TEAM ID	PNT2022TMID35869
PROJECT NAME	Smart waste management system for Metropolitan Cities

PROJECT REPORT

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6.2 Sprint Delivery Schedule

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Source Code GitHub & Project Demo Link

INTRODUCTION:

Project overview:

With urbanization, rising income and consumption, the production of waste increases. One of the most important directions in the field of sustainable development is the design and implementation of monitoring and management systems for waste collection and removal. Smart waste management (SWM) involves for example collection and analytics of data from sensors on smart garbage bins (SGBs), management of waste trucks and urban infrastructure; planning and optimization of waste truck routes; etc. It presents implications of the application of Internet of Things (IoT) technologies on Waste Management (WM) as well as the entire smart city.

Purpose:

Public health:

Public hygiene were primarily depending on individuals' activities. The ongoing urbanization not only led to a higher density of people in cities, but also to greater amounts of waste that were generated and could not be handled efficiently anymore. This became apparent as diseases and urban hygiene crisis were linked.

Reduction in the collection and unnecessary fuel consumption cost:

Due to using smart dumpsters, there will be no need for a physical check for every container This smart waste management solution reduces fuel consumption and cost. Therefore, this reduction allows waste collection companies or municipalities to allocate their resources efficiently.

Elimination of missed pickups:

As route optimization has become a must for smart waste management, there will be no more overflowed trash bins while almost full ones will be taken into account when they are are completely full.

Waste generation geo-specific data analysis:

Data constitutes the basis of the smart waste management system, and it is also used to follow the patterns that occur according to the regions. Data analysis produced by IoT gives customers demographic analysis and creates a chance to take action according to the filling patterns of that district.

Reduction of CO2 emissions:

Due to the more strategic scheduling of garbage collection trucks with real-time data, the carbon footprint is reduced. Thus, smart waste management solutions make the traditional waste collection system more environmentally friendly in each step.

LITERATURE SURVEY:

2.1 Existing problem:

The regular waste management system includes waste collection trucks and their drivers that follow a predefined route without examining the containers' fullness level. This system can't 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. To enhance the current regular system into a better one, technological innovations and advancements are implemented into the waste collection process. Thus, we started to optimize waste management operations by using the technical opportunities called the smart waste management system.

2.2 References :

PAPER 1

TITTLE: Smart Waste Management System using IOT
AUTHOR NAME: Tejashree Kadus1, Pawankumar Nirmal2, Kartikee Kulkarni3 Department of Mechanical Engineering MIT Academy of Engineering, Pune Savitribai Phule University
DESCRIPTIONS:
The paper is based on the concept of Automation used in waste management system under the domain of Cleanliness and Hygiene. Dumping garbage onto the streets and in public areas is a common synopsis found in all developing countries and this mainly end up affecting the environment and creating several unhygienic conditions. In order to deal with these problems Smart netbin is an ideology put forward which is a combination of 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.

PAPER 2

TITTLE:IOT based Smart Waste Management

AUTHOR NAME: Prof. Indu Anoop1, Ayush Jain1, Shweta Pathak1, Gauri Yadav1 Dept of Information Technology, Vidyalankar Institute of Technology, Mumbai, India1

DESCRIPTIONS:

Many times, in our city we see that the garbage bins or dustbins placed at public places are overloaded. It creates unhygienic conditions for people as well as ugliness to that place leaving bad smell. To avoid such situations the proposed project will be implemented for efficient waste management using IOT. These dustbins are interfaced with arduino based system having ultrasonic wireless systems along with central system showing current status of garbage, on mobile web application with Android app by Wi-Fi. Hence the status will be updated on to the App. Major part of the proposed project depends upon the working of the Wi-Fi module; essential for its implementation. The main aim of this project is to reduce human resources and efforts along with the enhancement of a smart city vision.

PAPER 3

TITTLE: Challenges and Opportunities of Waste Management in IoT-Enabled Smart Cities: A Survey

AUTHOR NAME:A Survey Theodoros Anagnostopoulos; Arkady Zaslavsky; Kostas Kolomvatsos; Alexey Medvedev; Pouria Amirian;

DESCRIPTIONS:

The new era of Web and Internet of Things (IoT) paradigm is being enabled by the proliferation of various devices like RFIDs, sensors, and actuators. Smart devices (devices having significant computational capabilities, transforming them to `smart things') are embedded in the environment to monitor and collect ambient information. In a city, this leads to Smart City frameworks. Intelligent services could be offered on top of such information related to any aspect of humans' activities. A typical example of services offered in the framework of Smart Cities is IoT-enabled waste management. Waste management involves not only the collection of the waste in the field but also the transport and disposal to the appropriate locations. In this paper, we present a comprehensive and thorough survey of ICT-enabled waste management models. Specifically, we focus on the adoption of smart devices as a key enabling technology in contemporary waste management. We report on the strengths and weaknesses of various models to reveal their characteristics. This survey sets up the basis for delivering new models in the domain as it reveals the needs for defining novel frameworks for waste management.

PAPER 4

TITTLE: Garbage Management Using IOT

AUTHOR NAME: Vijaykumar Dangi1, Pranav Tekale2, Swanand Dangare3, Astha Zope4, P.V.Ambekar5 1,2,3,4U.G. Student, Department of Computer Engineering, SITS, Narhe, Pune, India5 Professor, Department of Computer Engineering, SITS, Narhe, Pune, India

DESCRIPTIONS:

Brilliant Cities are being planned and worked for agreeable human residence. Among administrations that good urban areas can supply is that the naturally friendly waste/junk accumulation and getting ready. In this paper, we tend to inspire and propose a web of Things (IoT) – authorized framework engineering to accomplish dynamic waste accumulation and conveyance to handling plants or exceptional junk tips. Previously, squander accumulation was dealt with in a fairly static way utilizing traditional operations look into the approach. As planned during this paper, these days, with the multiplication of sensors and actuators, as well as solid and universal portable correspondences, the Web of Things (IoT) empowers dynamic arrangements went for advancing the waste vehicle fleet live, accumulation courses and organized waste get. We propose the best question based dynamic booking model to address the difficulties of close constant planning driven by sensor information streams. An Android application alongside an easy to use GUI is produced and introduced with a specific end goal to demonstrate the practicality and assess a waste gathering situation utilizing trial information. At long last, the planned model's square measure assessed on factory made and real data from the town district of St. Petersburg, Russia. The models illustrate consistency and accuracy.

PAPER 5

TITTLE: Cloud-based smart waste management for smart citie

AUTHOR NAME: Mohammad Aazam; Marc St-Hilaire; Chung-Horng Lung; Ioannis Lambadaris

DESCRIPTIONS:

With the ever increasing population, urbanization, migration issues, and change in lifestyle, municipal solid waste generation levels are increasing significantly. Hence, waste management becomes a challenge faced not only by the developing nations, but also the developed and advanced countries. The overall waste management involves three main types of entities: 1) users who generate waste, 2) waste collectors/city admin., 3) stakeholders. Waste management directly effects the lifestyle, healthcare, environment, recycling and disposal, and several other industries. Current waste management trends are not sophisticated enough to achieve a robust and efficient waste management mechanism. It is very important to have a smart way of managing waste, so that not only the waste status is notified in-time when to be collected, but also, all the stakeholders are made aware

in timely fashion that what type of waste in what quantity is coming up at what particular time. This will not only help in attracting and identifying stakeholders, but also aids in creating more effective ways of recycling and minimizing waste also making the overall waste management more efficient and environment friendly. Keeping all this in mind, we propose a cloud-based smart waste management mechanism in which the waste bins are equipped with sensors, capable of notifying their waste level status and upload the status to the cloud. The stakeholders are able to access the desired data from the cloud. Moreover, for city administration and waste management, it will be possible to do route optimization and select path for waste collection according to the statuses of waste bins in a metropolis, helping in fuel and time efficiency.

2.3 Problem Statement Definition

As prosperity grows, 62 million tons of garbage is generated everyday by the 377 million people living in urban India, now the world's Third largest garbage generator. However, it's not the amount of waste generated that's as much of an issue as the fact that more than 45 million tons, or 3 million trucks worth, of garbage is untreated and disposed of by municipal authorities every day in an unhygienic manner

. ➢ **What is the issue?**

Due to the increasing waste, the public bins which are used for collecting this waste are overflowing, the locality is jumbled of trash, causing not only malodorous streets but also a negative impact on the health and environment.

