Nalaiya Thiran -IBM Project

Batch No: B2 – 2M4E

KONGU ENGINEERING COLLEGE

Department of Computer Science and Engineering

Smart Waste Management System For Metropolitan Cities

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ABSTRACT

One issue that most cities and municipalities are dealing with currently, is the degradation of environmental cleanliness with reference to waste management. This is a result of improper garbage collection management. Dumping garbage onto the streets and in public areas is a common synopsis found in all developing countries and this mainly ends up affecting the environment and creating several unhygienic conditions. To avoid improper garbage management and to create a hygienic environment, the concept of automation is used in waste management system. Any city being referred to as a "smart city" is because of its orderly and tidy surroundings. But currently, many issues including those related to smart grids, smart environments, and smart living are faced. Today, cities and metropolitan areas' top priority is proper garbage management.

Traditional waste management techniques are too simplistic to create an effective and reliable waste management. The ideology put forward includes hardware and software technologies i.e. connecting Wi-Fi system to the normal dustbin in order to provide free internet facilities to the user for a particular period of time. The technology awards the user for keeping the surrounding clean and thus work hand in hand for the proper waste management in a locality. The smart bin uses multiple technologies - firstly the technology for measuring the amount of trash dumped and secondly the movement of the waste and lastly sending necessary signals and connecting the user to the WiFi system. The proposed system will function on client server model, a cause that will assure clean environment, good health, and pollution free society.

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APTER 1: INTRODUCTION

1.1 Project Overview

Smart waste management is an innovative approach to handling and collecting waste. Based on IoT (Internet of Things) technology, smart waste management provides data on waste generation patterns.

Our Smart waste management solution uses sensors placed in garbage bins to measure fill levels and notifies city collection services when bins are ready to be

emptied. There are load and ultrasonic sensors placed to continuously monitor the bins. This data is sent to the cloud (via a microcontroller that is connected to Wi-Fi) where it is stored after which it is processed further. When the levels exceed a certain limit, a notification is sent to the garbage collector via a web application.

Over time, historical data collected by sensors can be used to identify fill patterns, optimize driver routes and schedules, and reduce operational costs.

1.2 Purpose

Around 2.1 billion tonnes of municipal solid waste is generated annually around the globe. Population growth and rapid urbanization lead to a huge increase in waste generation, so the traditional methods of waste collection have become inefficient and costly. This system cannot measure the fullness levels of containers, and as a result, half-full containers can be emptied, and in contrast, pre-filled ones need to wait until the next collection period comes. Moreover, since drivers collect empty bins, predefined collection routes of the system cause waste of time, an increase in fuel consumption, and excessive use of resources.

In today's ever-technological world, an innovative and data-driven approach is the only way forward, the waste sector needs a solution that empowers event-driven waste collection. The most efficient way this extraordinary amount of waste can be solved is through smart waste management without obsolete methods of waste collection. This empowers municipalities, cities, and waste collectors to optimize their waste operations, become more sustainable, and make more intelligent business decisions.

CHAPTER 2: LITERATURE SURVEY

2.1 Existing Problem

Around 80% of waste collections happen at the wrong time. Late waste collections lead to overflowing bins, unsanitary environments, citizen complaints, illegal dumping, and increased cleaning and collection costs.

Early waste collections mean unnecessary carbon emissions, more traffic congestion, and higher running costs. The idea of smart garbage bins and systems have been in discussion for quite a long time. The technologies used at disposal to develop this smart system have also evolved, Internet of Things (IoT). Each idea seems to be similar but is slightly different at its core and our proposed work is no exception from the same. After the IoT field, finding its hold in our lives, this is our original plan for designing a smart garbage collection system which has provision for citizen participation and analysis of data for better decision making. At hardware level, the smart system is a garbage bin with ultrasonic sensor, a micro-controller and Wi-Fi module for transmission of data. The worldwide implementation of Internet of Things is possible with a Cloud centric vision. This work exploits the future possibilities, key technologies and application that are likely to drive IoT research. But a strong foundation to our work is provided, where the basics and applications of Arduino board is explained . It is quite interesting as it implements a GAYT (Get As You Throw) system concept as a way to encourage recycling among citizens. As we would discuss further, the citizen participation part of our system is quite influenced by their work idea of smart garbage bins and systems have been in discussion for quite a long time. The technologies used at disposal to develop this smart system have also evolved, Internet of Things (IoT). Each idea seems to be similar but is slightly different at its core and our proposed work is no exception from the same. After the IoT field, finding its hold in our lives, this is our original plan for designing a smart garbage collection system which has provision for citizen participation and analysis of data for better decision making. At hardware level, the smart system is a garbage bin with ultrasonic sensor, a micro-controller and Wi-Fi module for transmission of data. The worldwide implementation of Internet of Things is possible with a Cloud centric vision. This work exploits the future possibilities, key technologies and application that are likely to drive IoT research. But a strong foundation to our work is provided, where the basics and applications of Arduino board is explained . It is quite interesting as it implements a GAYT (Get As You Throw) system concept as a way to encourage recycling among citizens. As we would discuss further, the citizen participation part of our system is quite influenced by their work

2.2 References

S.NO	PAPER	AUTHOR	YEAR	METHOD AND ALGORITHM	ACCURACY

1.	Waste management using Internet of Things (IoT)	H. N. Saha et al	2017	Taking out the trash (and the Recyclables): RFID and the handling of municipal solid waste.	95%
2.	A Smart Waste Management and Segregation System that Uses Internet of Things, Machine Learning and Android Application	S. Varudandi, R. Mehta, J. Mahetalia, H. Parmar and K. Samdani	2021	A Smart Waste Management and Segregation System with the help of Internet Of Things to segregation of Waste in Metropolitan Cities .	90%
3.	Smart and Sustainable Built Environment	Yadav, H., Soni, U. and Kumar, G	2021	Analyzing challenges to smart waste management for a sustainable circular economy in developing countries.	96.5%
4.	Optimal Management of Solid Waste in Smart Cities using Internet of Things	Wyld, D	2010	Taking out the trash (and the Recyclables): RFID and the handling of municipal solid waste.	70%
5.	Smart garbage monitoring and clearance system using internet of things.	Kumar, S.V., Kumaran, T.S., Kumar, A.K., Mathapati, M	2017	They proposed a model using IoT to monitor and clear the smart waste in metropolitan cities	95%

2.3 PROBLEM STATEMENT:

SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITAN CITIES

TECHNOLOGY:

IOT

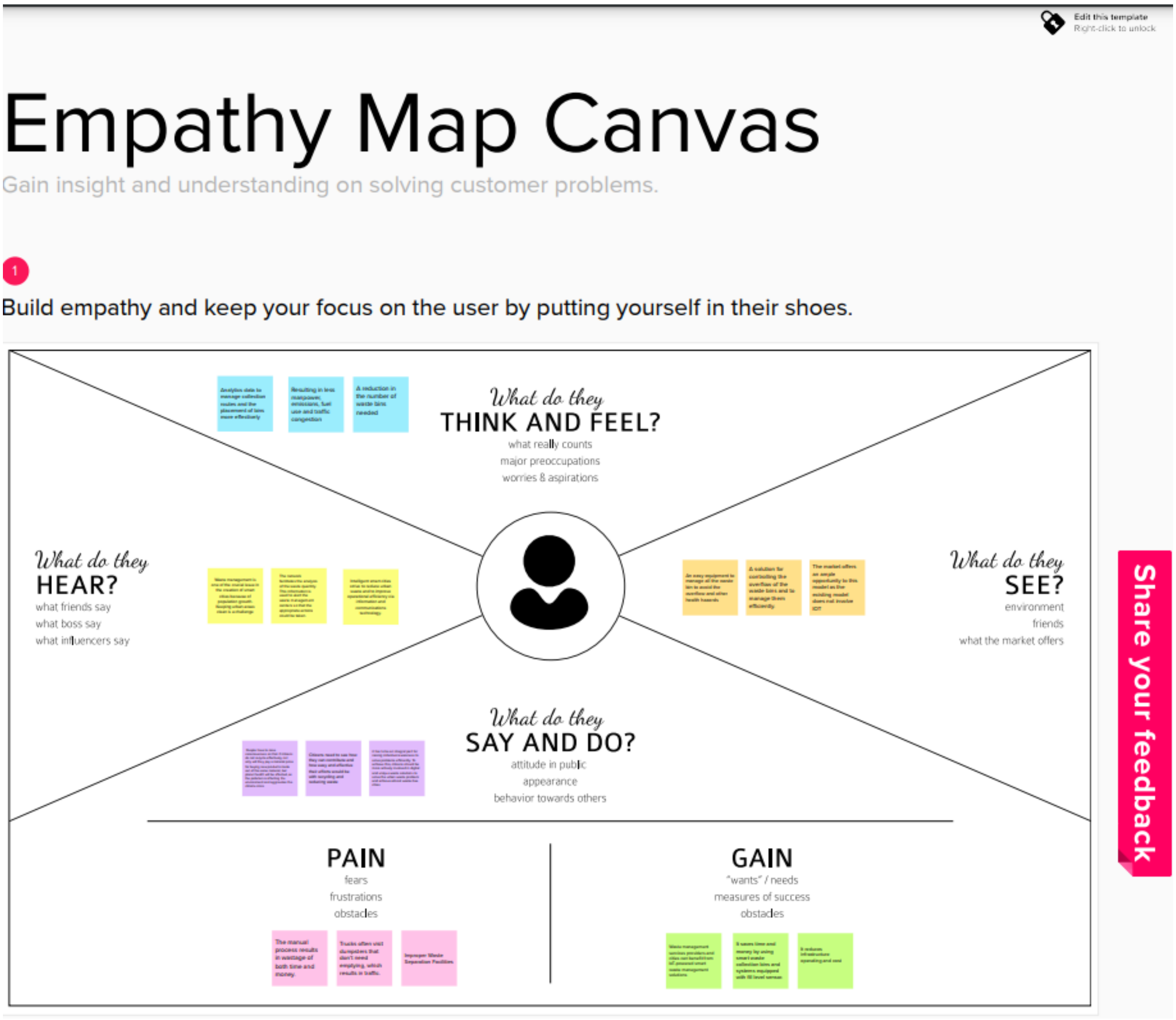
PROBLEM STATEMENT:

Urban India generates tonnes of wastes annually. Our country faces major challenge associated with waste management. Conventional garbage collection is not efficient since the authorities are not notified until the waste bin is full, and this leads to overflow of waste material. Efficient way of waste disposed garbage is essential for a sustainable and clean India.

This project smart waste management using IOT based waste bin for collection and monitoring the level of waste inside bin. The system is implemented using two ultrasonic sensors which is being controlled by Node MCU. One of the ultrasonic sensor detects the level of the waste in the bin and other detects the person approaching the bin to dispose the waste. This detection helps in automatic opening and closing of the lid. Servo motor is connected to the lid which serves the action of closing and opening of the lid. In this system, level of waste in the bin will be sent to concerned authorities. The IOT data is stored and monitored using app.

CHAPTER 3: IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



Edit this template
Right-click to unlock

Empathy Map Canvas

Gain insight and understanding on solving customer problems.

1

Build empathy and keep your focus on the user by putting yourself in their shoes.

What do they
THINK AND FEEL?
what really counts
major preoccupations
worries & aspirations

Analytics data to manage collection routes and the placement of bins more effectively

Resulting in less manpower, emissions, fuel use and traffic congestion

A reduction in the number of waste bins needed

What do they
HEAR?
what friends say
what boss say
what influencers say

Waste management is one of the crucial issue in the creation of smart cities because of population growth. Keeping urban areas clean is a challenge

The network facilitates the analysis of the waste quantity. This information is used to alert the waste management centers so that the appropriate actions could be taken.

Intelligent smart cities strive to reduce urban waste and to improve operational efficiency via information and communications technology.

What do they
SEE?
environment
friends
what the market offers

An easy equipment to manage all the waste bin to avoid the overflow and other health hazards

A solution for controlling the overflow of the waste bins and to manage them efficiently.

The market offers an ample opportunity to this model as the existing model does not involve IOT

What do they
SAY AND DO?
attitude in public
appearance
behavior towards others

[illegible]

Citizens need to see how they can contribute and how easy and effective their efforts would be with recycling and reducing waste

[illegible]

PAIN
fears
frustrations
obstacles

The manual process results in wastage of both time and money.

Trucks often visit dumpsters that don't need emptying, which results in traffic.

