PROJECT REPORT

SMART WASTE MANAGEMENT FOR METROPOLITAN CITIES

Submitted by:

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1. INTRODUCTION

1.1 Project Overview

The proper disposal of the waste is the main problem that affects the normal life and health of people. Keeping that in mind we suggest a solution using IOT. A sensor device is installed at each bins in order to alert the person about the overflow of the bins. IOT technology is an internet-based ecosystem that uses embedded systems to help collect, send, and analyze data of related environments with sensors, processors, or communication hardware. People can easily collect data about the overflow of bins that are installed with the sensor and can do the necessary actions.

1.2 Purpose

People are always conscious about their health and hygiene. In order to ensure this we need to manage the waste that are collected in the bins and are disposed properly at the right time. The waste management IOT solution enables cities and industries to manage their waste in an efficient way, reducing the environmental footprint and improving the quality of the service. The waste management solution includes smart sensors that use ultrasound technology to measure the fill levels in bins and containers. They send the data to the Smart Waste Management System, a powerful cloud-based platform. The objective is to provide cities and businesses with data-driven decision making, and optimization of waste collection routes. The main goal is to keep the cities clean. This saves costs and offers a good customer experience. By digitizing the waste management we can gain efficiency.

2. LITERATURE SURVEY

2.1 Existing problem

Even though Smart waste management system saving time and money through automation. The houses intelligent safety sensor which stops compaction cycle when it detects hand of human being .A reduction in the number of waste collections needed by up to 80%, resulting in less manpower, emissions, fuel use and traffic congestion. It improved Time management and give a better route planning and reduced operational cost

2.2 References

1.A Smart Waste Management with Self- Describing Complex Objects: It saving time and money through automation RFID tags can suffer from orientation issues as sometimes these tags do not connect with the readers when both are misaligned concerning each other.
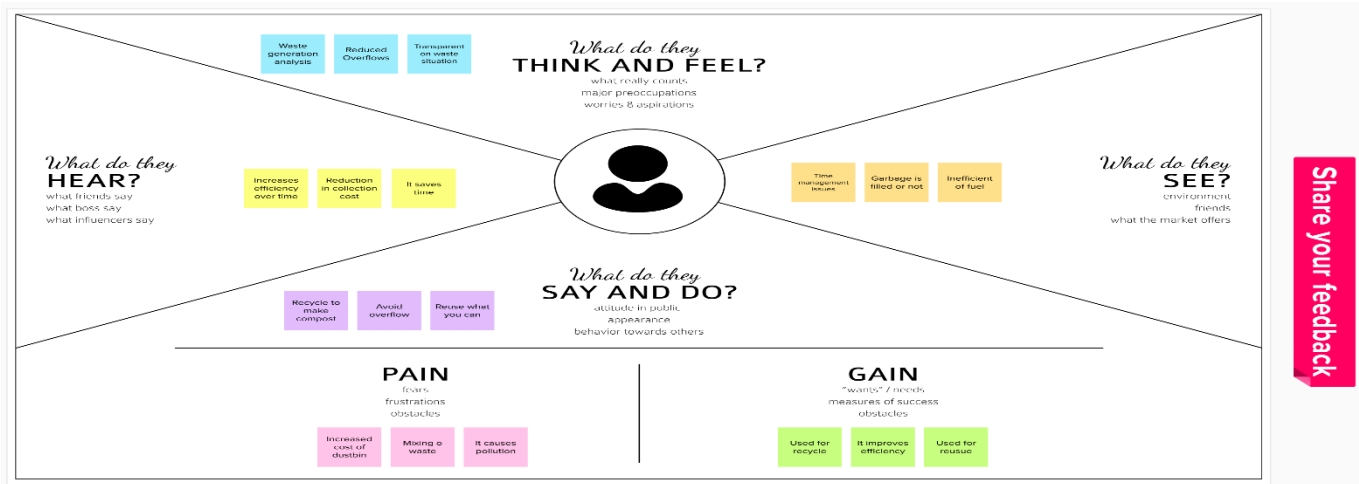
2.An Automated Machine Learning Approach for Smart Waste Management:
A reduction in the number of waste collections needed by up to 80%, resulting in less manpower, emissions, fuel use and traffic congestion. A need of more Data acquisition and Auto ML needs more time to learn data. High error susceptibility

2.3 Problem Statement Definition

In discriminate disposal of solid waste is a major issue in urban centers of most developing countries and it poses a serious threat to healthy living of the citizens. Access to reliable data on the state of solid waste at different locations within the city will help both the local authorities and the citizens to effectively manage the menace. An intelligent solid waste monitoring system is developed using Internet of Things (IOT) and cloud computing technologies. The fill level of solid waste in each of the containers, which are strategically situated across the communities, is detected using ultrasonic sensors. A Wireless Fidelity (Wi-Fi) communication link is used to transmit the sensor data to an IOT cloud platform known as Thing Speak. Depending on the fill level, the system sends appropriate notification message (in form of tweet) to alert relevant authorities and concerned citizen(s) for necessary action.