➢ **Who does the problem affect?**

General Public, Environment, Animals, Birds and Aquatic lives.

➢ **What is effects of the issue?**

> Air emissions
> Health Impact
> Ecosystem services in danger
> Soil Contamination, Surface and Groundwater
> Marine Pollution, pests etc

➢ **When does the issue occur?**

> No Availability of Man power for waste management
> Poor Infrastructure
> Irresponsibility of Public

➢ **How to resolve?**

> Garbage level detection in bins.

> Getting the weight of the garbage in the bin.

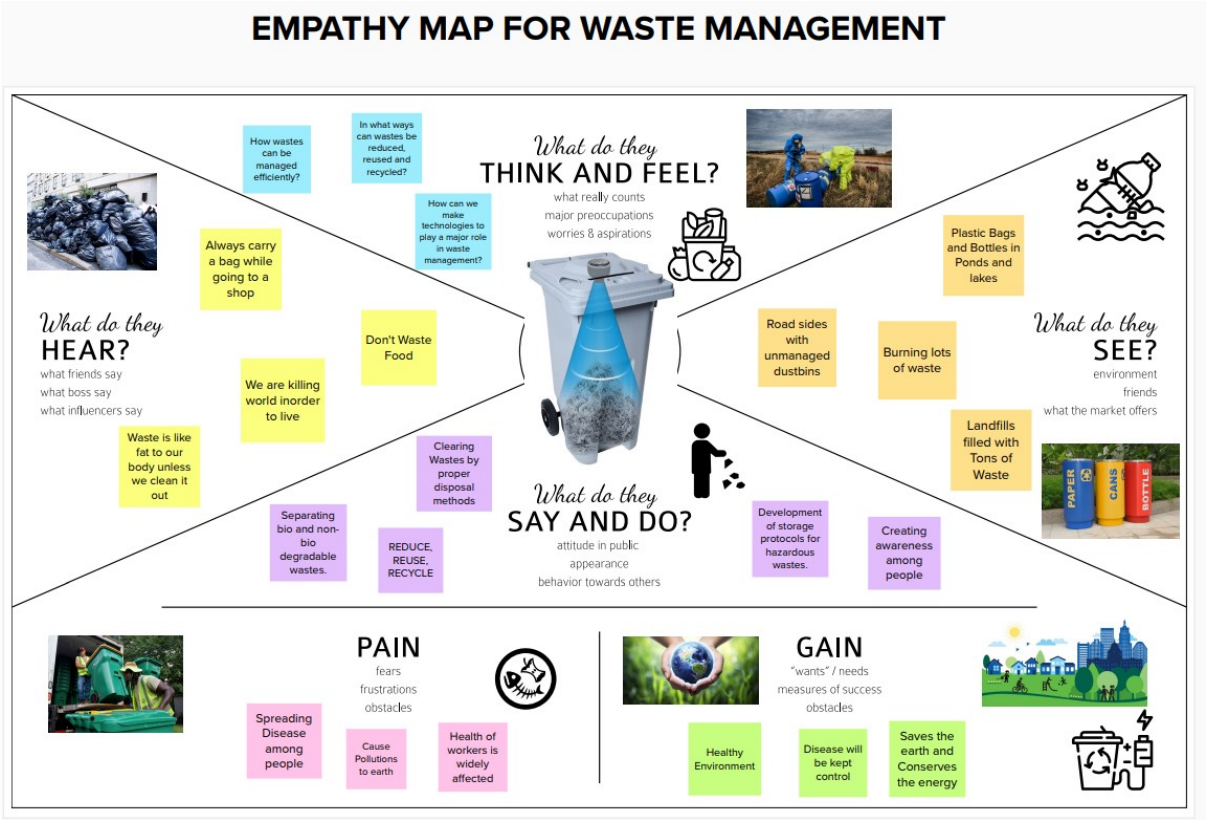
> Alerts the authorized person to empty the bin whenever the bins are full.

> Garbage level of the bins can be monitored through a web App.

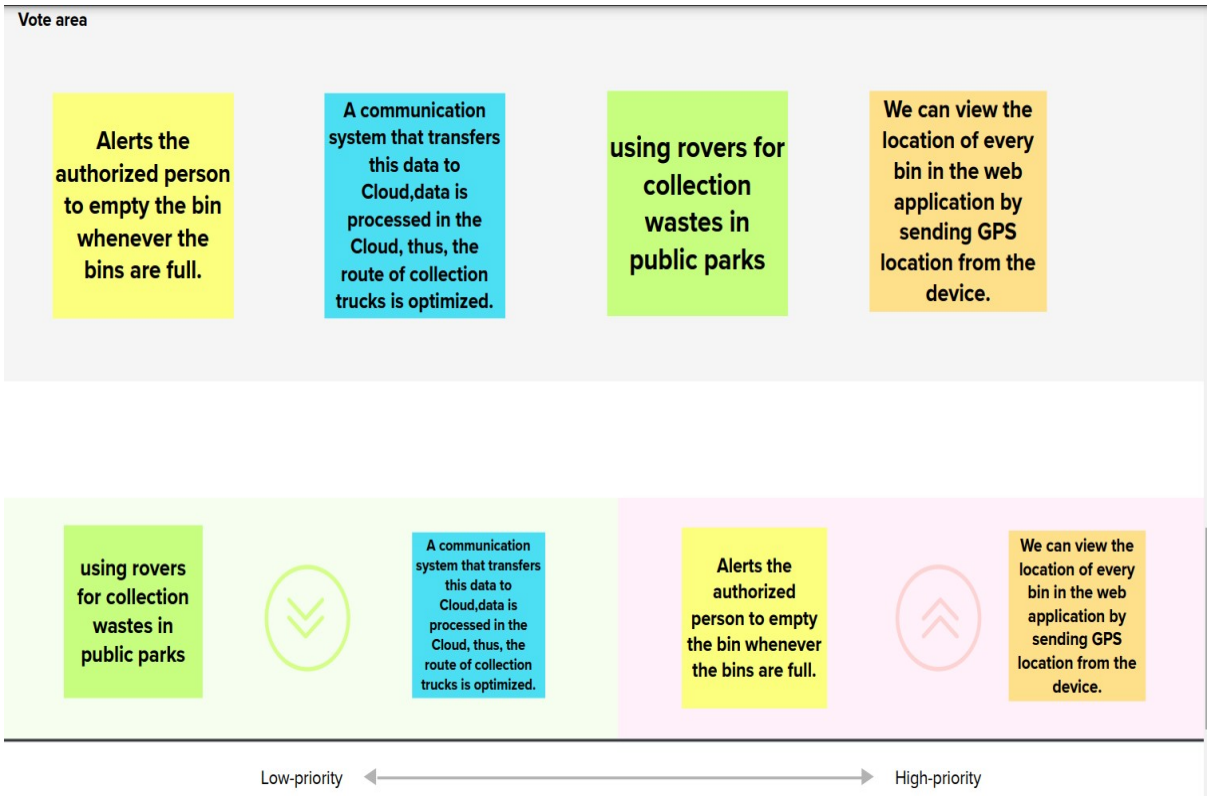
> We can view the location of every bin in the web application by sending GPS location from the device

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming



3.3 Proposed Solution

S.NO	PARAMETER	DESCRIPTION
1	Problem Statement (Problem to be solved)	The amount of waste produced everyday by the industries and the households is increasing at an appalling rate, and the major reason for this is soaring use of packaged items, textiles, paper, food, plastics, metals, glass etc, thus management of this refuse becomes a crucial part in our everyday life. Due to the increasing waste, the public bins which are used for collecting this waste are overflowing, the locality is jumbled of trash, causing not only malodorous streets but also a negative impact on the health and environment.
2	Idea / Solution description	● Garbage level detection in bins.