Improper Waste Separation Facilities

GAIN
"wants" / needs
measures of success
obstacles

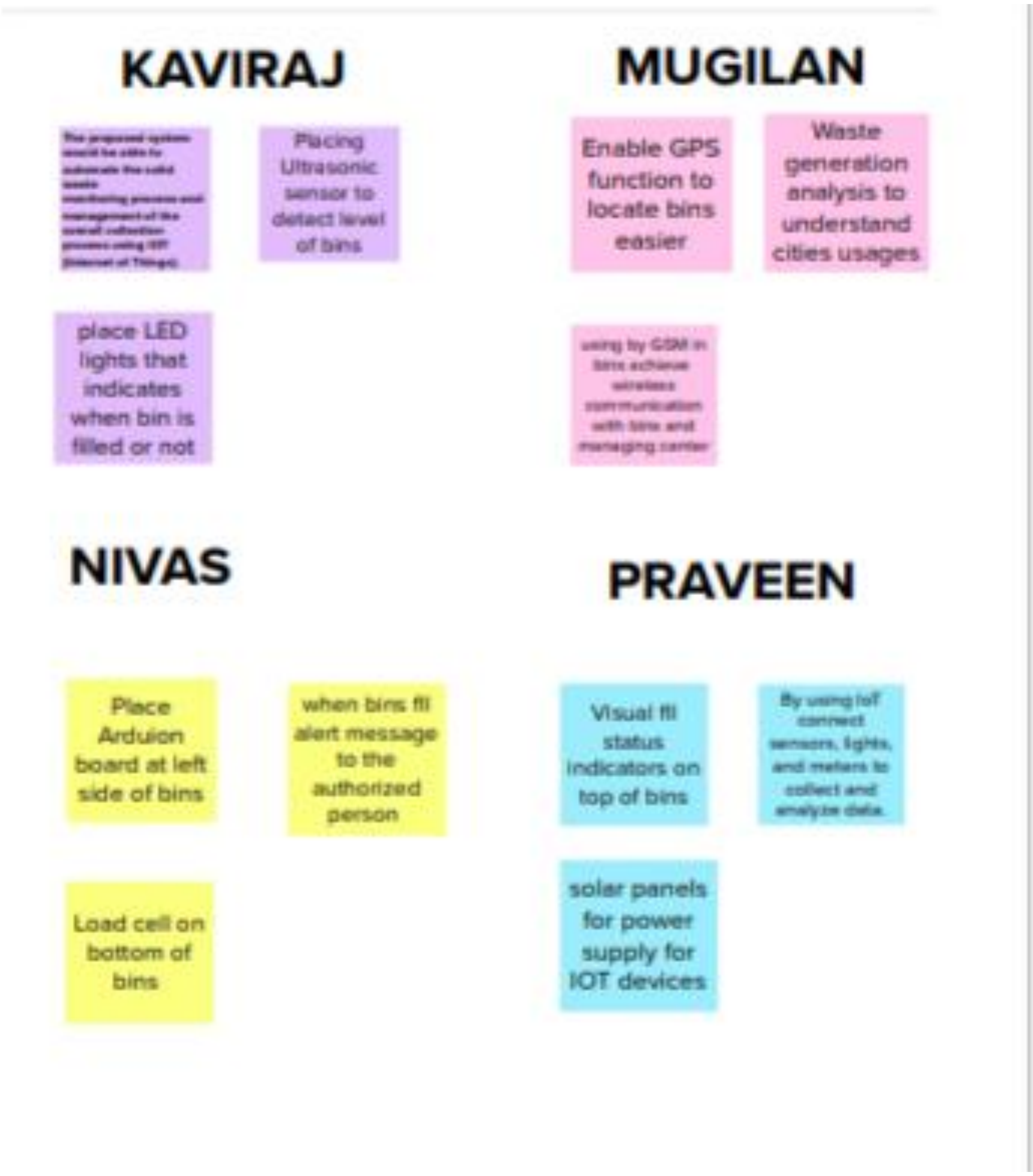
Waste management services providers and cities can benefit from IoT-powered smart waste management solutions

It saves time and money by using smart waste collection bins and systems equipped with fill level sensors

It reduces infrastructure operating and cost

Share your feedback

3.2 Ideation & Brainstorming



KAVIRAJ

The proposed system would be able to automate the solid waste monitoring process and management of the overall collection process using IOT (Internet of Things).

Placing Ultrasonic sensor to detect level of bins

place LED lights that indicates when bin is filled or not

MUGILAN

Enable GPS function to locate bins easier

Waste generation analysis to understand cities usages

using by GSM in bins achieve wireless communication with bins and managing center

NIVAS

Place Arduion board at left side of bins

when bins fill alert message to the authorized person

Load cell on bottom of bins

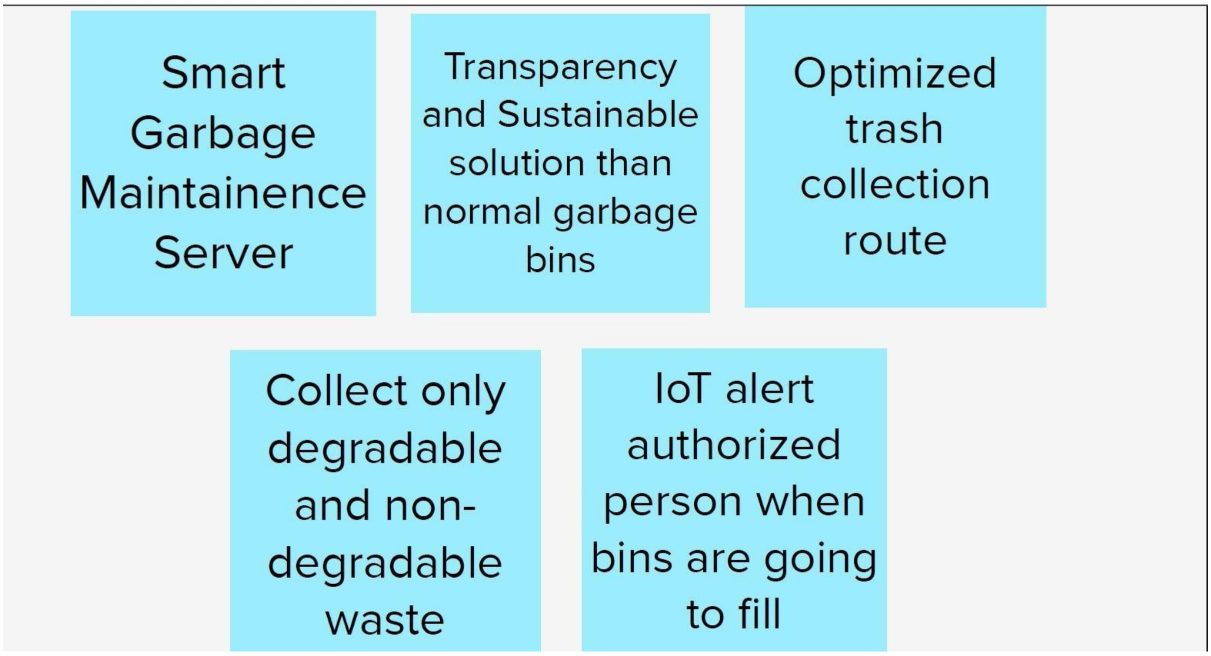
PRAVEEN

Visual fill status indicators on top of bins

By using IoT connect sensors, lights, and meters to collect and analyze data.

solar panels for power supply for IOT devices

3.2.2 Group ideas



Smart Garbage Maintainence Server

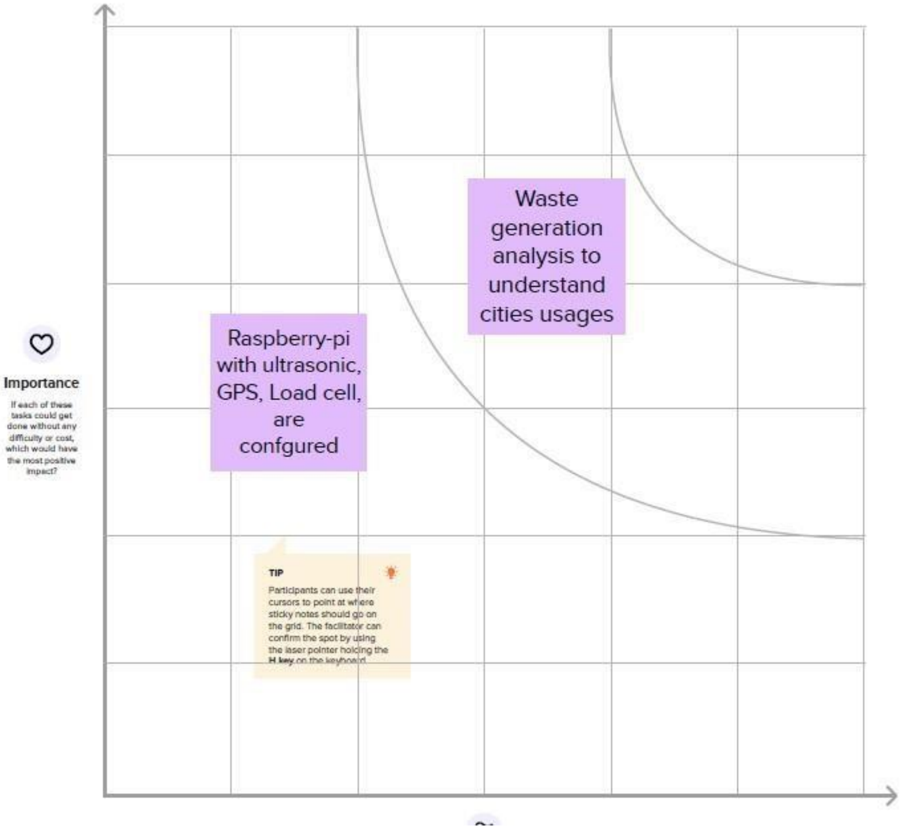
Transparency and Sustainable solution than normal garbage bins

Optimized trash collection route

Collect only degradable and non-degradable waste

IoT alert authorized person when bins are going to fill

3.2.3Prioritize


Importance
If each of these tasks could get done without any difficulty or cost, which would have the most positive impact?
Waste generation analysis to understand cities usages
Raspberry-pi with ultrasonic, GPS, Load cell, are confgured
TIP
Participants can use their cursors to point at where sticky notes should go on the grid. The facilitator can confirm the spot by using the laser pointer holding the H key on the keyboard

Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	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 authorised person 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.
2.	Idea / Solution description	The key research objectives are as follows: • The proposed system would be able to automate the solid waste monitoring process and management of the overall collection process using IOT (Internet of Things). • The Proposed system consists of main subsystems namely Smart Trash System(STS) and Smart Monitoring and Controlling Hut(SMCH). • In the proposed system, whenever the waste bin gets filled this is acknowledged by placing the circuit at the waste bin, which transmits it to the receiver at the desired place in the area or spot. • In the proposed system, the received signal indicates the waste bin status at the monitoring and controlling system.
3.	Novelty / Uniqueness	We are going to establish SWM in our college but the real hard thing is that janitor (cleaner) don't know to operate these thing practically so here our team planned to build a wrist band to them, that indicate via light blinking when the dustbin fill and this is Uniqueness we made here beside from project constrain.
4.	Social Impact / Customer Satisfaction	From the public perception as worst impacts of present solid waste disposal practices are seen direct social impacts such as neighbourhood of landfills to communities, breeding of pests and loss in property values

5.	Business Model (Revenue Model)	Waste Management organises its operations into two reportable business segments: Solid Waste, comprising the Company’s waste collection, transfer, recycling and resource recovery, and disposal services, which are operated and managed locally by the Company’s various subsidiaries, which focus on distinct geographic areas; and Corporate and Other, comprising the Company’s other activities, including its development and operation of landfill gas-toenergy facilities in the INDIA, and its recycling brokerage services, as well as various corporate functions.
6.	Scalability of the Solution	In this regard, smart city design has been increasingly studied and discussed around the world to solve this problem. Following this approach, this paper presented an efficient IoTbased and real-time waste management model for improving the living environment in cities, focused on a citizen perspective. The proposed system uses sensor and communication technologies where waste data is collected from the smart bin, in real-time, and then transmitted to an online platform where citizens can access and check the availability of the compartments scattered around a city.

CHAPTER 4: REQUIREMENT ANALYSIS

4.1 Functional Requirements:

FR No.	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 ofbins 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 whenthe 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 collectioncosts. The tool calculates a rating for each bin in termsof collection costs. The tool considers the average distance depobindischarge 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 bindistribution. Make sure all trash types are represented within astand. Based on the historical data, you can adjust bin capacity or location where necessary.

4.2 Non-functional Requirements:

Following are the non-functional requirements of the proposed solution

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	IoT device verifies that usability is a special and important perspective to analyze user requirements, which can further improve the design quality. In the design process with user experience as the core, theanalysis of users' product usability can indeed help designers better understand users' potential needs in waste management, behavior 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**	creating better working conditions for waste collectors and drivers. Instead of driving the same collection routesand servicing empty bins, waste collectors will

		spendtheir 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 binsseveral 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.