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

3.2 Ideation & Brainstorming

3.3 Proposed Solution

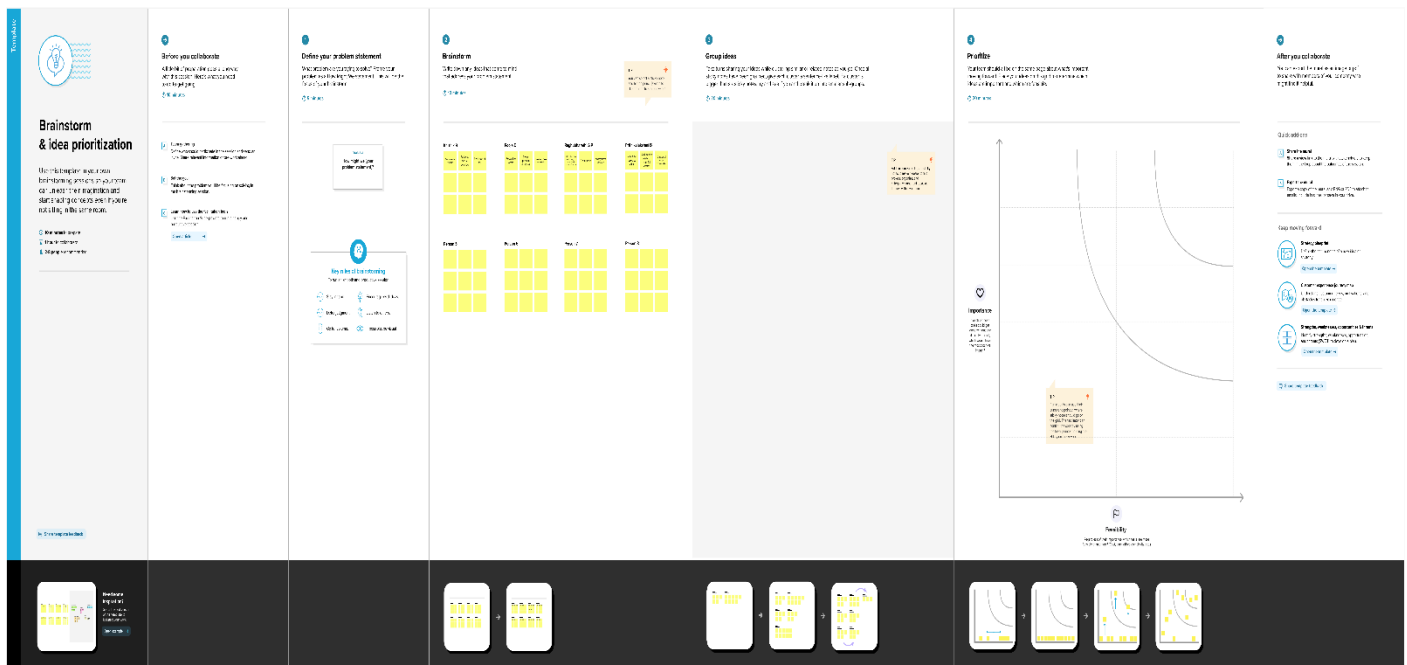| S.NO	Parameter	Description
1.	Problem statement	Indiscriminate disposal of solid waste is a major issue in urban centers of most developing countries and it poses a serious threat to healthy living of the citizens. Access to reliable data on the state of solid waste at different locations within the city will help both the local authorities and the citizens to effectively manage the menace. An intelligent solid waste monitoring system is developed using Internet of Things (IOT) and cloud computing technologies. The fill level of solid waste in each of the containers, which are strategically situated across the communities, is detected using ultrasonic sensors. A Wireless Fidelity (Wi-Fi) communication link is used to transmit the sensor data to an IOT cloud platform known as Thing Speak. Depending on the fill level, the system sends appropriate notification message (in form of tweet) to alert relevant authorities and concerned citizen(s) for necessary action
2.	Idea description	The main idea is detecting by using garbage levels in bins and getting the weight of the garbage in the bin. Alerts are produced when the weight is at estimated value and alerts the authorized person to empty the bin whenever the bins are full. Garbage level of the bins can be monitored through a web App. We can view the location of every bin in the web application by sending GPS location from the device. This helps the authorized person come and collect the garbage.
3.	Novelty/ uniqueness	Estimate the weights using a Load sensor. Load sensor predicts the accurate value and the values are passed to the sensor called Node MCU. It helps to store the data in Firebase or cloud and helps to send a message to the authorized person.

4.	Social impact/ customer satisfaction	The Ultimate use of Smart Waste Management for Metropolitan Cities is to prevent diseases caused from wastage. We can assure good health of the people. Cleanliness is maintained all over the cities. Due to fast disposal the work is done faster and easier.
5.	Business model (financial benefit)	City administration needs an understanding of the big picture, generating reports, control over pricing etc. District administrations are interested in controlling the process of waste collection, checking the quality of service (all waste collected, all in time, waste collected cleanly, waste transported to special places), quick and legal ways for solving disputes and problems. Municipalities can also deploy and maintain smart city infrastructure like capacity sensors in waste bins and wireless networks for data transferring.
6.	Scalability of solution	In this project we used Load sensor to estimate weight. Load sensor predicts the accurate value and the values are passed to the sensor called Node MCU. It helps to store the data in Firebase or cloud and helps to send a message to the authorized person. Instead of using Raspberry-pie we use Node MCU which is cost efficient and easy to maintain. The data's and signals from the sensor to the authorized person are well monitored.

3.4Problem Solution fit

CONSUMER
TREND CANVAS

R_ND   Write the trend here...

1. ANALYZE   2. APPLY

Basic Needs
Which deep consumer needs & desires does this trend address?

- Clean Environment
- Healthy Life
- Waste Management

Drivers of Change
Why is this trend emerging now? What's changing?