		● Getting the weight of the garbage in the bin. ● 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 bins.
3	Novelty / Uniqueness	We use optimal routing in trucks to reach sources,it decreases the usage of fuels used in vehicles ,thus reducing the fuel usage.
4	Social Impact / Customer Satisfaction	The proposed solution helps us to manage the wastes produced by domestic as well as commercial sources in an efficient manner. This further leads to a cleaner and hygienic environment leading to a healthy standard of living as this helps us to prevent many contaminated diseases.This solution also eases the work of sanitary workers which in turn increases their value in our society.
5	Business Model (Revenue Model)	Since we use optimal routing in trucks to reach sources,it decreases the usage of fuels used in vehicles ,thus reducing the fuel cost. Further ,we aim at producing a cost efficient and user friendly model.
6	Scalability of the Solution	This proposed solution is possible in both rural a and urban areas since the requirement is proper and sufficient internet facility. In short,this solution can be implemented in all areas which have proper network connectivity.

3.4 Problem Solution fit

Project Title: Smart Waste Management systems for metropolitan cities

Project Design Phase-I - Solution

Team ID: PNT2022TMID35869

Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

Who is your customer?

Citizens of urban cities.

People of highly populated areas.

6. CUSTOMER CONSTRAINTS CC

Overflowing bins

Rise in pollution

Unhygienic living condition

Increase in number of diseases

5. AVAILABLE SOLUTIONS AS

Smart Waste Bins
Waste Level Sensors
AI Recycling Robots
Garbage Truck Weighing Mechanisms
Pneumatic Waste Pipes
Solar-Powered Trash Compactors
E-Waste Kiosks
Recycling Apps

Explore AS, differentiate

Focus on J&P, tap into BE, understand RC

2. JOBS-TO-BE-DONE / PROBLEMS J&P

Make source segregation mandatory.

Route optimization for trucks for efficient pickup.

Using recovers for collection of wastes in public parks.

9. PROBLEM ROOT CAUSE RC

The rate at which solid waste are produced in most developing countries is becoming alarming.This increase is due to population growth and rural-urban migration.Garbage bin seen around which appear overfull to the point of spilling out,leading to offensive odour and causes environmental pollution.As a results, there is increase in diseases because it gives rooms for insects to breed.So we need a smart system that effectively manage the waste .

7. BEHAVIOUR BE

Install load cell and sensors for weight and level measurements in trash bins.

Use GPS for garbage locations.

Focus on J&P, tap into BE, understand RC

3. TRIGGERS TR

Serious threat to the healthy living of citizens triggers the customers.Water, air and soil are all subject to being polluted by improper waste disposal, leading to health epidemics like Cholera or Dysentery in a population.

4. EMOTIONS: BEFORE / AFTER

Customers are highly prone to diseases due to an unhygienic environment caused by solid waste.

Once the proposed solution is installed,it improves public health and reduce environmental pollution

10. YOUR SOLUTION

Smart alert system for garbage bins that are full and efficient route system for garage collection trucks

Using load cell and sensors for weight and level measurements and GPS for garbage locations

8.CHANNELS of BEHAVIOUR

CH

Offline

Consult with interested stakeholders.

Create a waste management-focused community outreach plan.

Determine locations or criteria for waste management sites..

Online

Search for companies with the appropriate solutions.

The detection, monitoring and management of wastes through sensors.

Developing recycling apps.

4. REQUIREMENT ANALYSIS

4.1 Functional requirement

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Ultrasonic sonic sensor for level detection	Waste collection costs can be greatly reduced by incorporating ultrasonic sensors into trash bins. Real- time data gives the necessary feedback which reduces scheduling costs, so trash bins are only collected when full. This real-time monitoring and historic monitoring allow for better route planning and scheduling. Ultrasonic trash sensors are lower power devices that can be powered from various sources. This low operational voltage means sensors can be powered by batteries or solar panels.
FR-2	Load cell for weight	Load Cells are attached below at the bottom of Trash Bins. Weight measurement may not accurately indicate fill level of trash bin, but in case the trash bin weight reaches to the specified limit of what Garbage Truck can pick up, then waste collector vehicles can be deployed for evacuation of such trash bins. Load cells can be configured to measure weight from few kilograms to few thousand kilograms easily.
FR-3	Gps for location of bin	A small RFID microchip is fitted under the lip of each bin, which allows the truck to register each individual lift and log it directly against each bin, and its physical location.

FR-4	Gsm module for data transmission to cloud	It Provide notification to the waste authority that the recyclable waste in the smart recycle bin is full. The status of a full recycle bin will be determined by a proximity sensor. Once detected, the system will trigger the GSM module to send a signal to the waste authority, and Global Positioning System (GPS) module is used to locate the location of a recycle bin on the Google Maps. This mechanism can reduce and optimize the collection time as the recycle bin is not always full depending on the number of users and location.

4.2 Non-functional Requirements:

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

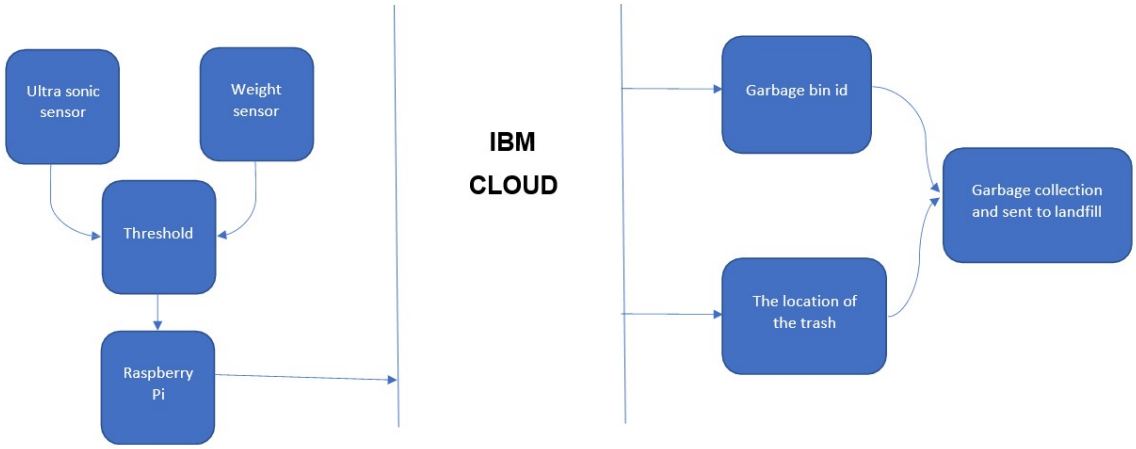
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	● IoT plays a crucial role in enhancing smart city applications through real-time monitoring and management of city processes. ● IOT powered smart management solutions focus on improving the total efficiency of waste collection and recycling.
NFR-2	**Security**	● Purchase wisely and recycle ● Use a reusable bottle ● Use reusable grocery bags ● Avoid single use food and drink containers.

NFR-3	**Reliability**	• All the technical aspects have been thoroughly designed keeping all the constraints in mind. • This project based on IoT gives users the freedom of changing hardware as well as software specifications as per the raising need.
NFR-4	**Performance**	• The Smart Sensors use ultrasound technology to measure the fill levels. • Using a variety of IoT networks, the sensors send the data to Waste Management Software System. • Customers are hence provided data-driven decision making, and optimization of waste collection routes.
NFR-5	**Availability**	• It all comes down to connecting the physical world to the digital world, such seemingly small devices powered by IoT technology can drastically improve the huge industry of waste management.
NFR-6	**Scalability**	• Analytics data to manage collection routes and the placement of bins more effectively • Improved environment (i.e., no overflowing bins and less unpleasant odours)

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.

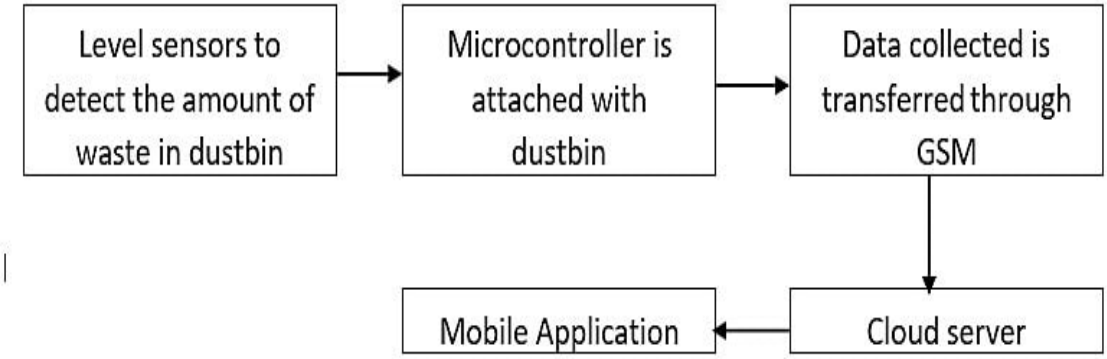


5.2 Solution & Technical Architecture

Solution architecture is a complex process – with many sub- processes – that bridges the gap between business problems and technology solutions. Its goals are to:

- To monitor the amount of waste in dustbins using level sensors.
- These sensors are interfaced with a micro-controller which is interfaced with a GSM module which will transfer the collected data to the cloud server.
- Usage of routing algorithms to find the best route for the filled dustbin.
- The proposed methodology communicates the amount of waste in the dustbin using level sensors to the desired user.

