from its inception to its fnal disposal | In some cases  waste can pose a threat to human health | A big part of this is deals with municipal solid waste |
| **M.Nasrin fathima** | Based on IOT technology smart waste management aims to optimize resource allocation | waste management deals with all types of waste ,including industrial,biological | proper management of waste is important for building sustainable and liveable cities |
| **V.Nivetha** | cities and municipalities use IOT technology to handle sustainable waste management operation | Smart waste management is the solution for small cities | This system can help reduce extra spending and ensure a more intelligent budget |
| **P.Kaleeswari** | Smart waste management using IOT can reduce managerial time | It is also used to increase the maximum revenue generation | Eco -friendly waste management is the best example for this |

**3.3 Proposed Solution Template:**

|  |  |  |
| --- | --- | --- |
| S.NO | PARAMETERS | DESCRIPTION |
| 1. | Problem Statement (Problem to be solved) | World faces major environmental challenges associated with waste generation and inadequate waste collection, transport, treatment and disposal. Current systems cannot cope with the volumes of waste generated by an increasing urban population, and this impacts on the environment and public health. |
| 2. | Idea / Solution description | The solution is a method in which waste management is automated. Waste management using IoT is an innovative way that will help to keep the cities clean and healthy. |
| 3. | Novelty / Uniqueness | IoT enables companies to automate processes and reduce labor costs. It also cuts down on waste and improves service delivery, making it less expensive to manufacture and deliver goods, as well as offering transparency into customer transactions. |
| 4. | Social Impact / Customer Satisfaction | IoT improves the total efficiency of waste collection and recycling. The most common use in waste management is route optimisation, which reduces fuel consumption. |
| 5. | Business Model (Revenue Model) | Smart Waste Management generates revenue through the provision of various waste management and disposal services and recycling solutions to residential, commercial, industrial, and municipal clients. They generate revenue by means of collecting fee. |
| 6. | Scalability of the Solution | Scalability issues can be sorted out using IoT provided that the wireless network is wide range with high data speed and flexible software infrastructure. |

**3.4 Problem Solution fit :**

1. CUSTOMER SEGMENT(S)

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

2.CUSTOMER CONSTRAINTS

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

3. TRIGGERS

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

4.JOBS TO-BE-DONE / PROBLEMS

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

5.ROOT CAUSES

Smart waste management is characterized by the usage of technology in order to be more efficient when it comes to managing waste. This makes it possible to plan more efficient routes for the trash collectors who empty the bins, but also lowers the chance of any bin being full for over a week.

6.BEHAVIOUR

First, setup Smart Garbage Management System in the public places Take survey on the usage and drawbacks if any. If the people are satisfied with the demo, then Setup the smart Waste Management system in all places.

7.SOLUTION

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

**4.REQUIREMENT ANALYSIS**

**4.1** **Functional requirement :**

Following are the functional requirements of the proposed solution.

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

**Non-functional Requirements:**

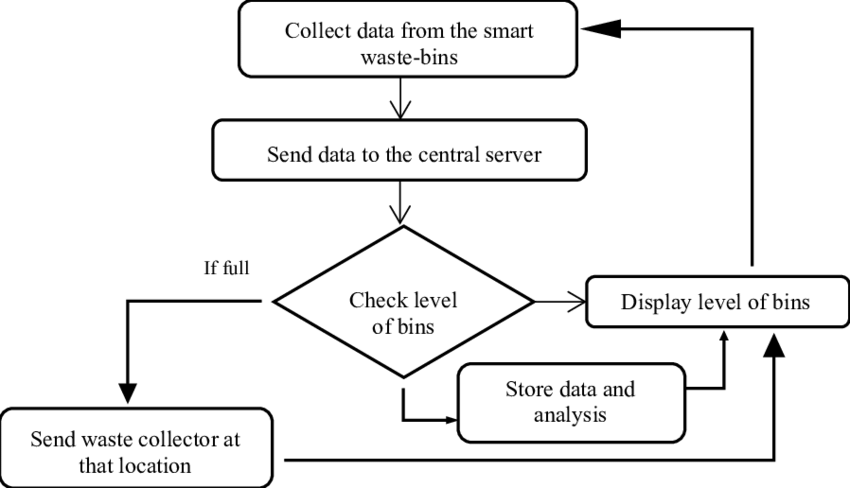
Following are the non-functional requirements of the proposed solution.