Shifts: Long-term, widespread macro changes / triggers: Recent, short term changes or technologies

- Garbage collection is a basic need
- Lack of public awareness
- Providing a smart solution in the form of smart bin
- IOT plays a major role in waste management system

Emerging Consumer Expectations
What new consumer needs, wants and expectations are created by the changes identified above? Where and how does this trend satisfy them?

- Updating information about the bins
- Reducing the pollution caused by the wastes
- Making the public more aware

Inspiration
How are other businesses applying this trend?

- Current disposal of wastes from the bins
- Periodic removal of bins
- Relocating of waste

Innovation Potential
How and where could you apply this trend to your business?

- Urban areas
- Rural areas
- Using load sensor and NODE IACU

YOUR INNOVATION(S!)

Who
Which (new) customer groups could you apply this trend to? What would you have to change?

- Municipal authorities
- Improvement in cleanliness and public hygiene
- Cost saving on emptying and refilling bins

Share your feedback

trendwatching.com PREMIUM

Download a blank worksheet at trendwatchingpremium.com

4.REQUIREMENT ANALYSIS

4.1Functional Requirements

FRNO	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Detailed bin inventory	All monitored bins and stands can be seen on the map, and you can visit them at any time via the Street View feature from Google. Bins or stands are visible on the map as green, orange or red circles. You can see bin details in the Dashboard – capacity, waste type, last measurement, GPS location and collection schedule or pick recognition.
FR-2	Real time bin monitoring	The Dashboard displays real-time data on fill-levels of bins monitored by smart sensors. In addition to the % of fill-level, based on the historical data, the tool predicts when the bin will become full, one of the functionalities that are not included even in the best waste management software.. Sensors recognize picks as well; so you can check when the bin was last collected. With real-time data and predictions, you can eliminate the overflowing bins and stop collecting half-empty ones.
FR-3	Expensive bins	We help you identify bins that drive up your collection costs. The tool calculates a rating for each bin in terms of collection costs. The tool considers the average distance depo-bin- discharge in the area. The tool assigns bin a rating (1-10) and calculates distance from depo-bin discharge.
FR-4	Adjust bin distribution	Ensure the most optimal distribution of bins. Identify areas with either dense or sparse bin distribution. Make sure all trash types are represented within a stand. Based on the historical data, you can adjust bin capacity or location where necessary.

FR-5	Eliminate un efficient picks	Eliminate the collection of half-empty bins. The sensors recognize picks. By using real-time data on fill-levels and pick recognition, we can show you how full the bins you collect are. The report shows how full the bin was when picked. You immediately see any inefficient picks below 80% full.
FR-6	Plan waste collection routes	The tool semi-automates waste collection route planning. Based on current bin fill-levels and predictions of reaching full capacity, you are ready to respond and schedule waste collection. You can compare planned vs executed routes to identify any inconsistencies.

4.2 NonFunctional Requirements

| FRNO	Non-Functional Requirement	Description
NFR-1	**Usability**	IoT device verifies that usability is a special and important perspective to analyse user requirements, which can further improve the design quality. In the design process with user experience as the core, the analysis of users' product usability can indeed help designers better understand users' potential needs in waste management, behaviour and experience.
NFR-2	**Security**	Use a reusable bottles Use reusable grocery bags Purchase wisely and recycle Avoid single use food and drink containers.
NFR-3	**Reliability**	Smart waste management is also about creating better working conditions for waste collectors and drivers. Instead of driving the same collection routes and servicing empty bins, waste collectors will spend their time more efficiently, taking care of bins that need servicing.

NFR-4	**Performance**	The Smart Sensors use ultrasound technology to measure the fill levels (along with other data) in bins several times a day. Using a variety of IoT networks ((NB-IoT ,GPRS), the sensors send the data to Sensoneo's Smart Waste Management Software System, a powerful cloud-based platform, for data-driven daily operations, available also as a waste management app. Customers are hence provided data-driven decision making, and optimization of waste collection routes, frequencies, and vehicle loads resulting in route reduction by at least 30%.
NFR-5	**Availability**	By developing & deploying resilient hardware and beautiful software we empower cities, businesses, and countries to manage waste smarter.
NFR-6	**Scalability**	Using smart waste bins reduce the number of bins inside town , cities coz we able to monitor the garbage 24/7 more cost effect and scalability when we moves to smarter.

5.PROJECT DESIGN
5.1 Data Flow Diagrams

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.

Data Flow Diagrams:
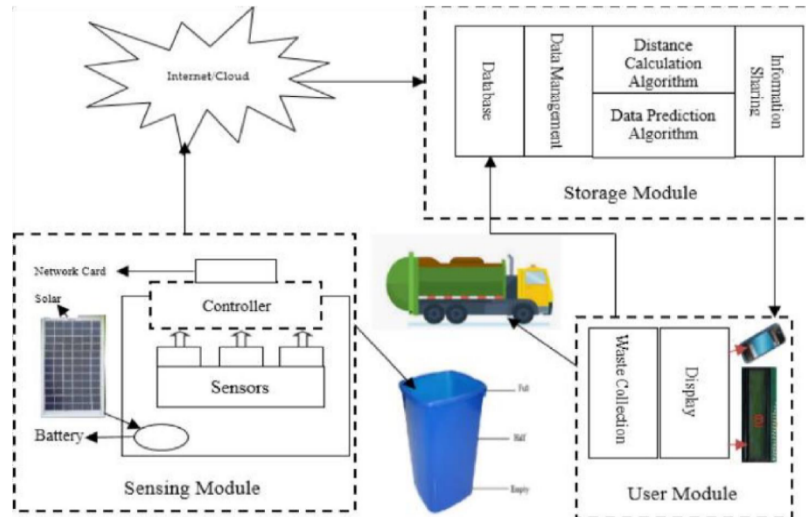
5.2 Solution & Technical Architecture