Solution Architecture Diagram:



5.3 User Stories

User Type (Epic)	Functional Requirement	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Admin(Who manager web server)	Administration	USN-1	As an admin, I give user id and password to every worker and manage them.	I can manage wweb account/dashboard	Medium	Sprint-2
Co Admin	Supervision	USN-2	As a Co Admin , I'll manage the garbage level monitor,If the garbage get filled alert I will post location and	I can manage garbage monitoring	High	Sprint-1

			garbage id to trash truck			
Truck Driver	Maintenance	USN-3	As truck driver , I'll follow the route send by Co Admin to reach the filled garbage	I can drive to reach the garbage filled route in shortest route given	Medium	Sprint-2
Local Garbage Collector	Maintenance	USN-4	As a Waste Collector , I'll collect all the trash from garbage and load into garbage truck and send them to landfill	I can drive to reach the garbage filled route in shortest route given	Medium	Sprint-2
Municipality	Maintenance	USN-5	As a Municipality , I'll check the process are happening in discipline manner without any issues	I can manage all these process going good	High	Sprint-1

6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

TITLE	DESCRIPTION	DATE
Literature Survey & Information Gathering	Literature survey on the selected project & gathering information by referring the technical papers, research publications etc.	1 SEPTEMBER 2022
Prepare Empathy Map	Prepare Empathy Map Canvas to capture the user Pains & Gains, Prepare list of problem statements	7 SEPTEMBER 2022
Ideation	List the by organizing the brainstorming session and prioritize the top 3 ideas based on the feasibility & importance.	15 SEPTEMBER 2022
Proposed Solution	Prepare the proposed solution document, which includes the novelty, feasibility of idea, business model, social impact, scalability of solution, etc.	23 SEPTEMBER 2022
Problem Solution Fit	Prepare problem - solution fit document.	20 SEPTEMBER 2022
Solution Architecture	Prepare solution architecture document.	22 SEPTEMBER 2022

Customer Journey	Prepare the customer journey maps to understand the user interactions & experiences with the application (entry to exit).	5 OCTOBER 2022
Functional Requirement	Prepare the functional requirement document.	12 OCTOBER 2022
Data Flow Diagrams	Draw the data flow diagrams and submit for review.	13 OCTOBER 2022
Technology Architecture	Prepare the technology architecture diagram.	14 OCTOBER 2022
Prepare Milestone & Activity List	Prepare the milestones & activity list of the project.	22 OCTOBER 2022
Project Development - Delivery of Sprint-1, 2, 3 & 4	Develop & submit the developed code by testing it.	IN PROGRESS..

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Login	USN-1	As an Administrator, I will give user id and passcode for every worker over there in the municipality.	10	High	Kabilan, Poornesh
Sprint-2	Login	USN-2	As an Administrator, I will create the app to monitor the waste bins at different locations. Once the waste reaches a particular level in the trash bin, the	10	High	Faarah Farheen, Charusri

			app will notify the truck driver about the bin with its location			
Sprint-3	Dashboard	USN-3	As a Truck Driver, I'll follow the app created by admin to reach the filling bin in short routes and save time	10	Low	Poornesh, Charusri
Sprint-4	Dashboard	USN-4	As a Local Garbage Collector, I'II gather all the waste from the garbage, load it onto a garbage truck, and deliver it to Landfills	10	Medium	Kabilan, Faarah Farheen

6.2 Sprint Delivery Schedule

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

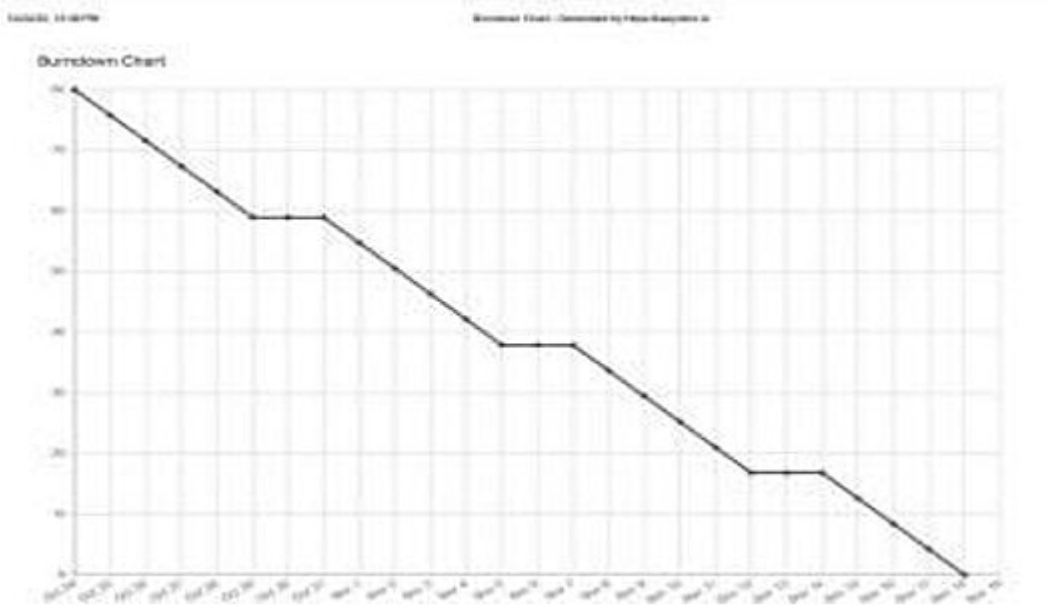
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

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)

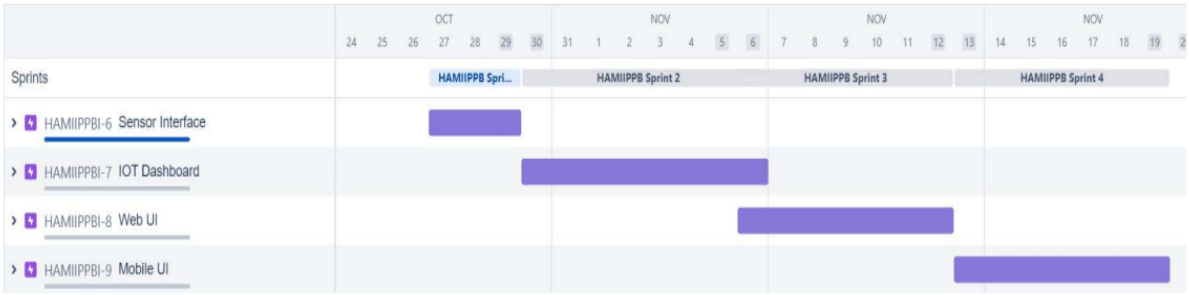
$$AV=20/6=3.33 \text{points per day}$$

Burndown Chart:



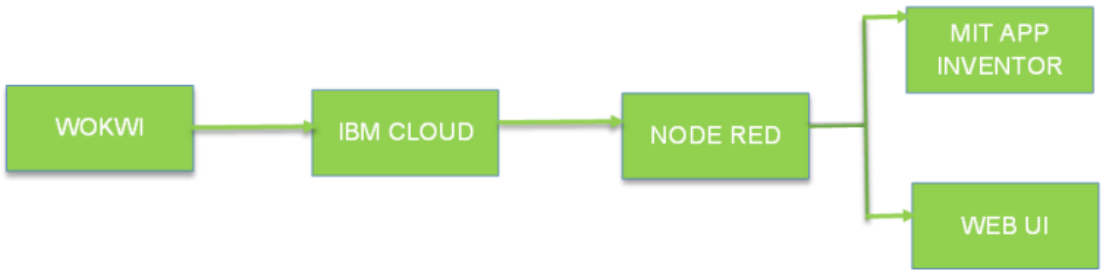
A burndown chart is a graphical representation of work left to do versus time. It is often used in agile software development methodologies such as Scrum. However, burn down charts can be applied to any project containing measurable progress over time.