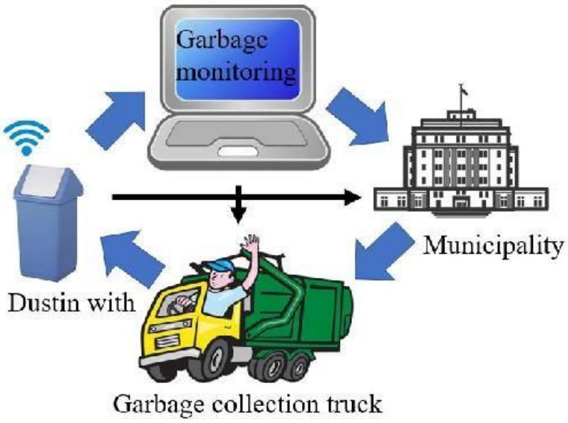
CHAPTER 5: PROJECT DESIGN

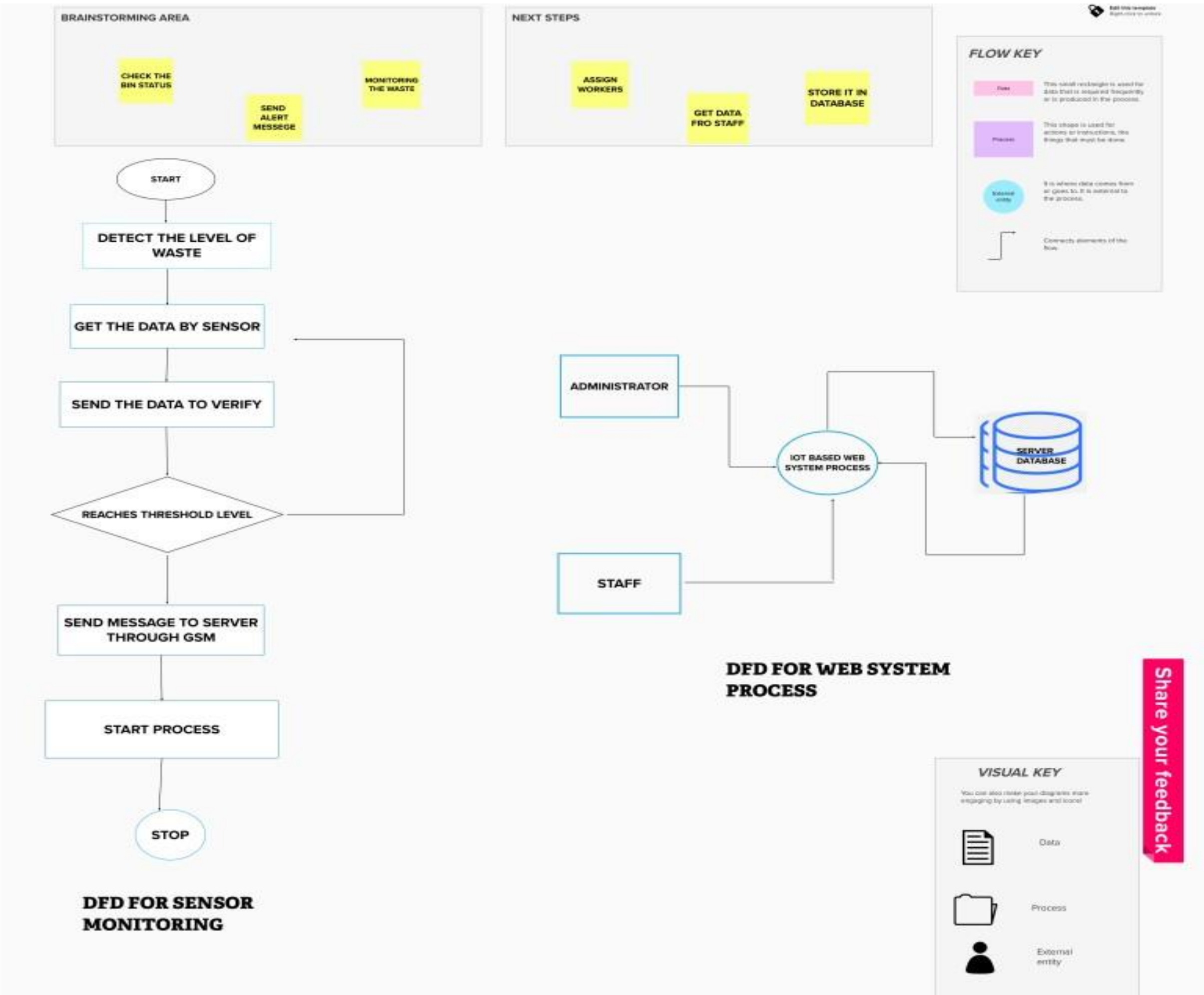
5.1 Data Flow Diagram:

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.

Data Flow Diagram For Smart Cities

The waste in the garbage are monitored by the sensor and send the value to the cloud and the application send the alert to the municipality if the bin was filled and sent the shortest path to collect the garbage




BRAINSTORMING AREA
CHECK THE BIN STATUS
SEND ALERT MESSEGE
MONITORING THE WASTE
NEXT STEPS
ASSIGN WORKERS
GET DATA FRO STAFF
STORE IT IN DATABASE
Edit this template
Right click to unlock
FLOW KEY
Data
This small rectangle is used for data that is required frequently or is produced in the process.
Process
This shape is used for actions or instructions, the things that must be done.
External entity
It is where data comes from or goes to. It is external to the process.
Connects elements of the flow.
START
DETECT THE LEVEL OF WASTE
GET THE DATA BY SENSOR
SEND THE DATA TO VERIFY
REACHES THRESHOLD LEVEL
SEND MESSAGE TO SERVER THROUGH GSM
START PROCESS
STOP
DFD FOR SENSOR MONITORING
ADMINISTRATOR
IOT BASED WEB SYSTEM PROCESS
SERVER DATABASE
STAFF
DFD FOR WEB SYSTEM PROCESS
Share your feedback
VISUAL KEY
You can also make your diagrams more engaging by using images and icons!
Data
Process
External entity

User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Admin (who manage web server)	Web server login	USN-1	As a admin, I have my user name and password for every worker and co-workers to manage them.	I can manage web account and direct workers.	High	Sprint-1
Co-admin	Login	USN-2	As a co-admin, I'll manage other monitoring activities like garbage level monitoring, location accuracy, garbage separation and removal of waste within a scheduled time.	I can monitor garbage bins activities.	High	Sprint-2
Customer (Web user)	User	USN-3	Here comes the customer, he/she will have access to mobile apps or login web pages to view progress of bins and to report if any query found.	He/ she has the right to make a query if any.	High	Sprint-3

Customer Care Executive	Worker	USN-4	The customer care executive, will try to rectify the queries from customers by contacting co- admin. If case of any critical/ emergency situation query can be conveyed to higher authority.	I can attend calls and respond people by rectifying the problem.	High	Sprint-4
Truck driver	Worker	USN-5	Here, truck driver is a worker who has particular assignments that he has to report when and where the garbage has been picked according to the daily schedule. And should update the happenings in the given website (web page login).	I can update my activities on site when the given task has been completed.	Moderate	Sprint-5

Technical Architecture:

Table-1 : Components & Technologies:

S.No	Component	Description	Technology
1.	User Interface	Web Portal	HTML,CSS,NodeRed, Javascript.o r on
2.	Application Logic-1	To calculate the distance 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 portal.	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.	Load cell/Python.
4.	Application Logic-3	Getting location of the Garbage.	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 API1.	Firebase is a set of hosting services for any type of	Firebase.

		application. It offers NoSQL and real-time hosting of databases, content, social authentication, and notifications, or services, such as a real-time communication server.	
8.	Ultrasonic Sensor.	To throw alert message when garbage is getting full.	Distance Recognition Model.
9.	Infrastructure (Server / Cloud)	Application Deployment on Local System / Cloud Local Server Configuration:localhost Cloud Server Configuration:localhost,Firebase.	Localhost,Web portal.

Table-2: Application Characteristics:

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	NodeRed,Python,IBM Simulator.	IoT
2.	Security Implementations	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 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	IoT
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	IoT.

		smaller bin.	
5.	Performance	Number of request:RPI manages to execute 129139 read requests per second. Use of Cache:512mb Use of CDN's:Real time	IoT/Web portal.

CHAPTER 6: PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation:

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Login	USN-1	As a Administrator, I need to give user id and passcode for ever workers over there in municipality	10	High	Mugilan
Sprint-1	Login	USN-2	As a Co-Admin, I'll control the waste level by monitoring them on real time web portal. Once the filling happens, I'll notify trash truck with location of bin with bin ID	10	High	Praveen
Sprint-2	Dashboard	USN-3	As a Truck Driver, I'll follow Co-Admin's Instruction to reach the filling bin in short roots and save time	20	Low	Praveen
Sprint-3	Dashboard	USN-4	As a Local Garbage Collector, I'll gather all the waste from the garbage, load it onto a garbage truck, and deliver it to Landfills	20	Medium	Nivas
Sprint-4	Dashboard	USN-5	As a Municipality officer, I'll make sure everything is proceeding as planned and without any problems	20	High	KaviRaj

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

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

Velocity:

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

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

CHAPTER 7: CODING AND SOLUTIONING

7.1 Feature 1:

The main and first feature of the smart waste management is to get the live location of anyone who access the website for putting out a request for garbage collection in their locality. The live location is obtained as a result of the below code.

Web Application to get the Live location:

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>Waste Management</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-db.js"></script>
<script type="module">
  // Import the functions you need from the SDKs you need   import { initializeApp } from
"https://www.gstatic.com/firebasejs/9.14.0/firebaseapp.js";   import { getAnalytics } from
"https://www.gstatic.com/firebasejs/9.14.0/firebaseanalytics.js";
   // TODO: Add SDKs for Firebase products that you want to use
   // https://firebase.google.com/docs/web/setup#available-libraries

   // Your web app's Firebase configuration
  //  For  Firebase  JS  SDK  v7.20.0  and  later,  measurementId  is  optional
    const firebaseConfig = {
   apiKey: "AIzaSyCLmn-TzMoUVe9sBa6h56Bd4WnFJtjm0aE",
authDomain: "ibm-smart-waste.firebaseapp.com",
   databaseURL: "https://ibm-smart-waste-default-rtdb.firebaseio.com",           projectId:
"ibm-smart-waste",
   storageBucket:  "ibm-smart-waste.appspot.com",        messagingSenderId:
"426276430128",
     appId: "1:426276430128:web:4f8671bf97c4c9450728f5",
     measurementId: "G-16DJ7XEDK5"
   };
  // Initialize Firebase   const firebase =
initializeApp(firebaseConfig);   const analytics =
getAnalytics(firebase);
  </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" >LOCATION</h1>
                <div id="map"></div>
                <div id="alert_msg">ALERT MESSAGE!</div>
    </div>
 </div>
<center><a
href="https://www.google.com/maps/place/Perundurai+New+Bus+Stand/@11.273363,77.5778373,17z/data=!3m1!4b1!4m5!3m4!1s0x3ba96d434da63087:0x91b2c203d46019b3!8m2!3d11.273363!4d77.5800313"    type="button" class="btn btn-dark">Get
Dumpster</a></center>

 <script

     src="https://maps.googleapis.com/maps/api/js?key=AIzaSyBBLyWj3FWtCbCXGW3ysEiI2fDfrv2v0Q&callback=myMap"></script></div>
</body>

</html>
```

Style.css:

```
html, body
 {
     height:              100%;
    margin: 0px;
   padding:0px;
 }
#container
```

```
{

display: flex; flexdirection:
row; height: 100%; width:
100%; position: relative; }
#logo_container { height:
100%; width: 12%;
background-color:
#C5C6D0; display: flex;
flexdirection: column;
verticalalign: text-bottom;
}
.logo { width:70%;
margin: 5% 15%;

/* border-radius: 50%; */
}
#logo_3
{ vertical-align: textbottom;

}
#data_container { height:
100%; width: 20%;
margin-left: 1%; margin-
right: 1%; display: flex;
flexdirection: column; }
#data_status { height:60%;
width:8%; margin:7%;
background-color:
#691F6E; display: flex;
flex-direction:
column; borderradius:20px;
}
#load_status background-image: url("/Images/KG.png");
background-repeat: no-repeat; background-size:
170px; background-position: left center;
}
#cap_status { background-image:
url("/Images/dust.png"); background-repeat:
no-repeat; backgroundsize: 150px;
background-position: left center; }
.status { width: 80%;
height: 40%; margin:5%
10%;
backgroundcolor:#185adc
```

```
{

;        borderradius:20px;
display:   flex;       justify-
content:  center;       align-
items:    center;       color:
white;
 font-size: 60px;


}
.datas {  width:86%;  margin:2.5%
7%;  height:10%;    background:
url(water.png);     background-repeat:
repeat-x;     animation: datas 10s
linear infinite;

    box-shadow: 0 0 0 6px #98d7eb, 0  20px 35px
rgba(0,0,0,1);