Technical Architecture:

The Deliverable shall include the architectural diagram as below and the information as per the table1 & table 2

Example: Order processing during pandemics for offline mode

Table-1 : Components & Technologies:

| S.No	Component	Description	Technology
1.	User Interface	IBM Watson IOT cloud platform	MQTT Protocol
2.	Application Logic-1	The bin waste data's are collected using sensors	Python
3.	Application Logic-2	The collected data's are monitored using IOT	IBM Watson STT service
4.	Application Logic-3	Based on data's thealerting message will send to the workers for disposing the wastes.	IBM Watson Assistant
5.	Database	MySQL is a relational database that is based on a tabular design.NoSQL is non-relational and has a document-based design.	MySQL, NoSQL
6.	Cloud Database	This module will receive real time status updates from all the garbage bins and continuously display it on web application and also push the notifications on client sides (Municipal Corporation, Garbage collector truck drivers etc.) mobile application	IBM DB2, IBM Cloud
7.	File Storage	Data storage makes it easy to back up files for safekeeping and quick recovery in the event of an unexpected computing crash or cyberattack.	IBM Block Storage or Other Storage Service
8.	External API-1	External APIs expose a project's internal resources to outside users or applications	IBM Weather API, etc.

9.	External API-2	External API allow you to access third party resources that are available through RESTful web services	Aadhar API, etc.
10.	Machine Learning Model	The proper algorithm makes planning good. It will guide the goodness character and which path should be taken and which garbage bin should be collected first	Python IDLE or Anaconda navigator or Jupitar
11.	Infrastructure (Server / Cloud)	Application Deployment on Local System / Cloud Cloud Server Configuration: Cloud deployment is the process of deploying an application through one or more hosting models—software as a service (SaaS), platform as a service (PaaS) and or infrastructure as a service (IaaS) that leverage the cloud Local Server Configuration : A local server gives you exclusive access to data and objects in a set of Windows folders called data directories	Cloud server-MySQL Local server-HTTP

Table-2: Application Characteristics:

S N o	Characteristics	Description	Technology
1.	Open-Source Frameworks	Transport, teatment, and disposal of waste together with monitoring	Python

			and regulation. It also encompasses the legal and regulatory framework that relates to waste management encompassing guidance on recycling."	
2.	Security Implementations	Fundamental component of data, security that dictates who's allowed to access and use company information and resources. Firewalls use a rule-based access control model with rules expressed in an access control list.	Firewall	
3.	Scalable Architecture	Using smart wast bins, reduce the number of bins inside town and cities because that we can able to monitor the garbage 24/7.It will be more cost efficient and scalable when we moves to smarter.	Technology used	
4.	Availability	By developing & deploying resilient hardware and beautiful software we empower cities, businesses,and countries to manage waste smarter.	IOT, RFID	
5.	Performance	The Smart Sensors use ultrasound technology to measure the fill levels (along with other data) in bins several times a day. Using a variety of IoT networks ((NB-IoT, GPRS), the sensors send the data to Sensor's Smart Waste Management Software System, a powerful cloud-based platform, for data-driven daily operations, available also as a waste management app.	IOT, GPRS	