6.3 Reports from JIRA:



7. CODING & SOLUTIONING (Explain the features added in the project along with code)

Workflow:



Features:

The list of technologies used in our project execution are

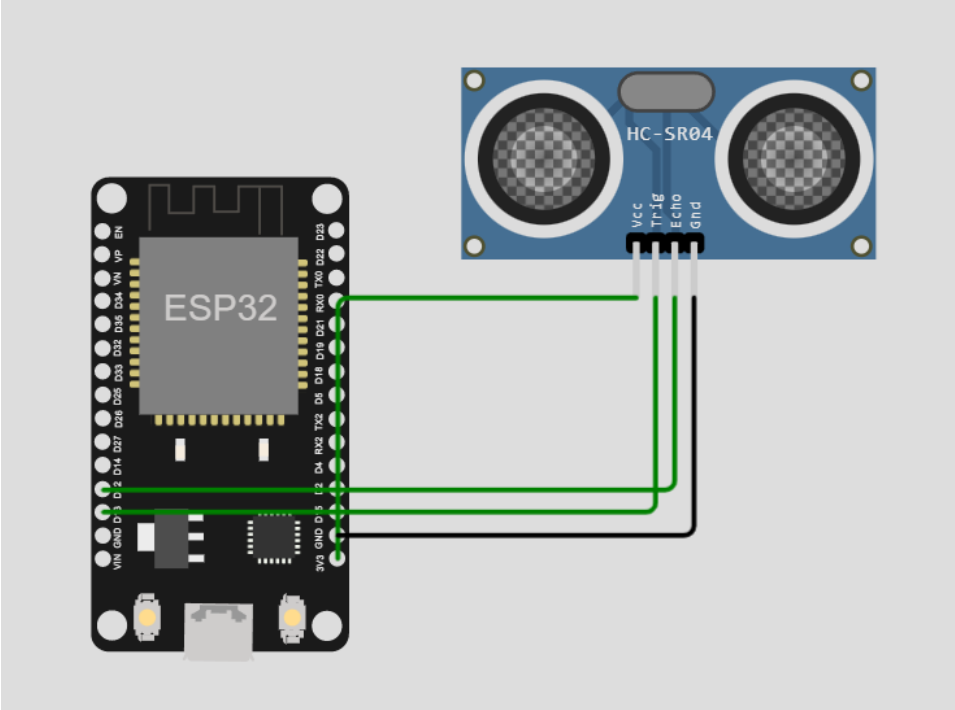
1. Wokwi
2. IBM cloud
3. Node Red
4. MIT app inventor
5. Web UI

7.1 Feature 1:

Wokwi:

Wokwi is an Online Electronic simulator. It is used to simulate Arduino, ESP32, and many other popular brands, parts and sensors.

Wokwi Simulation:



CODE:

Function for ultrasonic sensor:

```
#ifndef Ultrasonic_h
#define Ultrasonic_h

/*
 * Values of divisors
 */
```

```
#define CM 28
#define INC 71

class Ultrasonic {
  public:
    Ultrasonic(uint8_t sigPin) : Ultrasonic(sigPin, sigPin) {};
    Ultrasonic(uint8_t trigPin, uint8_t echoPin, unsigned long timeOut
= 20000UL);
    unsigned int read(uint8_t und = CM);
    unsigned int distanceRead(uint8_t und = CM) __attribute__
((deprecated ("This method is deprecated, use read() instead.")));
    void setTimeout(unsigned long timeOut) {timeout = timeOut;}
    void setMaxDistance(unsigned long dist) {timeout = dist*CM*2;}

  private:
    uint8_t trig;
    uint8_t echo;
    boolean threePins = false;
    unsigned long previousMicros;
    unsigned long timeout;
    unsigned int timing();
};

#endif
```

We have used Ultasonic sensor to detect the amount of garbage in the trash bin. This sensor is used to measure the distance of a object from the sensor. So we have placed this sensor at the inside region of the lid of the trash bin. The readDistanceCM function will get values from Ultrasonic sensor and calculate the distance of the garbage from the sensor inside the trash bin.

If the distance is less than a particular level then the garbage is near the sensor which means the trash bin is almost full so the bin will be made closed using servo motors.

When the distance is more than that the garbage is far away from then sensor which means the trash bin is not yet full, so still garbage can be filled so the lid will be kept open using servo motor.

Wokwi simulation: https://wokwi.com/projects/348234599030063698

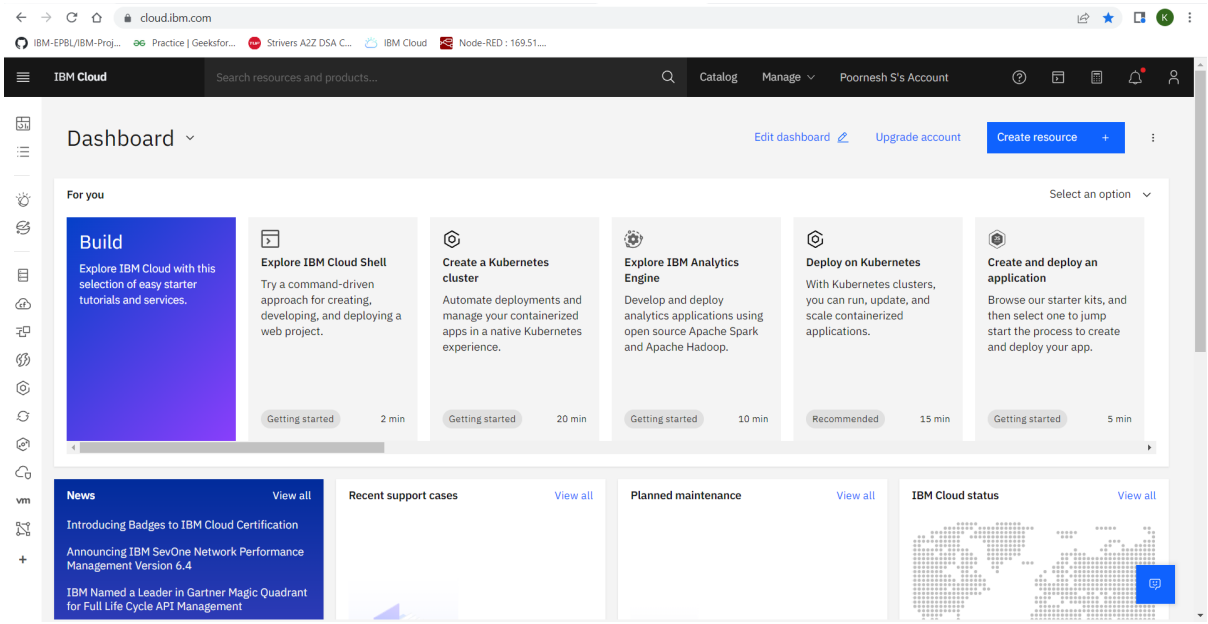
7.2 Feature 2:

IBM Cloud:

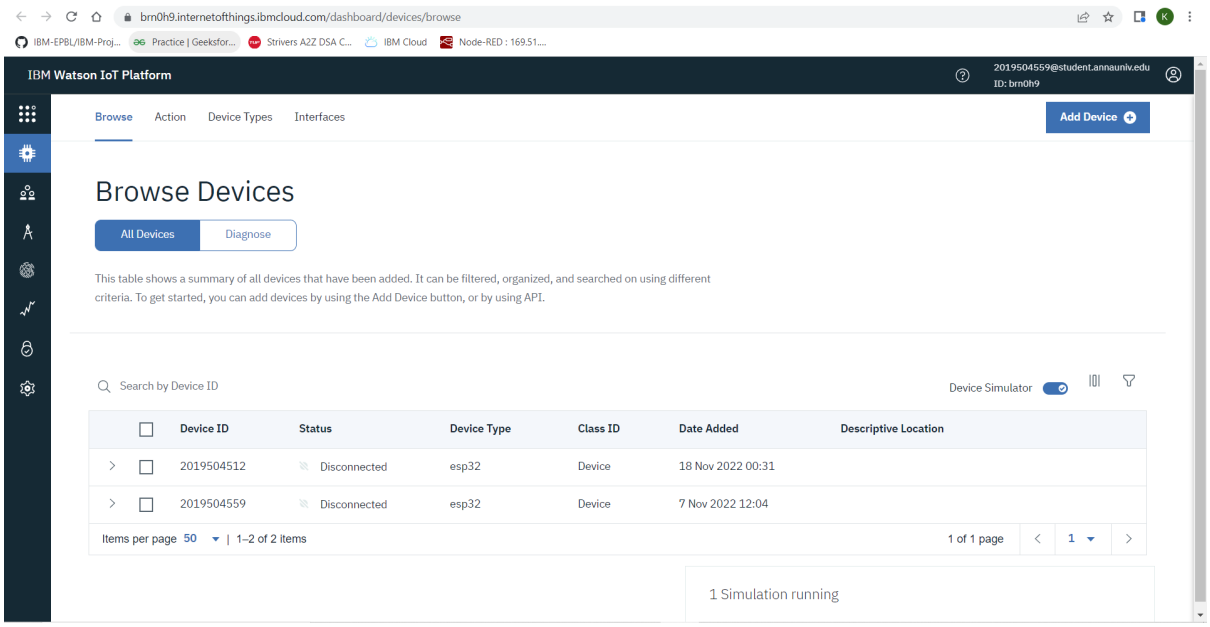
IBM Cloud is a suite of cloud computing services from IBM that offers both platform as a service (PaaS) and infrastructure as a service (IaaS).

IBM Cloud platform supports access to other IBM tools and services -- including IBM Watson and IBM Cloud Functions for serverless computing -- as well as those from third-party vendors.

IBM Cloud Dashboard:



IBM Watson IOT Platform:

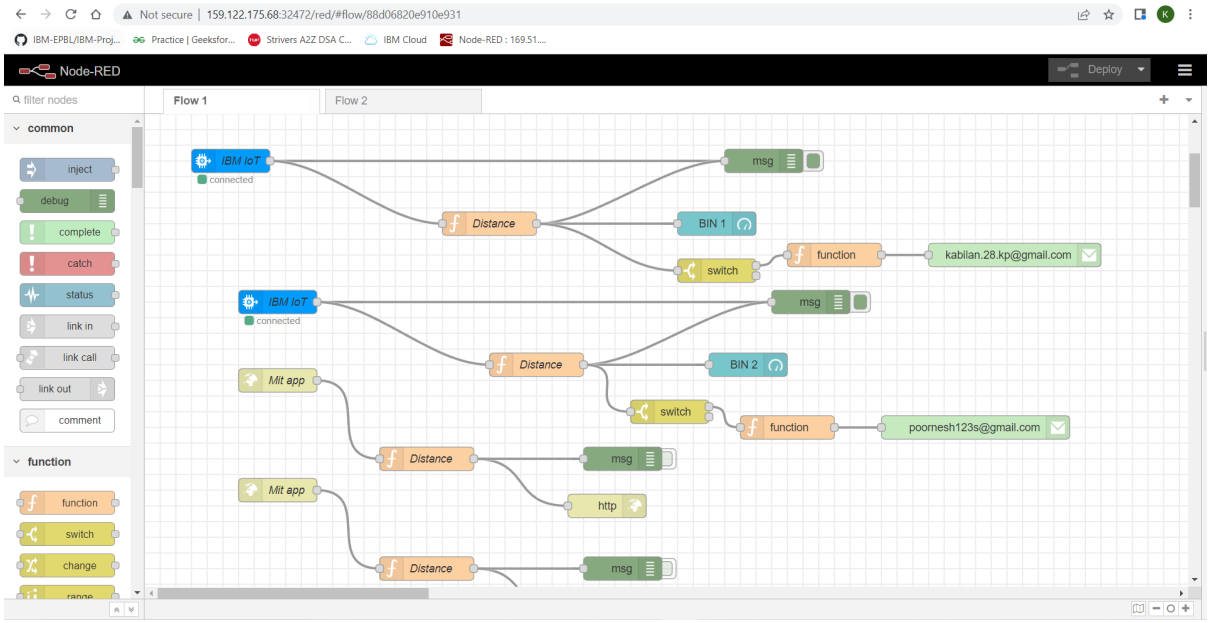


7.3 Feature 3:

NodeRed:

Node-RED is a programming tool for wiring together hardware devices, APIs and online services in new and interesting ways. It provides a browser-based editor that makes it easy to wire together flows using the wide range of nodes in the palette that can be deployed to its runtime in a single-click.

NodeRed:



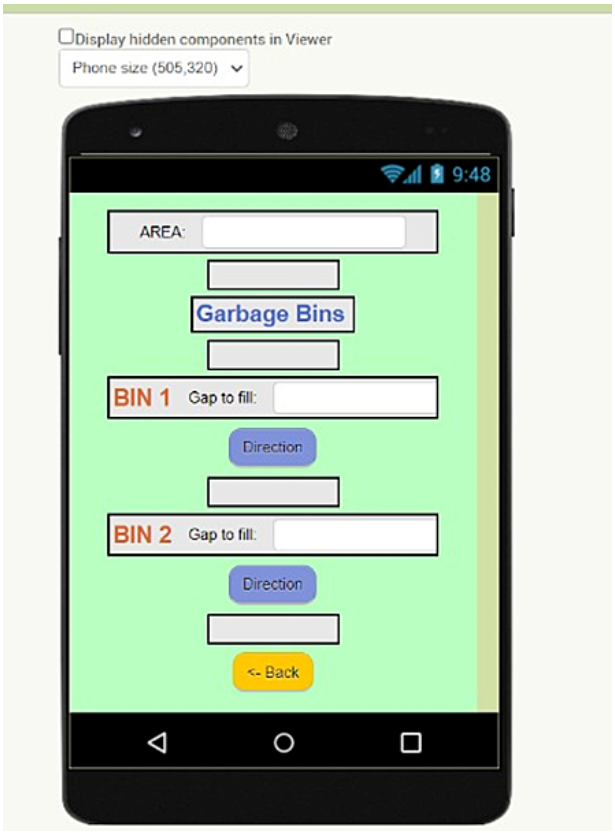
7.4 Feature 4:

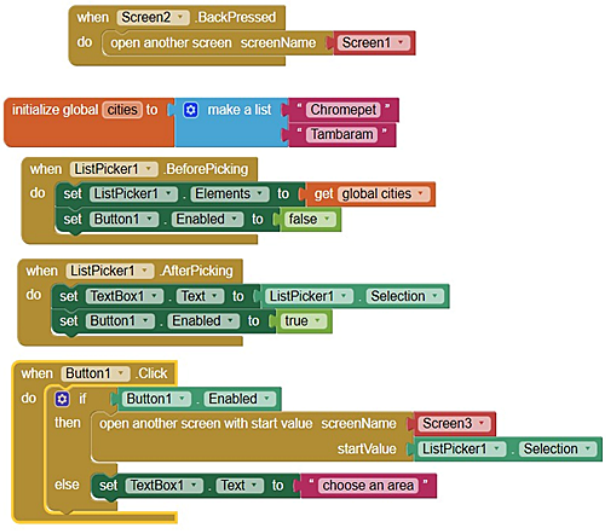
MIT App Inventor:

MIT App Inventor is a web application integrated development environment originally provided by Google, and now maintained by the Massachusetts Institute of Technology.MIT App Inventor is an intuitive, visual programming environment that allows everyone even children to build fully functional apps for smartphones and tablets.