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

**5.PROJECT DESIGN**

**5.1 Data Flow Diagram :**

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



**5.2 Solution & Technical Architecture :**

**Table -1: Components & Technologies**

|  |  |  |  |
| --- | --- | --- | --- |
| **S.No** | **Components** | **Description** | **Technology** |
| 1. | User  Interface | Web Portal | HTML,CSS,NodeRed,  Javascript. |
| 2. | Application Logic-1 | Tocalculatethedistance of dreck and show the real time level in web portal , information getting via ultra sonic sensor and the alert message activate with python script to web porta**l.** | Ultrasonic sensor/ Python. |
| 3. | Application Logic-2 | To calculate the weight of the garbage and show the real time weight in web portal, this info getting via load cell and the alert message activate with python to web portal. | Loadcell**/**Python |
| 4. | Application Logic-3 | GettinglocationoftheGarbage**.** | GSM/GPS. |
| 5. | Cloud  Database | Database Service on cloud. | IBM DB2, IBM Cloudant etc.. |
| 6. | File  Storage | File Storage requirements. | GitHub, Local file System. |
| 7. | External API-1 | Firebase is a set of hosting services for any type of application | Firebox. |
|  |  | It offers NoSQL and real-time hosting of databases, content, social authentication, and notifications, or  services, such as a realtime communication server. |  |
| 8. | Ultrasonic Sensor. | To throw alert message when garbage is getting full.  Distance Recognition Model. | Distance Recognition Model. |
| 9. | Infrastructure (Server/Cloud). | Application Deployment on Local  System / Cloud Local  Server  Configuration: localhost  Cloud Server  Configuration: localhost,  Firebox | Localhost, Web portal. |

**Table-2: Application Characteristics:**

|  |  |  |  |
| --- | --- | --- | --- |
| **S No** | **Characteristics** | **Description** | **Technology** |
| 1. | Open -Source Framework | NodeRed**,**Python**,**IBMSimulator**.** | Iot. |
| 2. | Security Implementation | Raspberry Pi is connected to the internet and for example used to broadcast  live data, further security  measures are recommended  and use the  UFW(uncomplicated  Firewall). | Iot. |
| 3. | Scalable Architecture | Raspberry pi:Specifications  Soc: rspi ZERO W  CPU: 32-bit computer with a  1 GHz ARMv6  RAM: 512MB | Iot. |
|  |  | Networking: Wi-Fi Bluetooth: Bluetooth 5.0, Bluetooth Low Energy (BLE).  Storage: MicroSD  GPIO: 40-pin GPIO header, populated  Ports: micro HDMI 2.0,  3.5mm analogue audiovideo jack, 2x USB 2.0, 2x USB 3.0, Ethernet Dimensions: 88mm  x 58mm x 19.5mm, 46g |  |
| 4. | Availability | These smart bins use sensors like ultrasonic and load cell to send alert message about the trash level recognition technology, and artificial intelligence, enabling them to automatically sort and categorize recycling litter into one of its smaller bin. | Iot. |
| 5. | Performance | Number of request:RPI manages to execute 129-139 read requests per  second.Use of Cache:512mb  Use of CDN’s:Real time | Iot/web portal. |