TECHNOLOGY ARCHITECTURE:
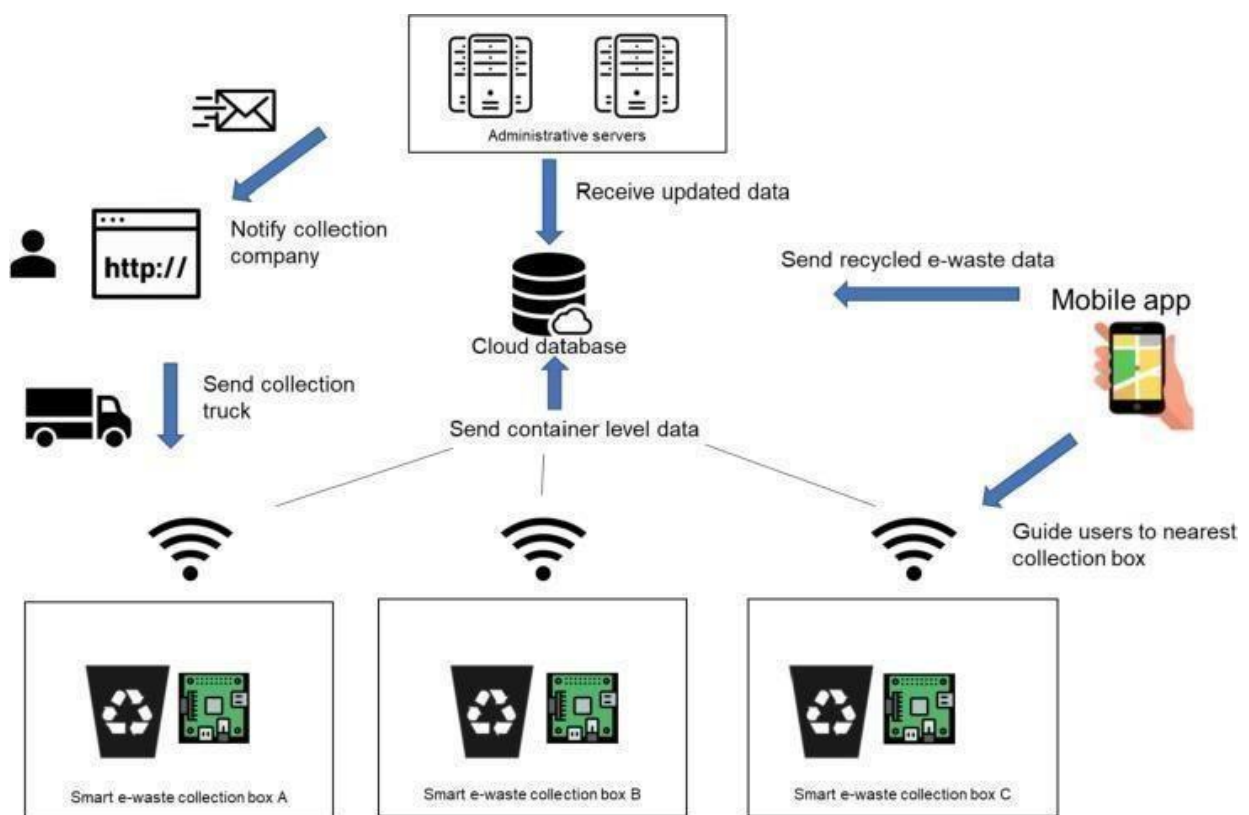
6.PROJECT PLANNING & SCHEDULING

6.1Sprint Planning & Estimation

Product Backlog, Sprint Schedule, and Estimation (4 Marks)
Use the below template to create product backlog and sprint 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	Karthik B
Sprint-1		USN-2	As a user, I will receive confirmation email once I have registered for the application	1	High	Prithikalakshmi B
Sprint-2		USN-3	As a user, I can register for the application through Facebook	2	Low	Pooja D
Sprint-1		USN-4	As a user, I can register for the application through Gmail	2	Medium	Raghubharathi S P
Sprint-1	Login	USN-5	As a user, I can log into the application by Entering email &password	1	High	Karthik B

Project Tracker, Velocity & Burndown Chart:

Sprint	Total Story Points	Dura tion	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	2 0	29 Oct 202
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	3 0	30 Oct 202
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	4 9	06 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	5 0	07 Nov 2022

7.CODING & SOLUTIONING

```html
<html

    <head>
    <title>Use-less Login</title>
            <link rel="icon" href="sellingPageBg.png">
     <meta name="viewport" content="width=device-width, initial-scale=1">
     <link rel="stylesheet" type="text/css" href="static/style.css?g=1280549780">
     <meta charset="UTF-8">
     <link rel="stylesheet" href="https://www.w3schools.com/w3css/4/w3.css">
     <link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Montserrat">
     <link rel="stylesheet"
    href="https://cdnjs.cloudflare.com/ajax/libs/font-awesome/4.7.0/css/font-awesome.min
    .css">
    </head>
    <body onload=""
            onpageshow="if (event.persisted) noBack();" onunload="noBack();">
     <div class="loginbox">
     <img src="static/Avatar.png" class="Avatar">
        <h1><b>Login Here</b></h1>
        <form action="/sellingPage.html" method="POST">
            <p>E-Mail ID</p>
            <input type="text" type="text" placeholder="Enter E-Mail Id" required
    name="userName">
            <p>Password</p>
            <input type="password" type="text" placeholder="Enter Password" required
    name="userPass">
            {% with messages = get_flashed_messages() %}
                {% if messages %}
```