}
#map_container  {
height: 100%;  width:
100%;  display: flex;
flex-direction:
column;
}
#live_location_heading                margin-
top:10%;
text-align: center;
color:  GREY;
}
#map
{    height:  70%;    width:
90%;    margin-left:  4%;
margin-right:4%;
border: 10px solid white;
border-radius:    25px;    }
#alert_msg                    {
width:92%;   height:20%;
margin:4%;
backgroundcolor:grey;
borderradius:          20px;
display:   flex;      justify-
content:  center;      align-
```

```
{

items:   center;      color:
#41af7f;  font-size: 25px;
fontweight: bold;
}
.lat {
margin: 0px;
font-size:0px;
}




@keyframes datas{
   0%
   {
      background-position: -500px 100px;
   }
   40%
   {
      background-position: 1000px -10px;
   }

   80% {
```

```
{

        background-position: 2000px 40px;
      }
      100% {
        background-position: 2700px 95px;
      }

    }
```

Map.js:

```
    const database = firebase.database();

    function myMap()
    {  var ref1 =
    firebase.database().
    ref();

      ref1.on("value", function(snapshot)
       {
           snapshot.forEach(function (childSnapshot)
{                var value = childSnapshot.val();
                         const  latitude  =  value.latitude;
                         const          longitude          =
value.longitude;

                         var latlong = { lat: latitude, lng: longitude}
                         var mapProp =
                         {
                                 center: new google.maps.LatLng(latlong),
                                 zoom: 10,
                         };
                var    map    =    new    google.maps.Map(document.getElementById("map"),
    mapProp);

                var marker = new google.maps.Marker({ position: latlong });
       marker.setMap(map);
         });
       }, function (error) {
         console.log("Error: " + error.code);
       });

    }
```

Database.Js:

```
{

        import "firebase/database"; const cap_status =
        document.getElementById('cap_status'); const alert_msg =
        document.getElementById('alert_msg');

        console.log(firebase); 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);
        });
```

7.2 Feature 2:

In this part, the filled level of the bin is measured with the help of IBM IOT Watson platform devices, IBM Cloud interface and Node-RED is used for creating the dashboard nodes that helps us create a UI to display the distance, that is, the fill level of the bin. It also intimates the location of the bin with the fill level and alerts the collection authority if the fill level goes beyond a threshold value.

Node Red Connection With IBM IoT Platform:

```
#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 "3defta" //IBM organisation id
#define DEVICE_TYPE "hariprasath" // Device type mentioned in ibm watson iot platform
#define DEVICE_ID "12345" // Device ID mentioned in ibm watson iot platform
#define TOKEN "CpL-H1C-Pt4i9iM-F5" // 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[] = "use-token-auth";
// authentication method  char token[] = TOKEN;   char clientId[] = "d:" ORG ":"
DEVICE_TYPE ":" DEVICE_ID; //Client id
//
WiFiClient wifiClient; // creating instance for wificlient
PubSubClient client(server, 1883, wifiClient);
#define ECHO_PIN 12
#define TRIG_PIN 13
float
dist;

void setup()
{
Serial.begin(115200);
pinMode(LED_BUILTIN,                     OUTPUT);
pinMode(TRIG_PIN,                        OUTPUT);
pinMode(ECHO_PIN, INPUT);
//pir
pinMode(4, INPUT);
//ledpins
pinMode(23,OUTPUT);
pinMode(2,OUTPUT);
pinMode(4,OUTPUT);
pinMode(15,OUTPUT); lcd.init();

lcd.backl
ight();
lcd.setC
ursor(1,0
);
lcd.print
("");
wifiCon
nect();
mqttCon
nect(); } float
readcmC
M()
{
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.cle
```

```
{


ar();
publish
Data();
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("WokwiGUEST", "", 6);
while (WiFi.status() != WL_CONNECTED)
Serial.print(".");
}
Serial.print("WiFi connected, IP address: ");
Serial.println(WiFi.localIP());
} void
mqttConn
ect()  {
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()
{
 }  void
publishData()
{
float cm = readcmCM();
if(digitalRead(34)) //PIR motion detection
{
Serial.println("Motion Detected"); Serial.println("Lid Opened"); digitalWrite(15, HIGH);
}

e

l
```

```
{



s

e

{

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");
}
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");
} e
l

s

e

{

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();
}
}
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
{
```

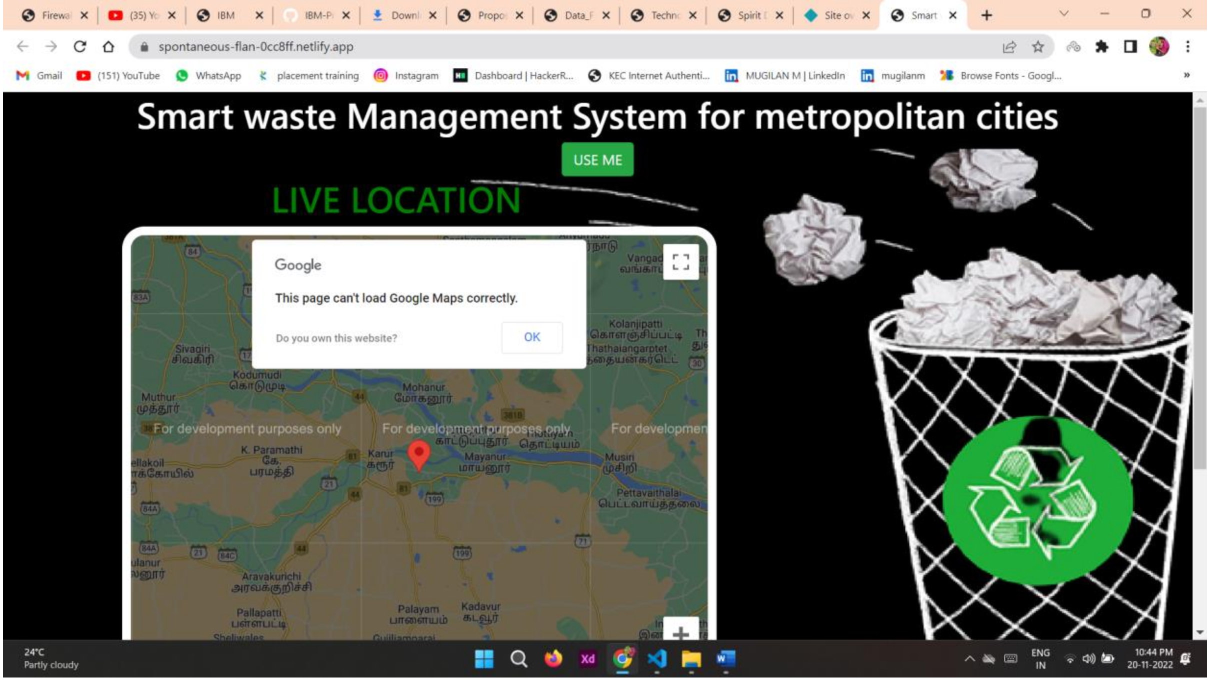
```
{


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");
}

e

l

s

e

{

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();
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");
} e
l

s

e

{

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:

Web Application:

Link: https://spontaneous-flan-0cc8ff.netlify.app/


spontaneous-flan-0cc8ff.netlify.app
Smart waste Management System for metropolitan cities
USE ME
LIVE LOCATION
For development purposes only
24°C
Partly cloudy
ENG
IN
10:44 PM
20-11-2022

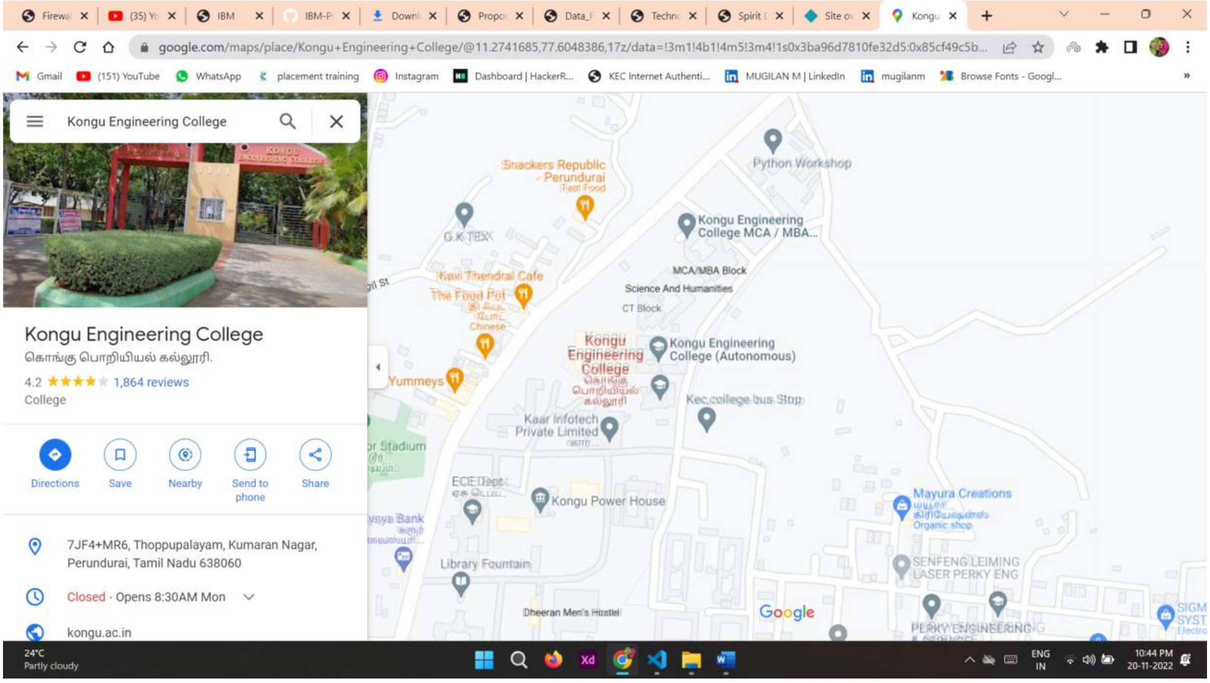
Google

This page can't load Google Maps correctly.

Do you own this website?

OK

{


google.com/maps/place/Kongu+Engineering+College/@11.2741685,77.6048386,17z/data=!3m1!4b1!4m5!3m4!1s0x3ba96d7810fe32d5:0x85cf49c5b...

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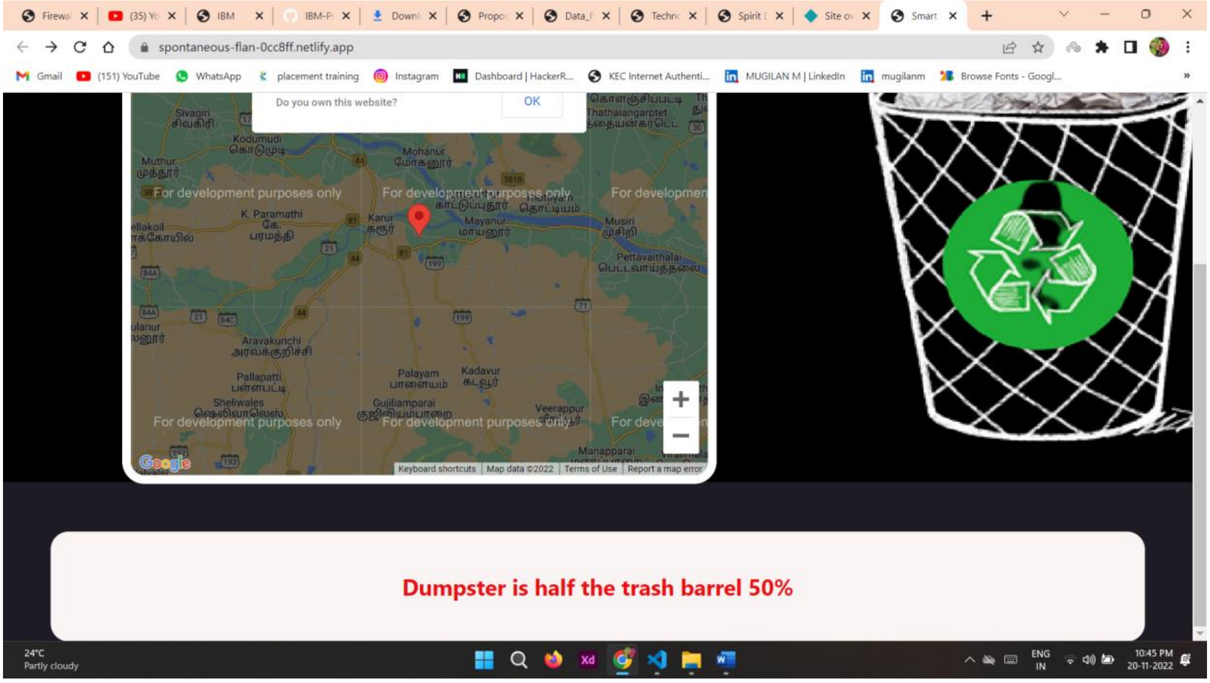
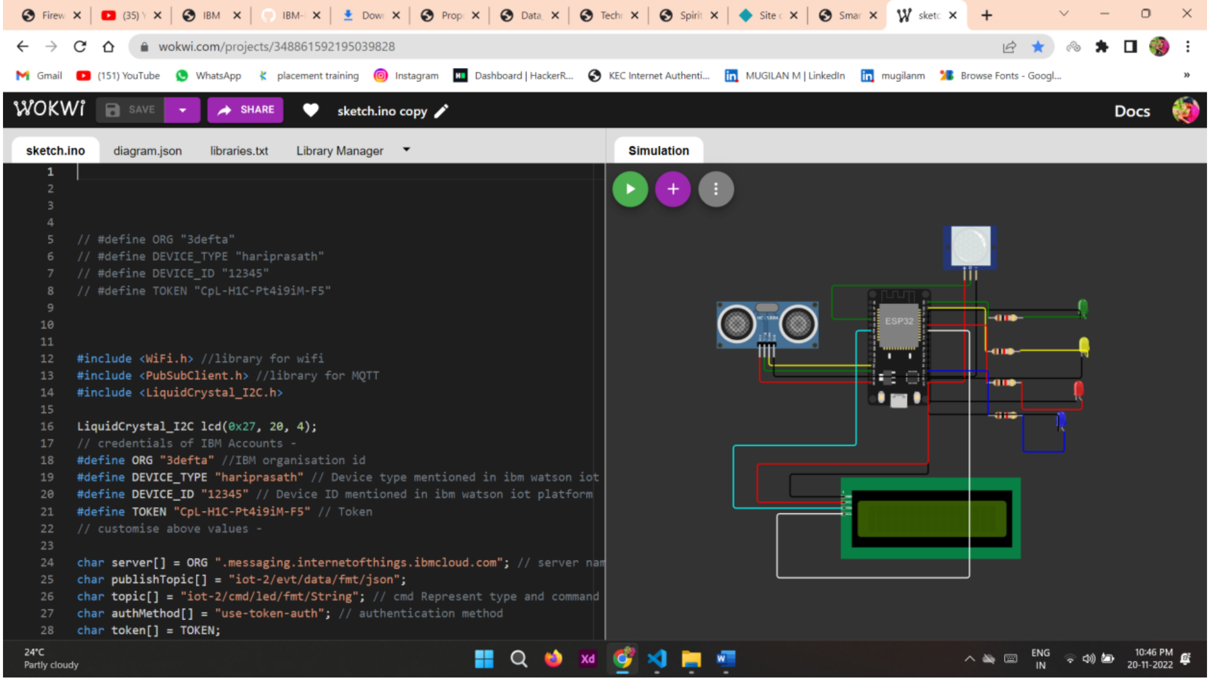