**5.3 Customer Journey:**

Use the below template to create product backlog and sprint schedule

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **User Type** | **Functional Requirement**  **(Epic)** | **User Story Number** | **User Storey Or Task** | **Acceptance Criteria** | **Priority** | **Release** |
| Customer | Registration | USN-1 | As a user I can register for the product through mail. | I can access my account | High | Spirit-1 |
|  |  | USN-2 | As a user I can say demerits of product |  | Medium | Spirit-1 |
|  |  | USN-3 | As a user I can access procedure to use product |  | High | Spirit-1 |
|  |  | USN-4 | As a user I can register via face book and whatsapp | I can register & access the  dashboard with Face book  Login | Low | Spirit-2 |
|  |  | USN-5 | As a user i can get my own password to access dashboard | I can receive confirmation  email & click confirm | High | Spirit-1 |
| Customer (Web  User) |  |  |  |  |  |  |
| Customer Care  Executive |  |  |  |  |  |  |
| Administrator |  |  |  |  |  |  |

**6.PROJECT PLANNING & SCHEDULING**

**6.1 Sprint Planning & Estimation:**

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

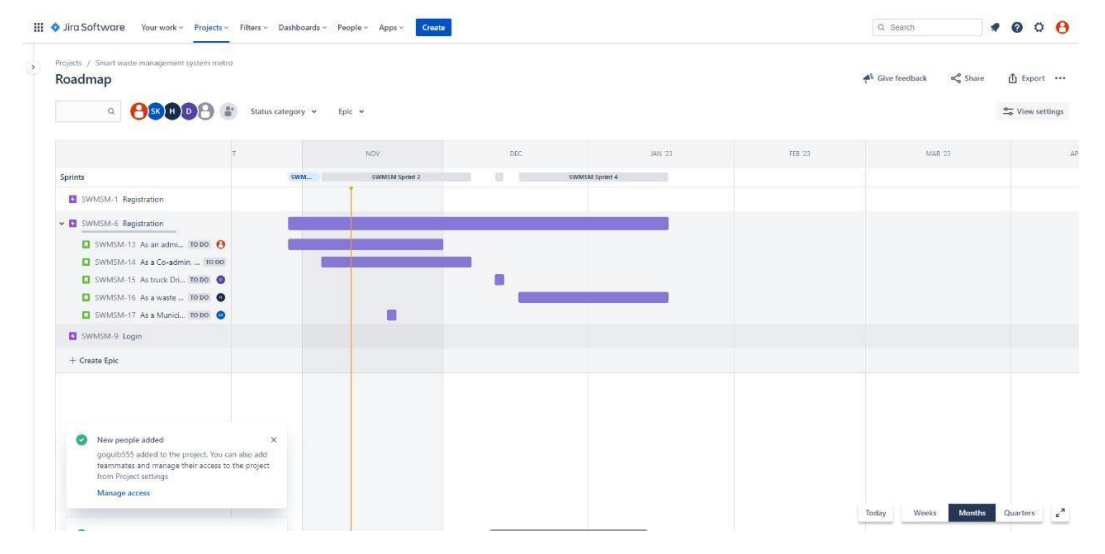
**6.2 Sprint Delivery Schedule:**

| **Sprint** | **Functional Requirement (Epic)** | **User Story Number** | **User Story / Task** | **Story Points** | **Priority** | **Team Members** |
| --- | --- | --- | --- | --- | --- | --- |
| Sprint-1 | Registration | USN-1 | As a user, I can register for the application by entering my email, password, and confirming my password. | 2 | High | Pavithra K |
| Sprint-1 |  | USN-2 | As a user, I will receive confirmation email once I have registered for the application. | 2 | High | Nasrin Fathima M |
| Sprint-2 |  | USN-3 | As a user, I can register for the application through Facebook. | 2 | Low | Nivetha V |
| Sprint-1 |  | USN-4 | As a user, I can register for the application through Gmail. | 2 | Medium | Kaleeswari P |
| Sprint-1 | Login | USN-5 | As a user, I can log into the application by entering email & password. | 2 | High | Pavithra K |
| Sprint-1 | Dashboard | USN-6 | As a user, I can easily navigate through dashboard and I can use the dashboard to get details about app and instruction to use the app | 2 | High | Nasrin Fathima M |
| Sprint-1 | Login and Dashboard | USN-7 | As a web app user, I can login into application by using my email and password and I can access all resources same as mobile users. | 2 | High | Nivetha V |
| Sprint-1 | Login | CCE1 | As a CCE I can login to app using my id and password and I can interact with user. | 2 | High | Kaleeswari P |
| Sprint-1 | Dashboard | CCE2 | As a CCE I can access dashboard using id and password and I can see all user queries, explain app usage and attend their queries. | 2 | High | Pavithra K |
| Sprint-1 | Login and Dashboard | A1 | As an administrator, I can login and access dashboard and manage and direct activities. | 2 | High | Nasrin Fathima M |