Register Here

User Name

Eg.ABC Internationals

Email Id

Eg.abcinternationals@gmail.com

Password

Enter password

Confirm Password

confirm password

Phone Number

9876543210

Address

Enter your address

Password

Enter password

Confirm Password

confirm password

Phone Number

9876543210

Address

Enter your address

Postal code

123456

☐ Agree to terms and conditions ⓘ

Register

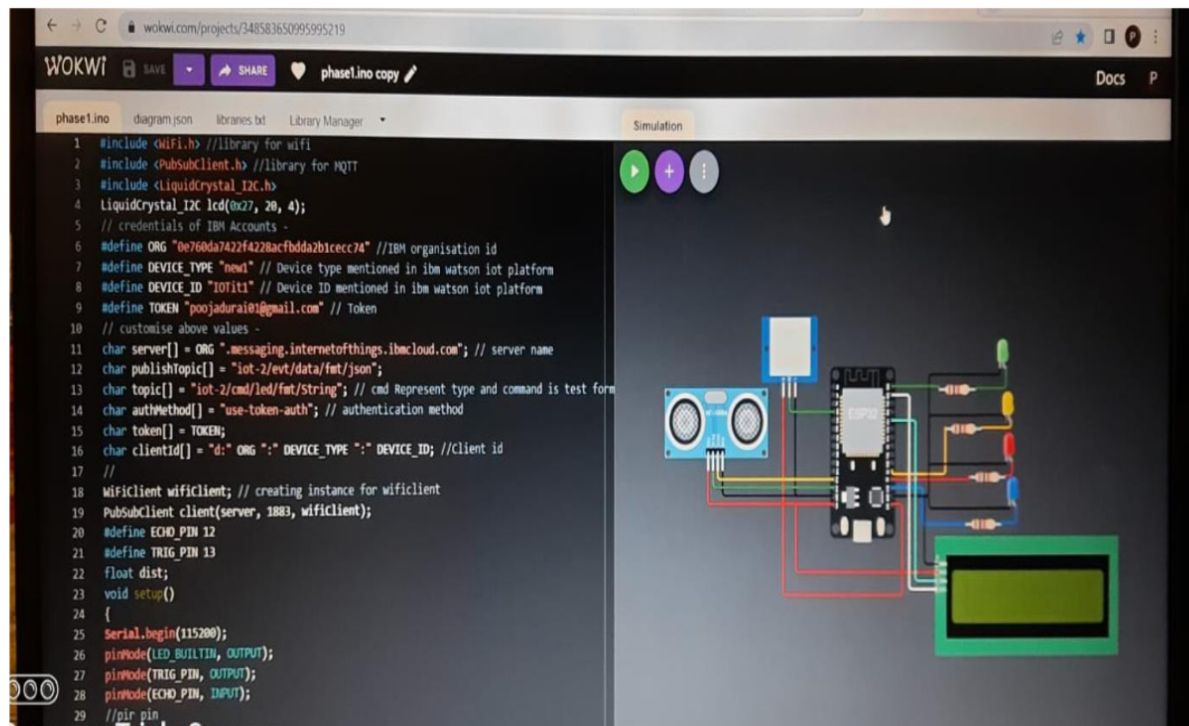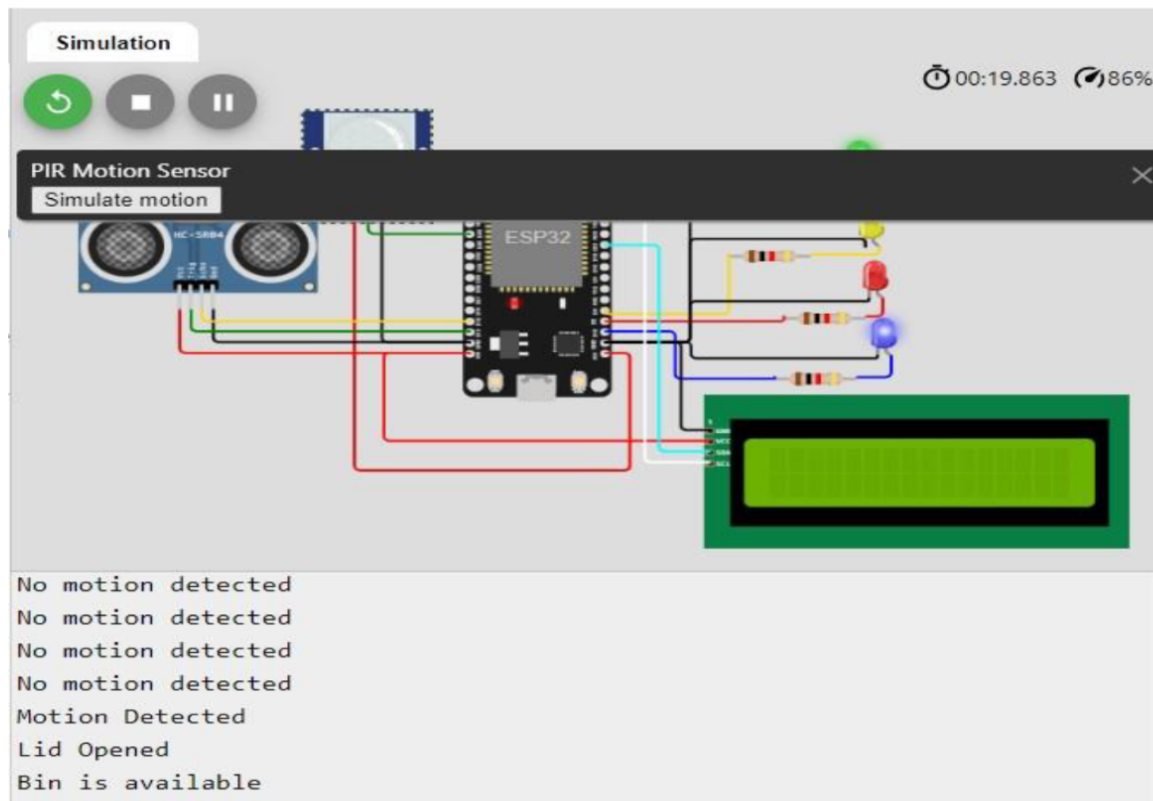Already have an account?