spontaneous-flan-0cc8ff.netlify.app

Do you own this website? OK

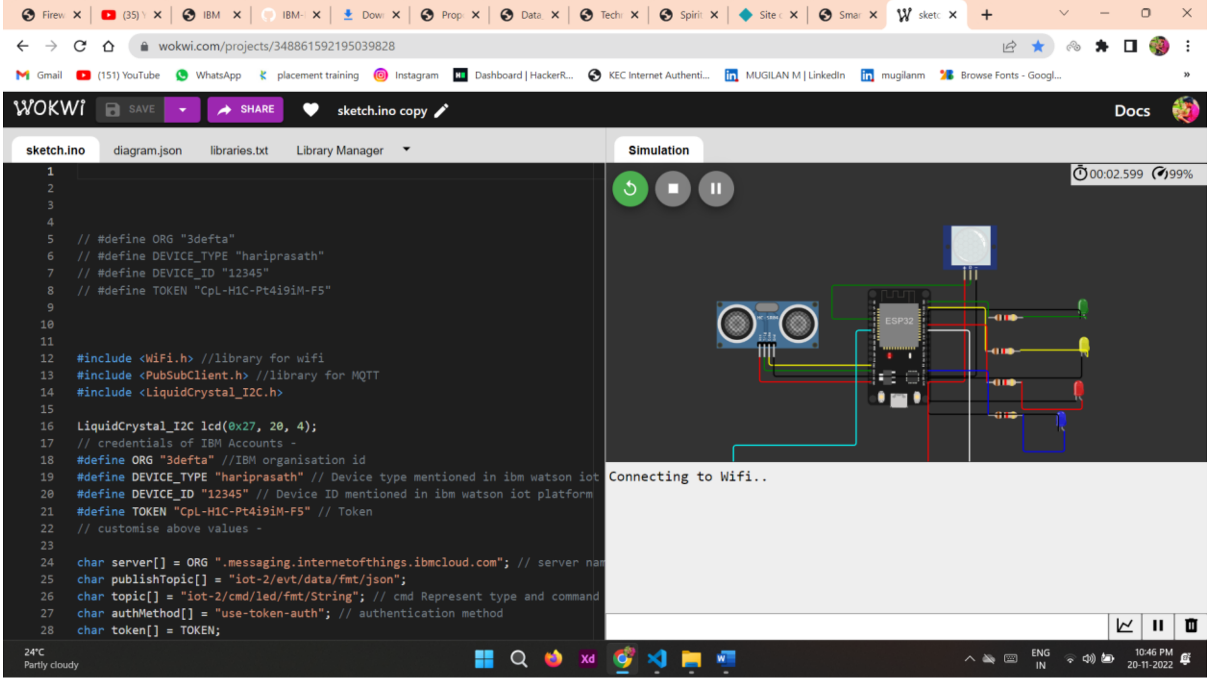
Dumpster is half the trash barrel 50%

{

Node Red Connection With IBM IoT Platform:



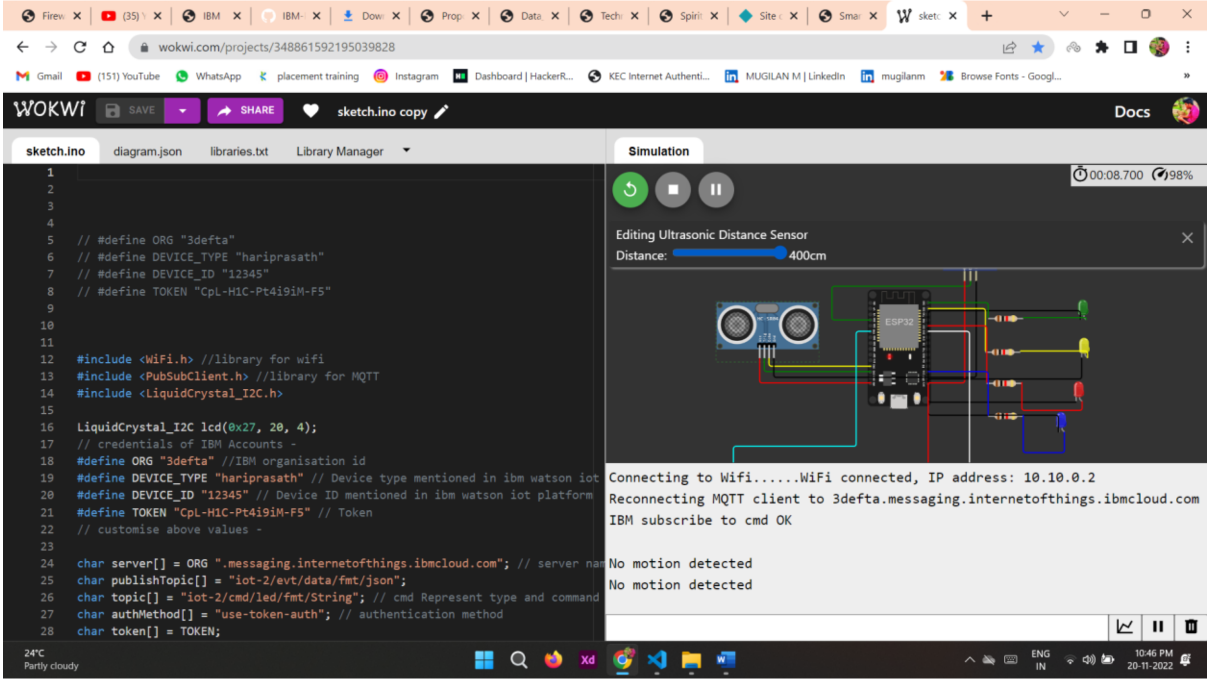
```
// #define ORG "3defta"
// #define DEVICE_TYPE "hariprasath"
// #define DEVICE_ID "12345"
// #define TOKEN "CpL-H1C-Pt4i9iM-F5"



#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 "3defta" //IBM organisation id
#define DEVICE_TYPE "hariprasath" // Device type mentioned in ibm watson iot
#define DEVICE_ID "12345" // Device ID mentioned in ibm watson iot platform
#define TOKEN "CpL-H1C-Pt4i9iM-F5" // Token
// customise above values -

char server[] = ORG ".messaging.internetofthings.ibmcloud.com"; // server nam
char publishTopic[] = "iot-2/evt/data/fmt/json";
char topic[] = "iot-2/cmd/led/fmt/String"; // cmd Represent type and command
char authMethod[] = "use-token-auth"; // authentication method
char token[] = TOKEN;
```



```
// #define ORG "3defta"
// #define DEVICE_TYPE "hariprasath"
// #define DEVICE_ID "12345"
// #define TOKEN "CpL-H1C-Pt4i9iM-F5"



#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 "3defta" //IBM organisation id
#define DEVICE_TYPE "hariprasath" // Device type mentioned in ibm watson iot
#define DEVICE_ID "12345" // Device ID mentioned in ibm watson iot platform
#define TOKEN "CpL-H1C-Pt4i9iM-F5" // Token
// customise above values -

char server[] = ORG ".messaging.internetofthings.ibmcloud.com"; // server nam
char publishTopic[] = "iot-2/evt/data/fmt/json";
char topic[] = "iot-2/cmd/led/fmt/String"; // cmd Represent type and command
char authMethod[] = "use-token-auth"; // authentication method
char token[] = TOKEN;
```

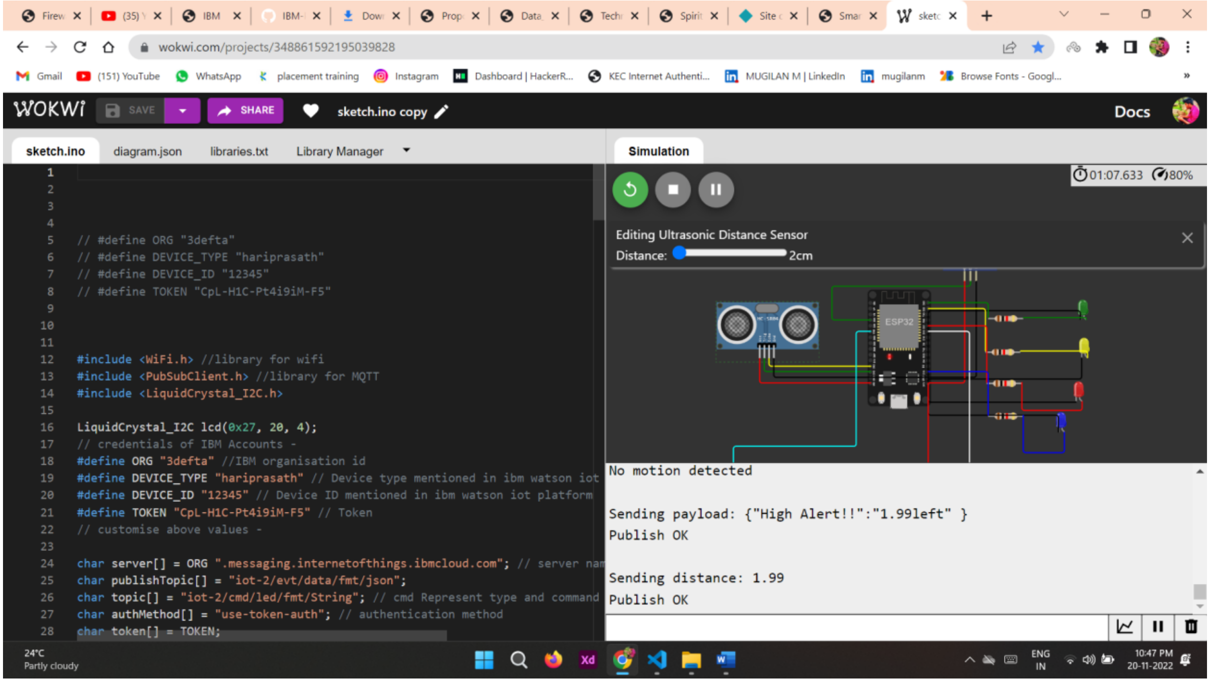
```
Connecting to Wifi..
```

{



```
// #define ORG "3defta"
// #define DEVICE_TYPE "hariprasath"
// #define DEVICE_ID "12345"
// #define TOKEN "CpL-H1C-Pt4i9iM-F5"



#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 "3defta" //IBM organisation id
#define DEVICE_TYPE "hariprasath" // Device type mentioned in ibm watson iot
#define DEVICE_ID "12345" // Device ID mentioned in ibm watson iot platform
#define TOKEN "CpL-H1C-Pt4i9iM-F5" // Token
// customise above values -

char server[] = ORG ".messaging.internetofthings.ibmcloud.com"; // server nam
char publishTopic[] = "iot-2/evt/data/fmt/json";
char topic[] = "iot-2/cmd/led/fmt/String"; // cmd Represent type and command
char authMethod[] = "use-token-auth"; // authentication method
char token[] = TOKEN;
```

```
Connecting to Wifi......WiFi connected, IP address: 10.10.0.2
Reconnecting MQTT client to 3defta.messaging.internetofthings.ibmcloud.com
IBM subscribe to cmd OK

No motion detected
No motion detected
```