**Project Tracker, Velocity & Burndown Chart:**

| **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 |

**6.3 Reports from JIRA:**

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**7.CODING & SOLUTIONING**

**7.1 Feature 1 :**

Code for Data Transfer from Sensors:

#include //library for wifi

#include //library for MQTT

#include LiquidCrystal\_I2C

lcd(0x27, 20, 4); // credentials of IBM Accounts –

#define ORG "ktymlx" //IBM organisation id

#define DEVICE\_TYPE "new" // Device type mentioned in ibm watson iot platform

#define DEVICE\_ID "09874" // Device ID mentioned in ibm watson iot platform

#define TOKEN "hariwignesh123" // Token // customise above values

char server[] = ORG ".messaging.internetofthings.ibmcloud.com"; // server name char publishTopic[] = "iot-2/evt/data/fmt/json"; char topic[] = "iot-2/cmd/led/fmt/String"; // cmd Represent type and command is test format of strings char authMethod[] = "usetokenauth"; // 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))

{

Serial.println("IBM subscribe to cmd OK");

}

Else

{

Serial.println("subscribe to cmd FAILED");

}

}

void publishData()

{

float cm = readcmCM();

if(digitalRead(34)) //PIR motion detection

{

Serial.println("Motion Detected");

Serial.println("Lid Opened");

digitalWrite(15, HIGH);

}

else

{

digitalWrite(15, LOW);

}

if(digitalRead(34)== true)

{

if(cm <= 100) //Bin level detection

{

digitalWrite(2, HIGH);

Serial.println("High Alert!!!,Trash bin is about to be full");

Serial.println("Lid Closed");

lcd.print("Full! Don't use");

delay(2000);

lcd.clear();

digitalWrite(4, LOW);

digitalWrite(23, LOW);

}

else if(cm > 150 && cm < 250)

{

digitalWrite(4, HIGH);

Serial.println("Warning!!,Trash is about to cross 50% of bin level");

digitalWrite(2, LOW);

digitalWrite(23, LOW);

}

else if(cm > 250 && cm <=400)

{

digitalWrite(23, HIGH);

Serial.println("Bin is available");

digitalWrite(2,LOW);

digitalWrite(4, LOW);

}

delay(10000);

Serial.println("Lid Closed");

}

else { Serial.println("No motion detected");

}

if(cm <= 100) { digitalWrite(21,HIGH);

String payload = "{\"High Alert!!\":\""; payload += cm; payload += "left\" }";

Serial.print("\n");

Serial.print("Sending payload: ");

Serial.println(payload);

if (client.publish(publishTopic, (char\*) payload.c\_str())) // if data is uploaded to cloud successfully,prints publish ok or prints publish failed

{

Serial.println("Publish OK");

}

}

if(cm <= 250)

{

digitalWrite(22,HIGH);

String payload = "{\"Warning!!\":\""; payload += dist; payload += "left\" }";

Serial.print("\n");

Serial.print("Sending distance: ");

Serial.println(cm);

if(client.publish(publishTopic, (char\*) payload.c\_str()))

{

Serial.println("Publish OK");

}

Else

{

Serial.println("Publish FAILED");