8.RESULTS

CIRCUIT DIAGRAM:
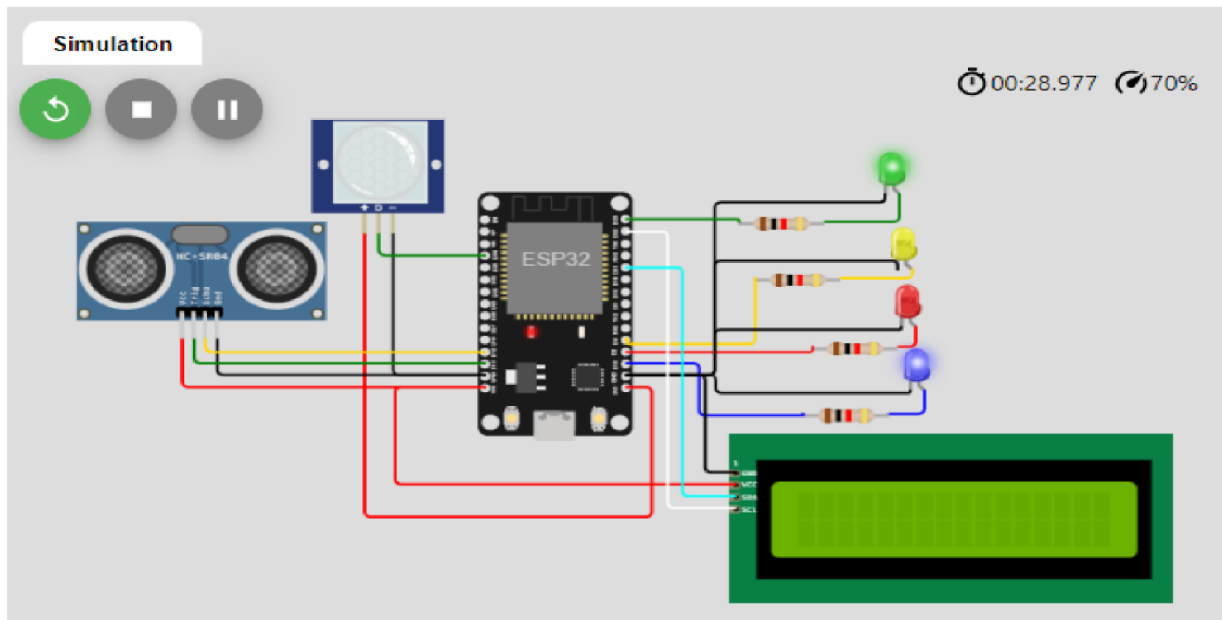
OUTPUT:

Wokwi Simulation:


```
No motion detected
No motion detected
No motion detected
No motion detected
Motion Detected
Lid Opened
Bin is available
```

Simulation

00:19.863 86%

PIR Motion Sensor
Simulate motion

ESP32

```
No motion detected
No motion detected
No motion detected
No motion detected
Motion Detected
Lid Opened
Bin is available
```


wokwi.com/projects/348583650995995219

WOKWI SAVE SHARE phase1.ino copy

phase1.ino   diagram.json   libraries.txt   Library Manager

Simulation

Docs P

```
1   #include <WiFi.h> //library for wifi
2   #include <PubSubClient.h> //library for MQTT
3   #include <LiquidCrystal_I2C.h>
4   LiquidCrystal_I2C lcd(0x27, 20, 4);
5   // credentials of IBM Accounts -
6   #define ORG "0e760da7422f4228acfbdda2b1cecc74" //IBM organisation id
7   #define DEVICE_TYPE "new1" // Device type mentioned in ibm watson iot platform
8   #define DEVICE_ID "IOTit1" // Device ID mentioned in ibm watson iot platform
9   #define TOKEN "poojadurai01@gmail.com" // Token
10  // customise above values -
11  char server[] = ORG ".messaging.internetofthings.ibmcloud.com"; // server name
12  char publishTopic[] = "iot-2/evt/data/fmt/json";
13  char topic[] = "iot-2/cmd/led/fmt/String"; // cmd Represent type and command is test form
14  char authMethod[] = "use-token-auth"; // authentication method
15  char token[] = TOKEN;
16  char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID; //Client id
17  //
18  WiFiClient wifiClient; // creating instance for wificlient
19  PubSubClient client(server, 1883, wifiClient);
20  #define ECHO_PIN 12
21  #define TRIG_PIN 13
22  float dist;
23  void setup()
24  {
25    Serial.begin(115200);
26    pinMode(LED_BUILTIN, OUTPUT);
27    pinMode(TRIG_PIN, OUTPUT);
28    pinMode(ECHO_PIN, INPUT);
29    //pir pin
```

4.Data transfer from IBM Watson IOT platform and wokwi to Node red.
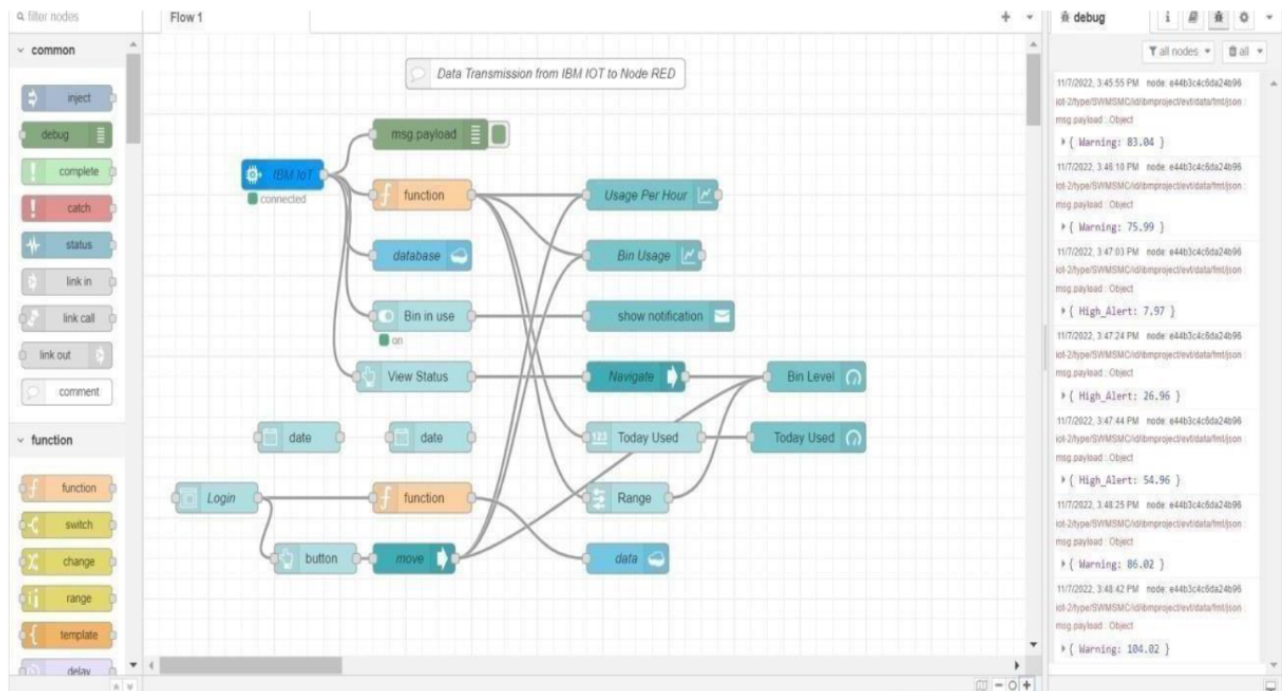
9. ADVANTAGES AND DISADVANTAGES