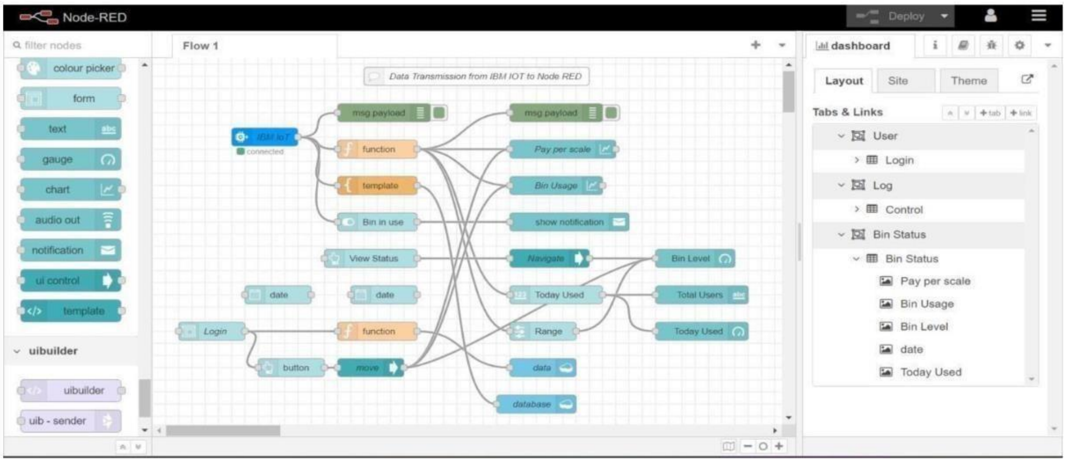
```
// #define ORG "3defta"
// #define DEVICE_TYPE "hariprasath"
// #define DEVICE_ID "12345"
// #define TOKEN "CpL-H1C-Pt4i9iM-F5"



#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 "3defta" //IBM organisation id
#define DEVICE_TYPE "hariprasath" // Device type mentioned in ibm watson iot
#define DEVICE_ID "12345" // Device ID mentioned in ibm watson iot platform
#define TOKEN "CpL-H1C-Pt4i9iM-F5" // Token
// customise above values -

char server[] = ORG ".messaging.internetofthings.ibmcloud.com"; // server nam
char publishTopic[] = "iot-2/evt/data/fmt/json";
char topic[] = "iot-2/cmd/led/fmt/String"; // cmd Represent type and command
char authMethod[] = "use-token-auth"; // authentication method
char token[] = TOKEN;
```

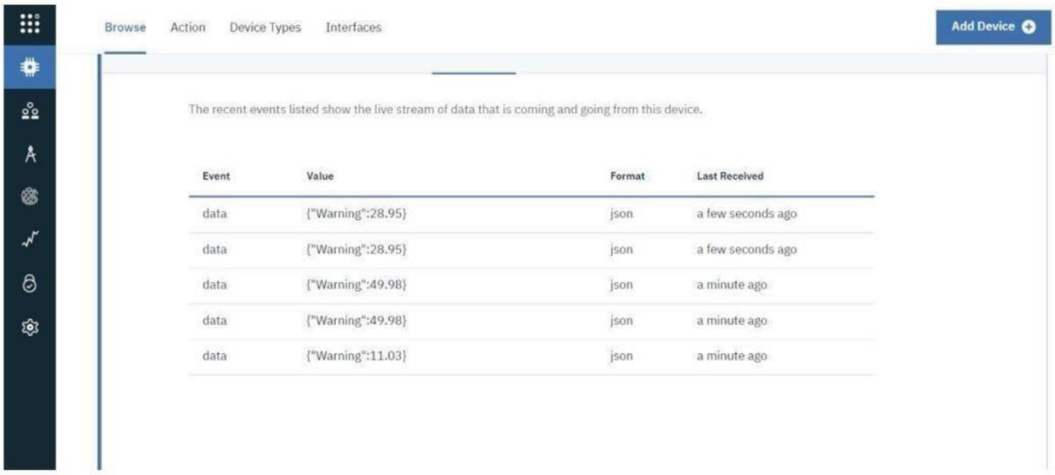
```
No motion detected

Sending payload: {"High Alert!!":"1.99left" }
Publish OK

Sending distance: 1.99
Publish OK
```

{

Sprint 3:

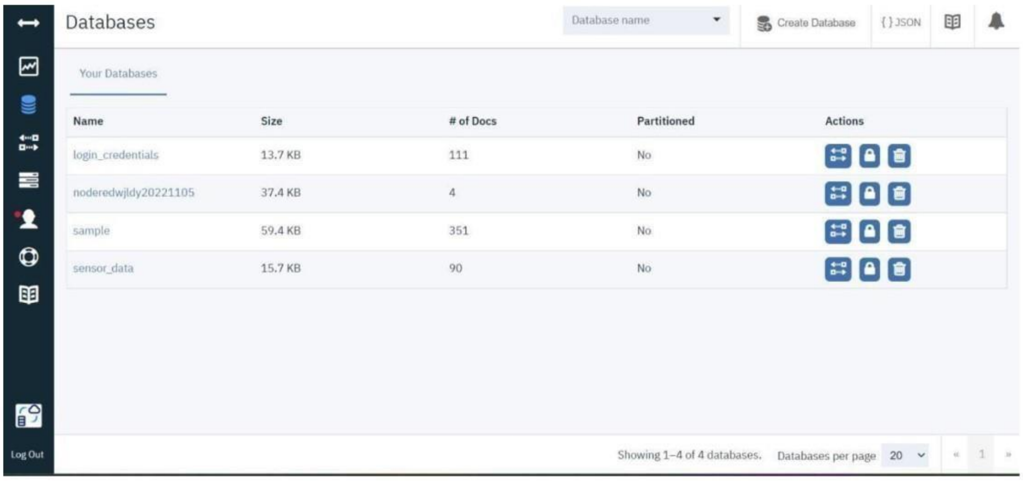
Node Red With Data Transfer from Working Setup to IBM IoT Platform





The recent events listed show the live stream of data that is coming and going from this device.

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



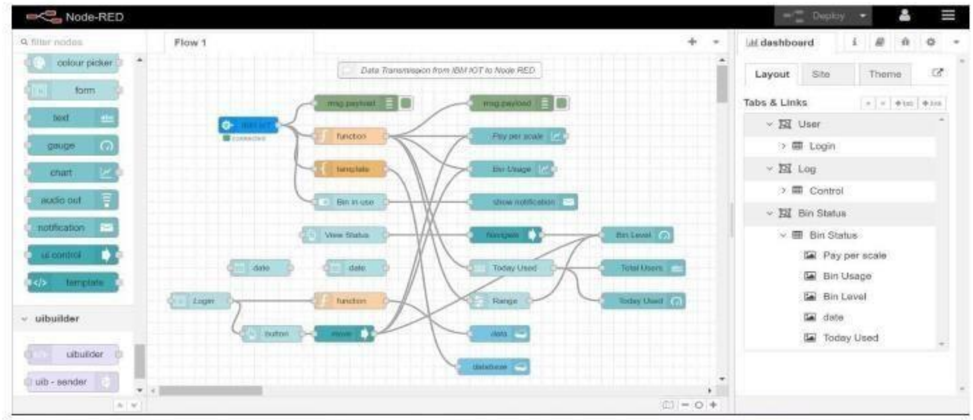
Name	Size	# of Docs	Partitioned	Actions
login_credentials	13.7 KB	111	No	
noderedwjldy20221105	37.4 KB	4	No	
sample	59.4 KB	351	No	
sensor_data	15.7 KB	90	No	

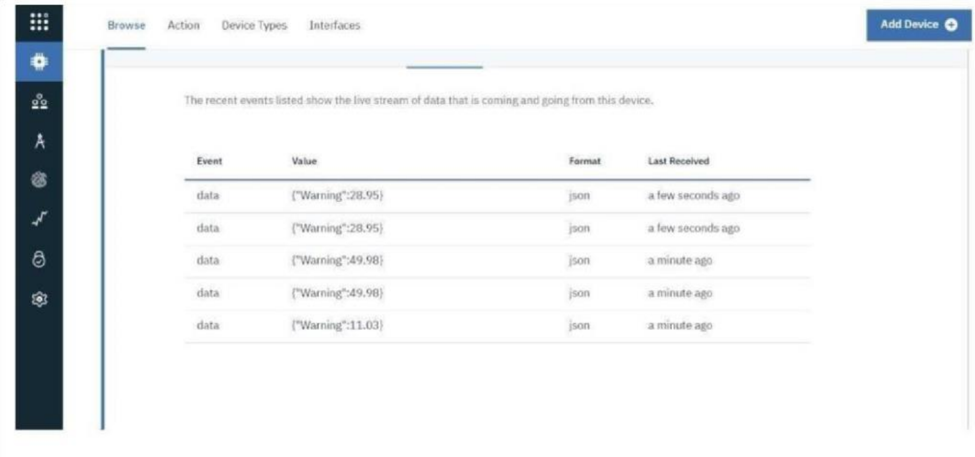
Showing 1–4 of 4 databases. Databases per page 20

{

Sprint 4:

Node red data transfer to IBM IoT with bin level



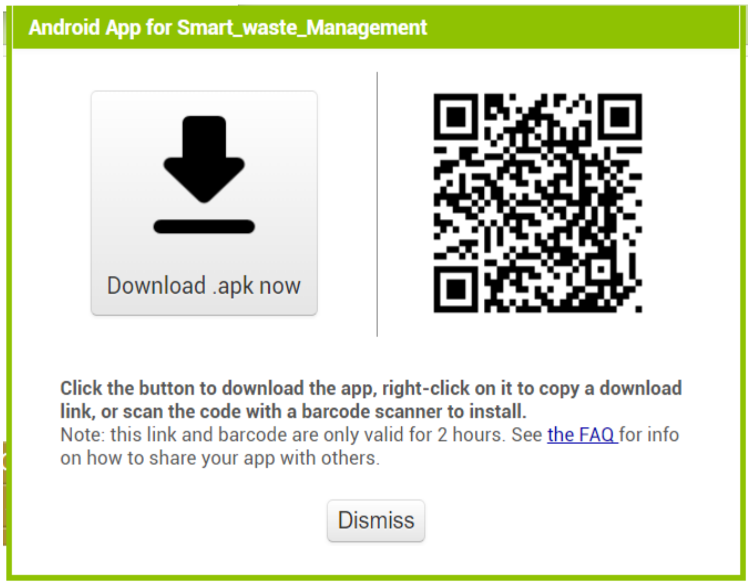


The recent events listed show the live stream of data that is coming and going from this device.