}

}

float inches = (cm / 2.54); //print on LCD lcd.setCursor(0,0);

lcd.print("Inches");

lcd.setCursor(4,0);

lcd.setCursor(12,0);

lcd.print("cm");

lcd.setCursor(1,1);

lcd.print(inches, 1);

lcd.setCursor(11,1);

lcd.print(cm, 1);

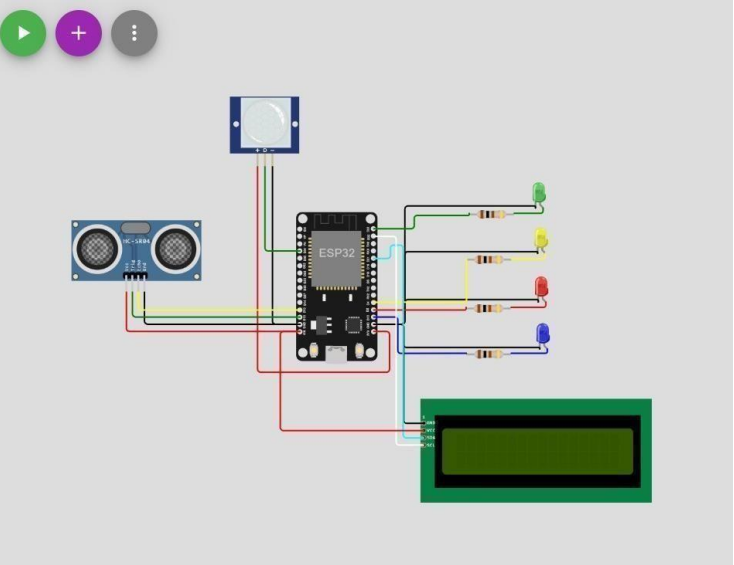
lcd.setCursor(14,1);

delay(1000);

lcd.clear();

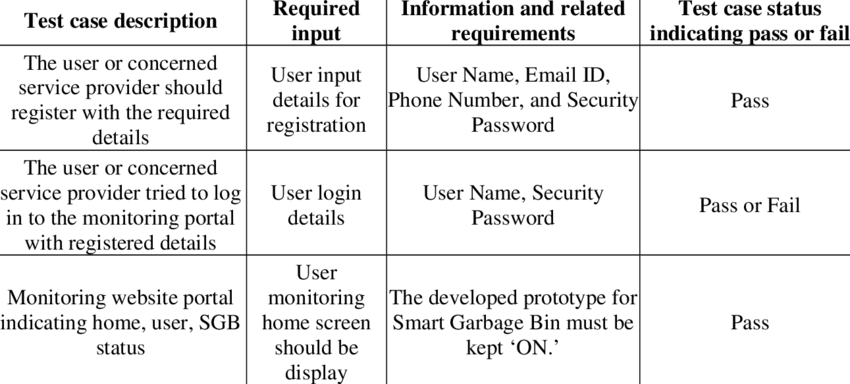
}

**OUTPUT:**



1. **TESTING**

8.1Test Cases



8.2User Acceptance Testing:

**How to prepare for user acceptance testing**

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

**Planning:**

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

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

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

**Scoping:**

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

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

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

**Execution, evaluation, and monitoring:**

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

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

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

1. **RESULTS**

9.1Performance Metrics:

* **OPERATION:** Automatic sensor based operation with zero manual intervention
* **HYGIENIC:**Hygienic disposal with automatic and touch-less waste disposal
* **GERM KILLING:**UVC technology kills germs and bacteria inside the bin
* **DISPLAY:**Smart indicators on the front display panel
* **DEODORIZER:**Foul odour elimination
* **DURABLE & LONG LIFE:**Made with high quality materials for a long durable life
* **ENERGY EFFICIENT:**Low power consumption; lesser than a light bulb!
* **SLEEK & COMPACT DESIGN:**Designed to fit in small spaces and add to the aesthetics of your premises
* **SUITABLE FOR:**Paper waste, plastic waste, food waste, and other commonly generated waste
* **WIDELY USED IN:**Restaurants, food courts, hotels, offices, ships, trains, airports, adventure parks and other premium places.
* **REMOTE WASTE LEVEL MONITORING:**Inbuilt with RecycloBin UltraEye waste level sensors and integrated with smart IoT app, RecycloBin Smart Assist.