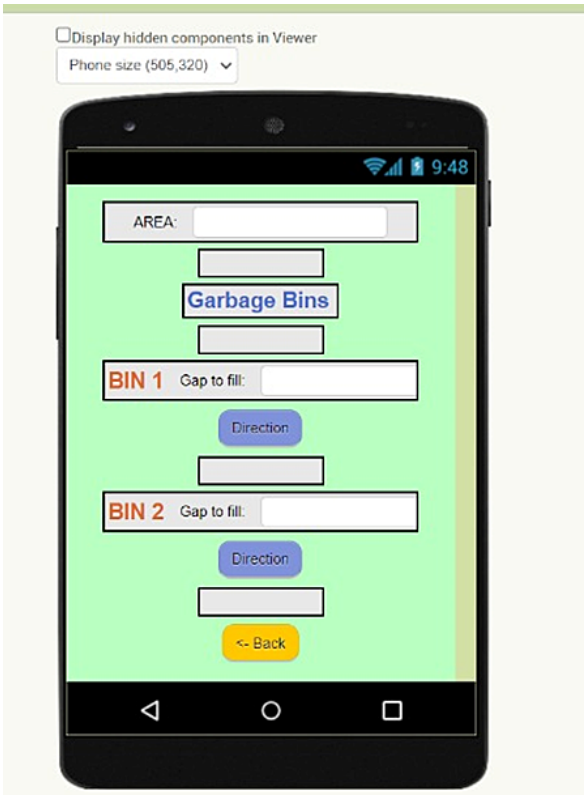
SCREEN 1:

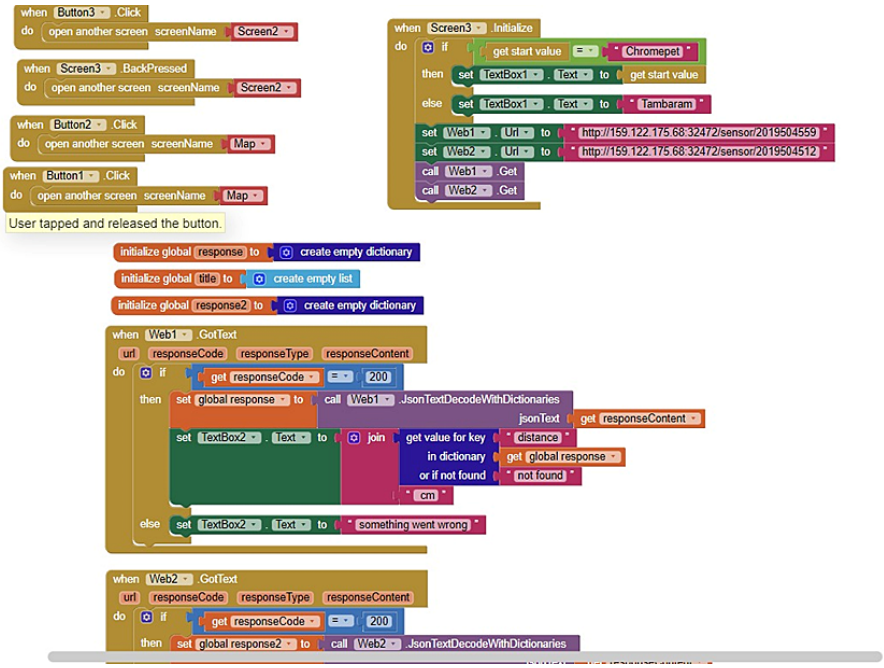
SCREEN 2:


Display hidden components in Viewer
Phone size (505,320)
9:48
AREA:
Garbage Bins
BIN 1
Gap to fill:
Direction
BIN 2
Gap to fill:
Direction
<- Back

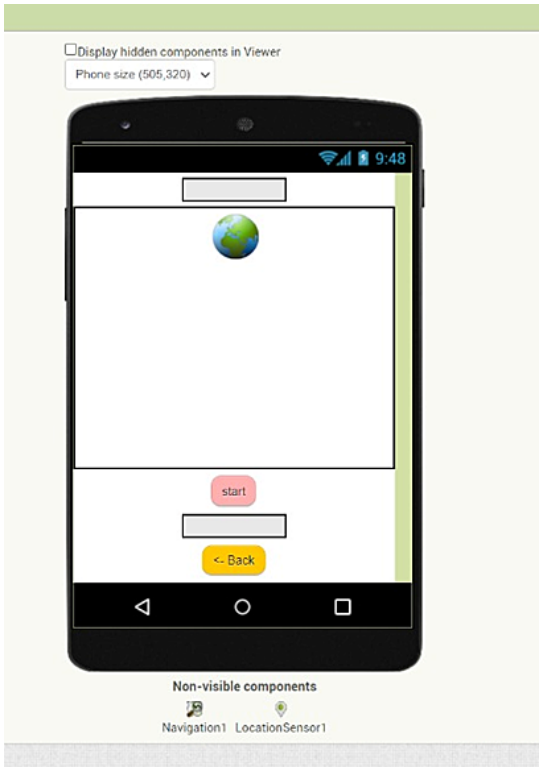

when Screen2 .BackPressed
do open another screen screenName Screen1
initialize global cities to make a list Chromepet Tambaram
when ListPicker1 .BeforePicking
do set ListPicker1 . Elements to get global cities
set Button1 . Enabled to false
when ListPicker1 .AfterPicking
do set TextBox1 . Text to ListPicker1 . Selection
set Button1 . Enabled to true
when Button1 .Click
do if Button1 . Enabled
then open another screen with start value screenName Screen3
startValue ListPicker1 . Selection
else set TextBox1 . Text to choose an area

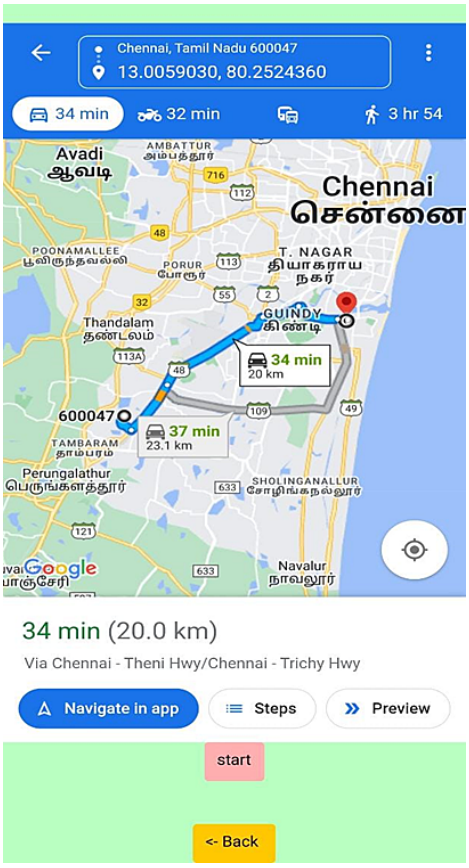
SCREEN 3:


Display hidden components in Viewer
Phone size (505,320)
9:48
AREA:
Garbage Bins
BIN 1 Gap to fill:
Direction
BIN 2 Gap to fill:
Direction
<- Back


when Button3 .Click
do open another screen screenName Screen2
when Screen3 .BackPressed
do open another screen screenName Screen2
when Button2 .Click
do open another screen screenName Map
when Button1 .Click
do open another screen screenName Map
User tapped and released the button.
when Screen3 .Initialize
do if get start value = Chromepet
then set TextBox1 . Text to get start value
else set TextBox1 . Text to Tambaram
set Web1 . Url to http://159.122.175.68:32472/sensor/2019504559
set Web2 . Url to http://159.122.175.68:32472/sensor/2019504512
call Web1 .Get
call Web2 .Get
initialize global response to create empty dictionary
initialize global title to create empty list
initialize global response2 to create empty dictionary
when Web1 .GotText
url responseCode responseType responseContent
do if get responseCode = 200
then set global response to call Web1 .JsonTextDecodeWithDictionaries
jsonText get responseContent
set TextBox2 . Text to join get value for key distance
in dictionary get global response
or if not found not found
cm
else set TextBox2 . Text to something went wrong
when Web2 .GotText
url responseCode responseType responseContent
do if get responseCode = 200
then set global response2 to call Web2 .JsonTextDecodeWithDictionaries

SCREEN 4:


Display hidden components in Viewer
Phone size (505,320)
9:48
start
<- Back
Non-visible components
Navigation1
LocationSensor1