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

{

MIT APP (USE ME APPLICATION)



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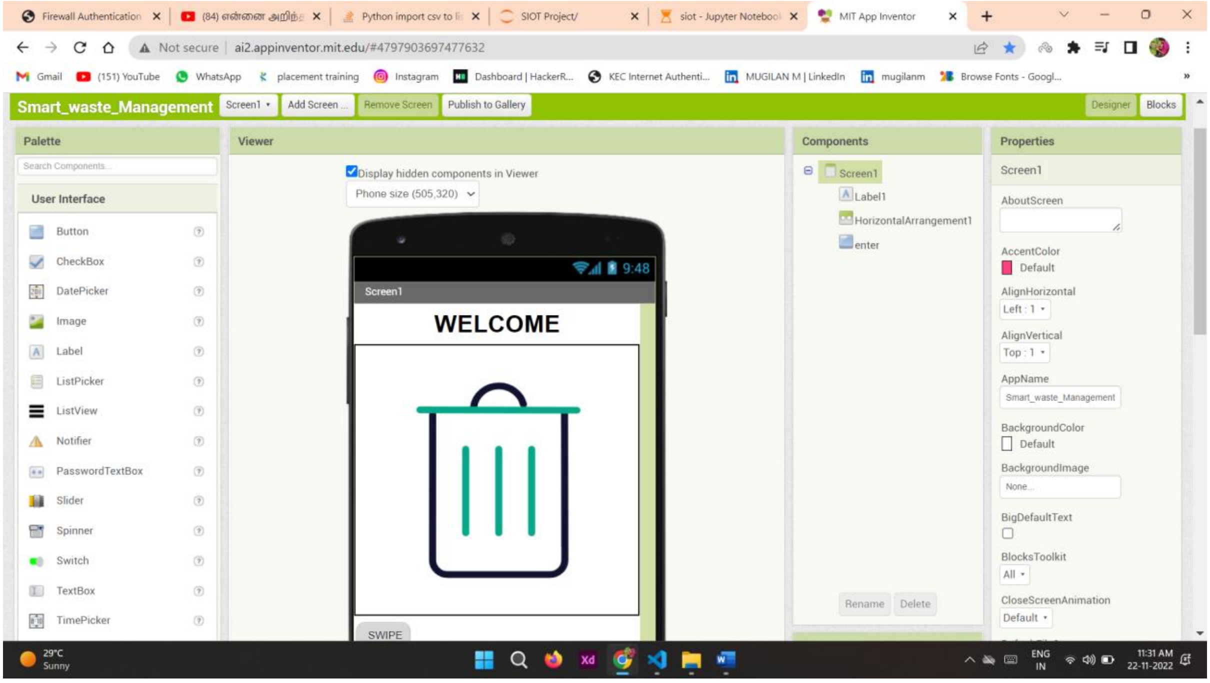
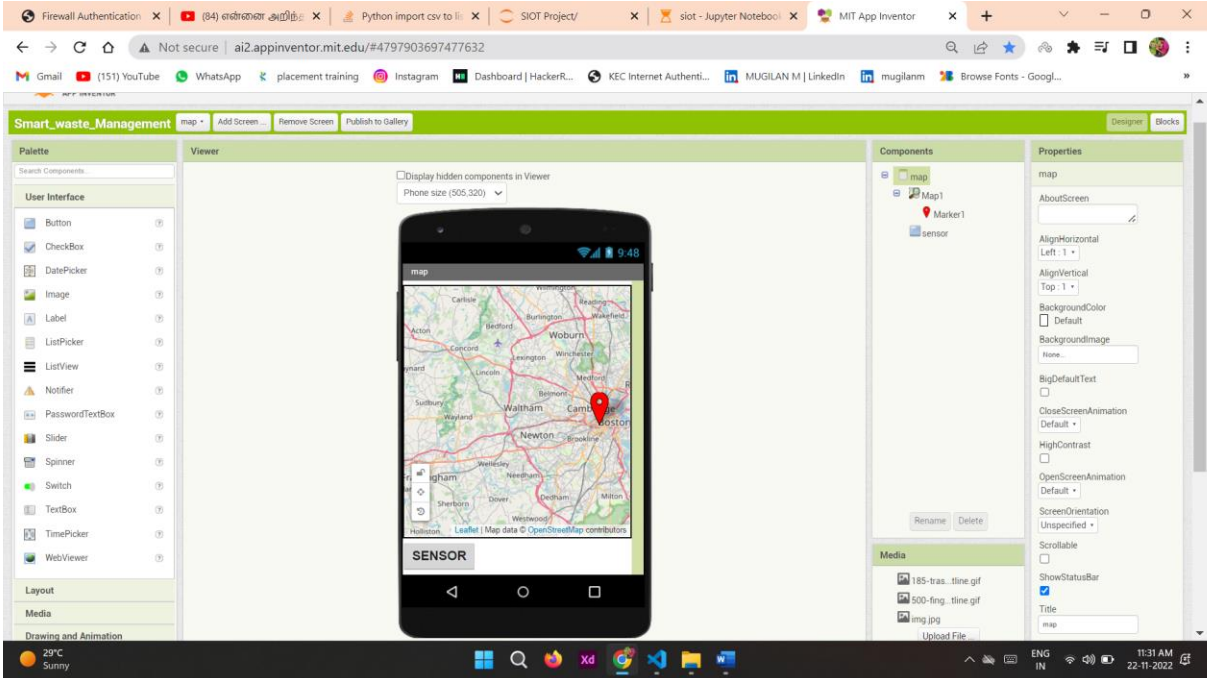
Note: this link and barcode are only valid for 2 hours. See the FAQ for info on how to share your app with others.

Dismiss



{



Smart_waste_Management

Components: map, Map1, Marker1, sensor

Properties: map

AboutScreen

AlignHorizontal: Left : 1

AlignVertical: Top : 1

BackgroundColor: □ Default

BackgroundImage: None...

BigDefaultText: □

CloseScreenAnimation: Default

HighContrast: □

OpenScreenAnimation: Default

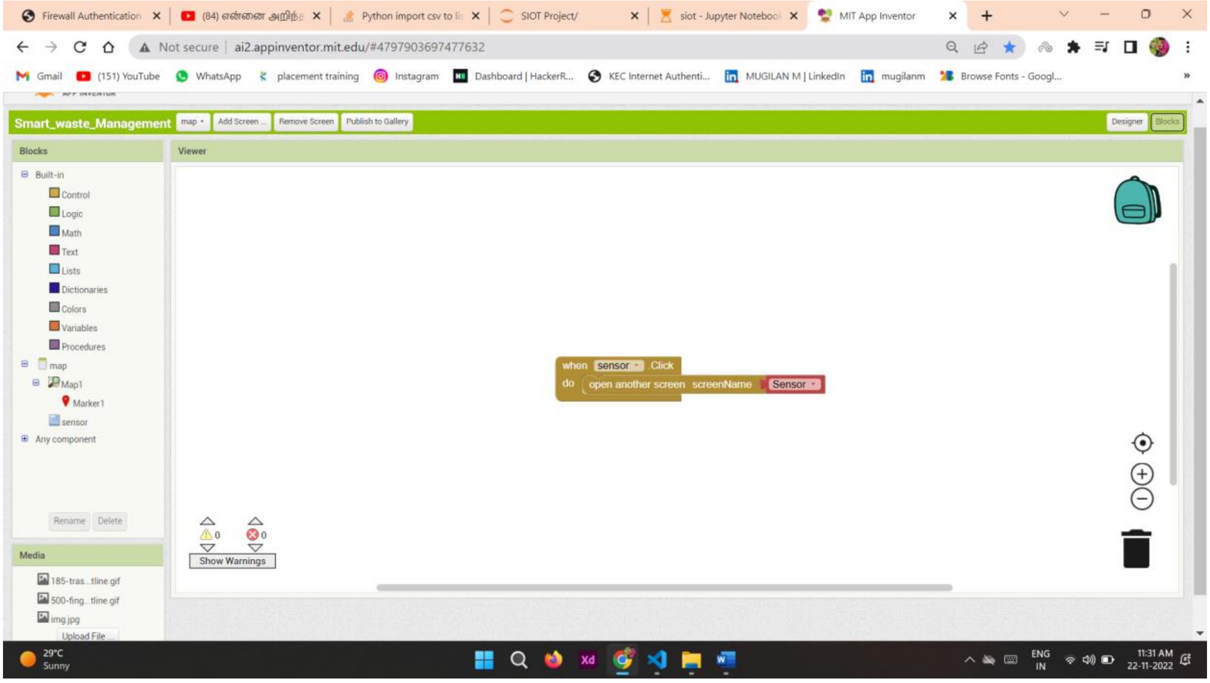
ScreenOrientation: Unspecified

Scrollable: □

ShowStatusBar: ☑

Title: map

Media: 185-tras...tline.gif, 500-fing...tline.gif, img.jpg



```
when sensor . Click
do  open another screen  screenName  " Sensor "
```

{

CHAPTER 8: TESTING

8.1 Test cases:

Test case no.	Sensor/Stage	Input	Expected output	Obtained output	Status
1.	Ultrasonic	Garbage level in bin i)Null ii)Full iii)Range in %	Correct level or distance	As expected	Pass
2.	ESP – 32	Microcontroller to process the input data	To collect the data from sensor	As expected	Pass
3.	Load cell	To measure mechanical force	Calculate the force due to the bin weight	As expected	Pass
4.	Gauge	To display the tares	Display the level for collection	As expected	Pass
5.	HX710	Weight of the bin (in kg)	Measure the weight	As expected	Pass

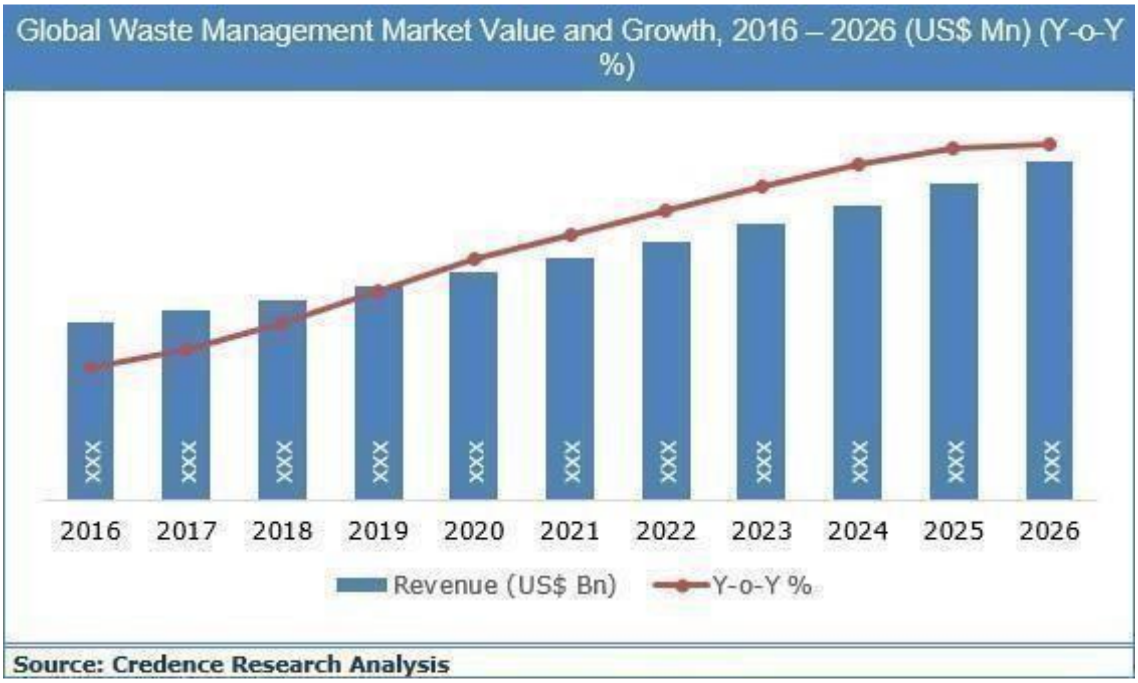
8.2 User Acceptance testing

Acceptance testing - is the final phase of product testing prior to public launch. A level of the software testing process where a system is tested for acceptability. The purpose of this test is to evaluate the system’s compliance with the business requirements and assess whether it is acceptable for delivery.

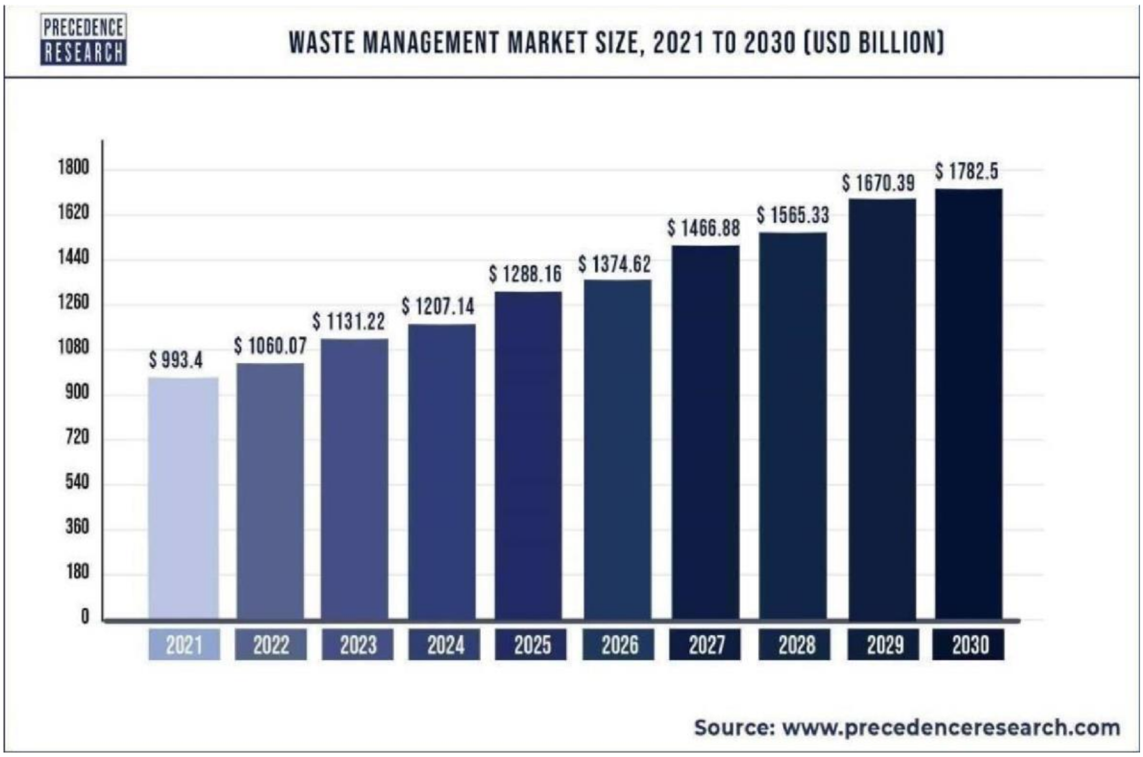
{

CHAPTER 9: RESULTS 9.1

Performance Metrics:



Source: Credence Research Analysis



Source: www.precedenceresearch.com

CHAPTER 10: ADVANTAGES AND DISADVANTAGES

{

10.1 Advantages:

- Intelligent compaction of waste by monitoring fill level in realtime using sensors.
- Reduces manpower requirement to handle the garbage collection
- Emphasizes of healthy environment and keep the cities cleaner and more beautiful.
- It reduces infrastructure, operating and maintenance costs by upto 30%.
- Increases recycling rate of waste.