Advantages

1)Saving time and money through automation
2)It houses intelligent safety sensor which stops compaction cycle when it detects hand of human being
3)Boost efficiency
4)Minimize the risk of human

Disadvantages

1)RFID tags can suffer from orientation issues as sometimes these tags do not connect with the readers when both are misaligned concerning each other.
2)SSDs will be more expensive than conventional complex disk systems.

10.CONCLUSION

The maintenance of proper personal and general hygiene is one of the most essential aspects of daily life. By using our proposed system utilizing smart bins and various sensors, we can achieve the expected level of hygiene. This system can be used to automate the process to maintain the cleanliness of our surroundings.

11.FUTURE SCOPE

The proposed system the development of garbage monitoring system, which is based on Arduino UNO. It is very useful in improving the efficiency of waste disposal management especially in the residential areas, by alerting the municipality for immediate collection. The proposed system can be adapted in all areas because of its reliability, reasonable cost and efficient environmental protection. In this method it is able to achieve above 90% of efficiency. In future,this system can also be installed in the home and if the dustbin gives bad odour, we can identify that it is time to dispose the dustbin, it can be done by placing gas sensor. An app based interface and webpage based interface will be handy for the civic bodies to monitor and manage multiple bins simultaneously.

APPENDIX

SOURCE CODE

1.index.html

```html
<html>
<head>
<title>USE-LESS COMPANY REGISTER</title>
        <link rel="icon" href="purchase bg.png">
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <link rel="stylesheet" type="text/css" href="static/companystylereg.css">
    <meta charset="UTF-8">
    <link rel="stylesheet" href="https://www.w3schools.com/w3css/4/w3.css">
    <link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Montserrat">
    <link rel="stylesheet"
href="https://cdnjs.cloudflare.com/ajax/libs/font-awesome/4.7.0/css/font-awesome.min.css">
</head>

<body>
    <div class="registerbox">
    <img src="static/company avatar.png" class="avatar">
        <h1><b>Register Here</b></h1>
        {% with messages = get_flashed_messages() %}
            {% if messages %}
                {% for message in messages %}
                    <h6 style="color:red;font-size:12px">{{ message }}</h6>
                {% endfor %}
            {% endif %}
        {% endwith %}
        <form action="/companyRegPopUp.html" method="POST">
            <p>User Name</p>
            <input type="text" type="text" required name="name" placeholder="Eg.ABC Internationals">
            <p>Email Id</p>
            <input type="email" type="text" required name="email"
placeholder="Eg.abcinternationals@gmail.com">
            <p>Password</p>
            <input type="password" type="text" required name="password" placeholder="Enter password"
```

```html
pattern="(?=.*\d)(?=.*[a-z])(?=.*[A-Z]).{8,}" onclick="myFunction()" required>
          <br>
          <p>Confirm Password</p>
          <input type="password" type="text" required name="conPass" placeholder="confirm password"
pattern="(?=.*\d)(?=.*[a-z])(?=.*[A-Z]).{8,}" required>
          <br>
          <p>Phone Number</p>
          <input type="tel" id="phone" required name="phone" placeholder="9876543210"
pattern="[0-9]{10}" required>
          <p>Address</p>
          <textarea type="text" type="text" required name="address" placeholder="Enter your address"
style="margin: 0px;width: 290px;height: 108px; color: black; background: transparent;border-color:
black; font-size: 18"></textarea>
          <br>
          <br>
          <p>Postal code</p>
          <input type="tel" id="phone" required name="code" placeholder="123456" pattern="[0-9]{6}"
required>
          <div class="inputfield terms">
          <label class="check">
          <input type="checkbox" type="checkbox" required name="tick" style="height: 20px;
width:20px;">
          <span class="checkmark"></span>
          </label>
              <p style="margin-top: - 6;margin-left: 30px;margin-top: -40;">Agree to terms and
conditions
               <a href="static/terms%20and%20conditions.pdf">
               <i class="fa fa-info-circle w3-large" style="padding-left: 260px;margin-top:
-18;"></i></a>
              </p>
          </div>
          <br>
          <input type="submit" name="" value="Register">
          <a href="companyLogin.html">Already have an account?</a>
      </form>
      <script>
      function myFunction() {
       alert("Use 8 or more characters with a mix of letters(atleast one upper and lower case
alphabets), numbers & symbols");
```

```
          }

</script>

</div>

</body>

</html>
```

GitHub Link:

https://github.com/IBM-EPBL/IBM-Project-26640-1660031630