1. **ADVANTAGES & DISADVANTAGES**

**ADVANTAGES:**

\*Improve Productivity and Performance.

\*Increase Profitability.

\*Boost Sustainability.

\*Superior Customer Engagement.

\*Become a Smart City.

\*Enhance Safety.

**DISADVANTAGES:**

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

\*Setting up the smart sensor

\*Non-optimized truck routes

\*Recycling

\*Non-uniform waste distribution of waste in bins.

1. **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.

1. **FUTURE SCOPE:**

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

1. **APPENDIX**

Source Code

**database.js:**

const cap\_status = document.getElementById('cap\_status');

const alert\_msg = document.getElementById('alert\_msg');

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

ref.on("value", function(snapshot)

{

snapshot.forEach(function (childSnapshot) {

var value = childSnapshot.val();

const alert\_msg\_val = value.alert;

const cap\_status\_val = value.distance\_status;

alert\_msg.innerHTML= `${alert\_msg\_val}`;

});

}, function (error) {

console.log("Error: " + error.code);

});

**index.html**

<!DOCTYPE html>

<html>

<head>

<link rel="stylesheet" href="https://cdn.jsdelivr.net/npm/bootstrap@4.3.1/dist/css/bootstrap.min.css" integrity="sha384-ggOyR0iXCbMQv3Xipma34MD+dH/1fQ784/j6cY/iJTQUOhcWr7x9JvoRxT2MZw1T" crossorigin="anonymous">

<meta charset="utf-8">

<meta name="viewport" content="width=device-width">

<title>Garbage Management System</title>

<link rel="icon" type="image/x-icon" href="/Images/DUMPSTER.png">

<link href="style.css" rel="stylesheet" type="text/css" />

<script src="https://www.gstatic.com/firebasejs/8.10.1/firebase-app.js"></script>

<script src="https://www.gstatic.com/firebasejs/8.10.1/firebase-database.js"></script>

<script>

var firebaseConfig =

{

apiKey: "AIzaSyB9ysbnaWc3IyeCioh-aJQT\_UCMd5CBFeU",

authDomain: "fir-test-923b4.firebaseapp.com",

databaseURL: "https://fir-test-923b4-default-rtdb.firebaseio.com",

projectId: "fir-test-923b4",

storageBucket: "fir-test-923b4.appspot.com",

messagingSenderId: "943542145393",

appId: "1:943542145393:web:9b5ec7593e6a3cbd7966d0",

measurementId: "G-BN7JNX1Q7B"

};

firebase.initializeApp(firebaseConfig)

</script>

<script defer src="database.js"></script>

</head>

<body style="background-color:#1F1B24;">

<script src="map.js"></script>

<div id="map\_container">

<h1 id="live\_location\_heading" >LIVE LOCATION</h1>

<div id="map"></div>

<div id="alert\_msg">ALERT MESSAGE!</div>

</div>

</div>

<center><a href="https://goo.gl/maps/G9XET5mzSw1ynHQ18"

type="button" class="btn btn-dark">DUMPSTER</a></center>

<script

src="https://maps.googleapis.com/maps/api/js?key=AIzaSyBBLyWj-3FWtCbCXGW3ysEiI2fDfrv2v0Q&callback=myMap"></script></div>

</body>

</html>

GitHub Link: <https://github.com/IBM-EPBL/IBM-Project-31502-1660201325>

Project Demo Link: <https://drive.google.com/file/d/1ET7l_ezi7hkUb1O144HDaCnSYIWxHWho/view?usp=share_link>