10.2 Disadvantages:

- Initial large-scale implementation takes cost.
- System requires more number waste bins for separate waste collection.
- Wireless technologies used should have proper connections as they have shorter range and lower data speed
- Training programs should be provided to people involving in the ecosystem of smart waste management.
- Sensors may encounter damage so it should be kept under protective ambience to prevent the damage.

CHAPTER 11: CONCLUSION

Improper disposal and improper maintenance of domestic waste create issues in public health and environment pollution thus this paper attempts to provide practical solution towards

{

managing the waste collaborating it with the use of IOT. by using the smart waste management system, we can manage waste properly we are also able to sort the Bio-degradable and non-Biodegradable waste properly which reduces the pollution in the environment. Various waste management initiatives taken for human well-being and to improve the TWM practices were broadly discussed in this chapter. The parameters that influence the technology and economic aspects of waste management were also discussed clearly. Different types of barriers in TWM, such as economic hitches, political issues, legislative disputes, informative and managerial as well as solutions and success factors for implementing an effective management of toxic organic waste within a globular context, were also discussed giving some real examples. The effect of urbanization on the environmental degradation and economic growth was also discussed. The proposed system will help to overcome all the serious issues related to waste and keep the environment clean.

CHAPTER 12: FUTURE WORK

Based on the real-time and historical data collected and stored in the cloud waste collection schedules and routes can be optimized. Predictive analytics could be used to make decisions ahead of time and offers insight into waste bin locations. Graph theory optimization algorithms can be used to manage waste

{

collection strategies dynamically and efficiently. Every day, the workers can receive the newly calculated routes in their navigation devices. The system can be designed to learn from experience and to make decisions not only on the daily waste level status but also on future state forecast, traffic congestion, balanced cost-efficiency functions, and other affecting factors that a priori humans cannot foresee.

Garbage collectors could access the application on their mobile phone/tablets using the internet. Real-time GPS assistance can be used to direct them to the pre-decided route. As they go collecting the garbage from the containers, the management is also aware of the progress as the vehicle, as well as the garbage containers, are traced in real-time. The management staff gets their own personalized administration panel over a computer/tablet which gives them a bird eye view over the entire operations.

An alternative solution using image processing and camera as a passive sensor could be used. But, the cost of those image processing cameras is higher as compared to the ultrasonic sensors, which leads to high solution implementation cost.

CHAPTER 13: APPENDIX

13.1 Source Code:

<u>Web Application to get the Live location:</u>

{

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>Waste Management</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-db.js"></script>
<script type="module">
   // Import the functions you need from the SDKs you need
 import                    {                    initializeApp                    }                    from
"https://www.gstatic.com/firebasejs/9.14.0/firebaseapp.js";   import  {  getAnalytics  }
from "https://www.gstatic.com/firebasejs/9.14.0/firebaseanalytics.js";
   // TODO: Add SDKs for Firebase products that you want to use
   // https://firebase.google.com/docs/web/setup#available-libraries

   // Your web app's Firebase configuration
  // For Firebase JS SDK v7.20.0 and later, measurementId is optional
    const firebaseConfig = {          apiKey:
"AIzaSyCLmnTzMoUVe9sBa6h56Bd4WnFJtjm0aE",
authDomain: "ibm-
smart-waste.firebaseapp.com",          databaseURL:  "https://ibm-
smartwaste-default-rtdb.firebaseio.com",            projectId:   "ibm-
smart-waste",      storageBucket: "ibm-smart-waste.appspot.com",
messagingSenderId:       "426276430128",                    appId:
"1:426276430128:web:4f8671bf97c4c9450728f5",
     measurementId: "G-16DJ7XEDK5"
   };

  // Initialize Firebase   const firebase =
initializeApp(firebaseConfig);   const analytics =
getAnalytics(firebase);
  </script>
 <script defer src="db.js"></script>
</head>
```

```
{


<body style="background-color:#1F1B24;">
 <script src="map.js"></script>



   <div id="map_container">
               <h1 id="live_location_heading" >LOCATION</h1>
               <div id="map"></div>
               <div id="alert_msg">ALERT MESSAGE!</div>
   </div>
 </div>  <center><a
href="https://www.google.com/maps/place/Perundurai+New+Bus+Stand/@11.273
363,7
7.5778373,17z/data=!3m1!4b1!4m5!3m4!1s0x3ba96d434da63087:0x91b2c203d46019b
3!8m2!3d11.273363!4d77.5800313"    type="button" class="btn btn-dark">Get
Dumpster</a></center>

 <script



    src="https://maps.googleapis.com/maps/api/js?key=AIzaSyBBLyWj3FWtCbCXGW3
y sEiI2fDfrv2v0Q&callback=myMap"></script></div>
</body>

</html>
```

Style.css:

```
html, body
 {
    height:      100%;
    margin: 0px;
   padding:0px;
 }
#container   {     display:
flex;  flexdirection: row;
height:  100%;     width:
100%;              position:
relative;                    }
```

```
{

    #logo_container {
    height: 100%; width:
    12%; background-
    color: #C5C6D0;
    display: flex;
    flexdirection: column;
    verticalalign: text-
    bottom;
    }
    .logo {
    width:70%;
    margin: 5% 15%;

    /* border-radius: 50%; */
    }
    #logo_3
    { vertical-align:
    textbottom;

    }
    #data_cont
    ainer {
    height:
    100%;
    width:
    20%;
    margin-
    left: 1%;
    margin-
    right: 1%;
    display:
    flex;
    flexdirecti
    on:
    column;
    }
    #data_status {
    height:60%;
    width:8%; margin:7%;
    background-color:
    #691F6E; display:
    flex; flex-direction:
    column; borderradius:20px; }
    #load_status { background-image:
    url("/Images/KG.png"); background-
    repeat: no-repeat; backgroundsize:
    170px; background-position: left
    center;
```

```
{


    }
    #cap_status   {      background-image:
    url("/Images/dust.png");
    backgroundrepeat:              no-repeat;
    background-size:                    150px;
    background-position: left center;
    }
    .status   {      width:
    80%;  height: 40%;
    margin:5%      10%;
    backgroundcolor:#
    185adc;
    borderradius:20px;
    display:           flex;
    justify-content:
    center;          align-
    items:           center;
    color: white;   font-
    size: 60px;



    }
    .datas    {       width:86%;
    margin:2.5%             7%;
    height:10%;
    background:
    url(water.png);
    background-repeat:
    repeat-x;
      animation: datas 10s linear infinite;

      box-shadow: 0 0 0 6px #98d7eb, 0  20px 35px rgba(0,0,0,1);

    }
    #map_container
    {  height: 100%;
    width: 100%;
    display: flex;
    flex-direction:
    column;
    }
    #live_location_heading
    {
       margintop:10%
    ;  textalign:
       center;
    color:  GREY;
    }
```

```
{

    #map
    { height: 70%;
    width: 90%;
    margin-left: 4%;
    margin-right:4%;
    border: 10px solid
    white; border-
    radius: 25px;
    }
    #alert_msg {
    width:92%;
    height:20%;
    margin:4%;
    background-
    color:grey; border-
    radius: 20px;
    display: flex;
    justifycontent:
    center; align-
    items: center;
    color: #41af7f;
    fontsize: 25px;
    fontweight: bold;
    }
    .lat { margin:
    0px;
    fontsize:0px;
    }




    @keyframes datas{
      0%
      {
        background-position: -500px 100px;
      }
      40%
      {
        background-position: 1000px -10px;
      }

      80% {
        background-position: 2000px 40px;
      }
      100% {
        background-position: 2700px 95px;
{

          }

      }
```

Map.js:

```
const database = firebase.database();

function myMap()
{                var        ref1        =
firebase.database().ref();

   ref1.on("value", function(snapshot)
    {
     snapshot.forEach(function (childSnapshot) {
           var value = childSnapshot.val();
                         const  latitude  =  value.latitude;
                         const          longitude          =
value.longitude;

                         var latlong = { lat: latitude, lng: longitude}
                         var mapProp =
                         {
                                   center: new google.maps.LatLng(latlong),
                                   zoom: 10,
                         };
   var map = new google.maps.Map(document.getElementById("map"), mapProp);

                         var marker = new google.maps.Marker({ position: latlong });
               marker.setMap(map);
       });
   },          function          (error)          {
console.log("Error: " + error.code);
    });

}
```

Node Red Connection With IBM IoT Platform:

```
#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 "3defta" //IBM organisation id
#define DEVICE_TYPE "hariprasath" // Device type mentioned in ibm watson iot platform
#define DEVICE_ID "12345" // Device ID mentioned in ibm watson iot platform
#define TOKEN "CpL-H1C-Pt4i9iM-F5" // 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[] = "use-token-auth"; // authentication method  char token[] =
TOKEN;  char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID; //Client id
//
WiFiClient wifiClient; // creating instance for wificlient
PubSubClient client(server, 1883, wifiClient);
#define ECHO_PIN 12
#define TRIG_PIN 13
float dist;

void setup()
{
Serial.begin(115200);
pinMode(LED_BUILTIN, OUTPUT);
pinMode(TRIG_PIN, OUTPUT);
pinMode(ECHO_PIN, INPUT);
//pir
pinMode(4, INPUT);
//ledpins
pinMode(23,OUTPUT);
pinMode(2,OUTPUT);  pinMode(4,OUTPUT);
pinMode(15,OUTPUT); lcd.init();

lcd.backl
ight();
lcd.setC
ursor(1,0
);
lcd.print
("");
wifiCon
nect();
mqttCon
nect(); } float
readcmC
M()
{
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.cle
ar();
publish
Data();
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)
{
d
el
a
y(
5
0
0
);
Serial.print(".");
}
Serial.print("WiFi connected, IP address: ");
Serial.println(WiFi.localIP());
} void
mqttConn
ect()  {
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");
}

e

l

s

e

{
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);
} e
l

s

e

{

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");
}
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");
}

e

l

s

e
```

```
{


{

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();
}
}
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");
}

e

l

s

e

{
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();  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");
} e
l

s

e

{
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();
}
```

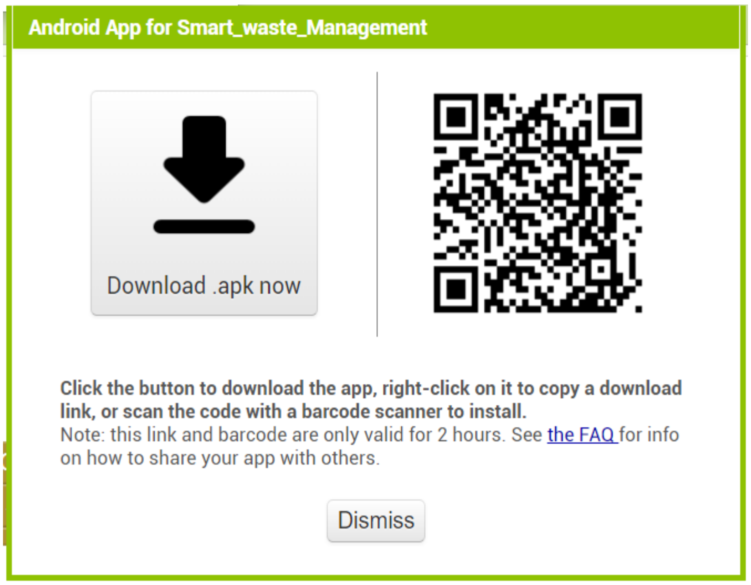
13.2 Github Link: https://github.com/IBM-EPBL/IBM-Project-29828-1660130895

13.3 Web Application Link: https://spontaneous-flan-0cc8ff.netlify.app/

```
{
```

13.4 Wokwi link : https://wokwi.com/projects/348861592195039828

13.5 MIT APP



Click the button to download the app, right-click on it to copy a download link, or scan the code with a barcode scanner to install.
Note: this link and barcode are only valid for 2 hours. See the FAQ for info on how to share your app with others.