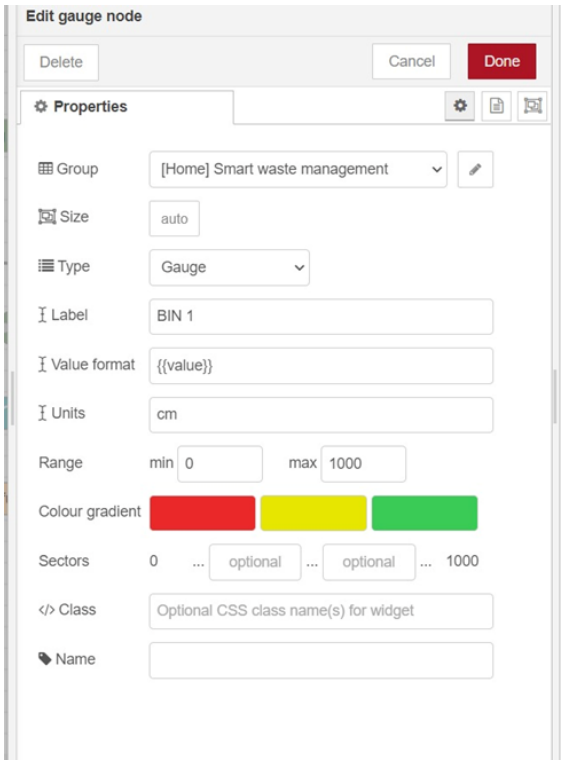

Chennai, Tamil Nadu 600047
13.0059030, 80.2524360
34 min
32 min
3 hr 54
Avadi
ஆவடி
AMBATTUR
அம்பத்தூர்
Chennai
சென்னை
POONAMALLEE
பூவிருந்தவல்லி
PORUR
போரூர்
T. NAGAR
தியாகராய நகர்
Thandalam
தண்டலம்
GUINDY
கிண்டி
34 min
20 km
600047
37 min
23.1 km
TAMBARAM
தாம்பரம்
Perungalathur
பெருங்களத்தூர்
SHOLINGANALLUR
சோழிங்கநல்லூர்
Navalur
நாவலூர்
Google
34 min (20.0 km)
Via Chennai - Theni Hwy/Chennai - Trichy Hwy
Navigate in app
Steps
Preview
start
<- Back

7.5 Feature 5:

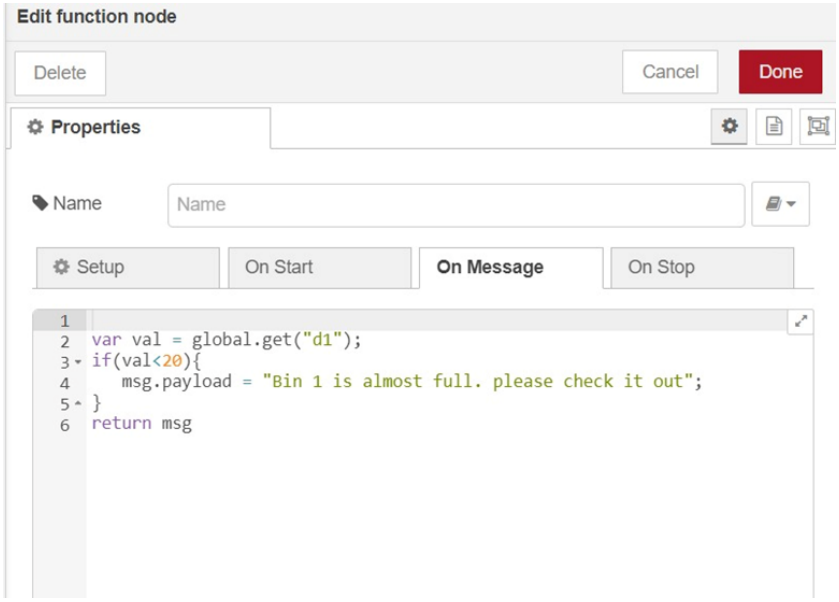
Web UI:

A Web user interface or Web app allows the user to interact with content or software running on a remote server through a Web browser. The content or Web page is downloaded from the Web server and the user can interact with this content in a Web browser, which acts as a client.

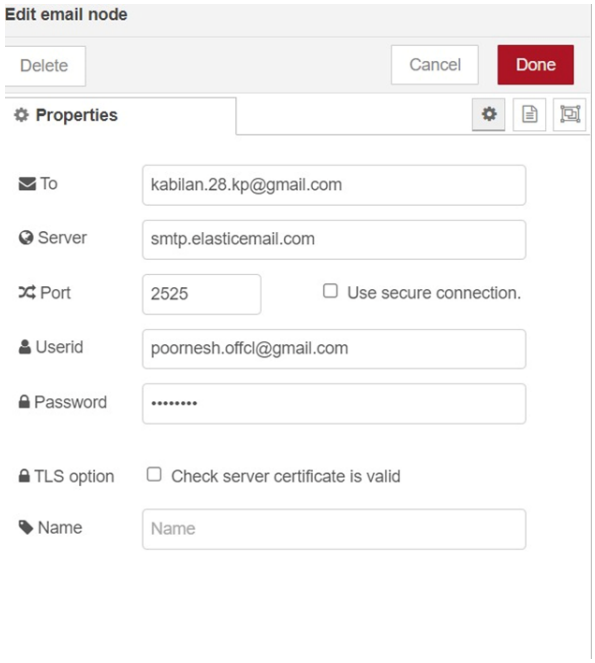
Configuring Gauge Node:



Sending Alert Function:



Alert through Email Mode:



8. TESTING:

8.1: Test Cases:

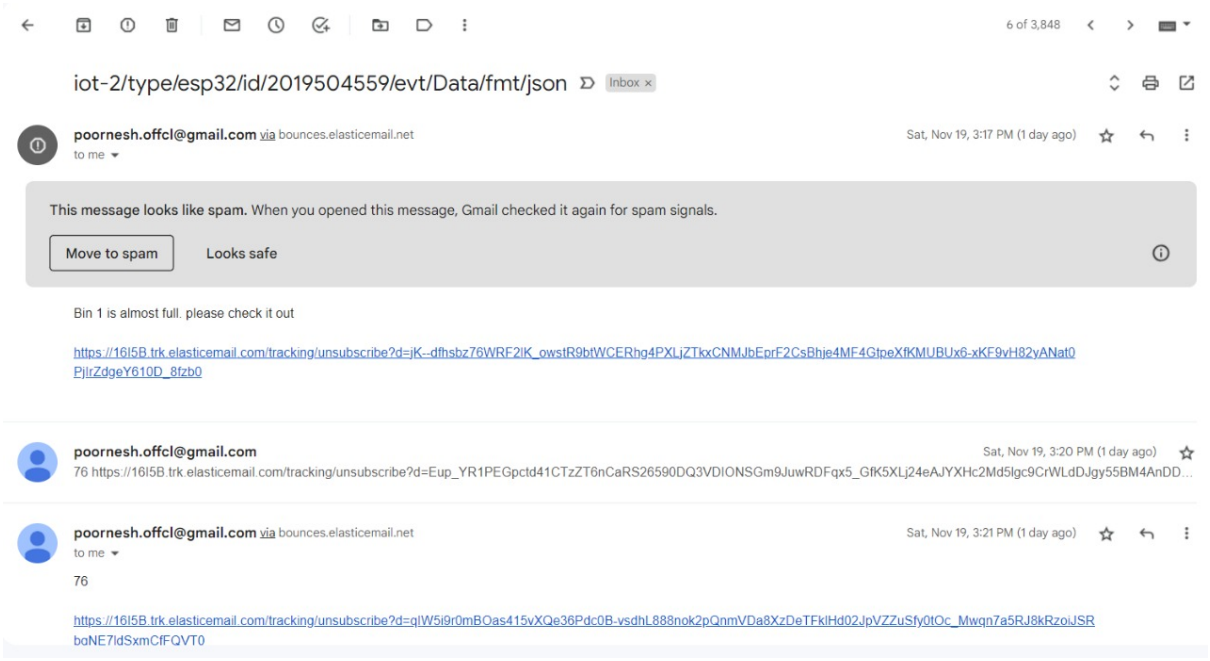
When the garbage level is below the threshold.

When the garbage level is above the threshold and waste collector receives the notification through email.

When the waste collector clicks the button indicating direction, then he is directed to gps location map page.

Using this gps map,waste collector can easily track the location of filled smart bins and empty it sooner.

EMAIL NOTIFICATION:



9. ADVANTAGES & DISADVANTAGES

ADVANTAGES:

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

DISADVANTAGES:

- ✓ System requires a greater number of waste bins for separate waste collection as per population in the city.
- ✓ This results into high initial cost due to expensive smart dustbins compare to other methods.
- ✓ Sensor nodes used in the dustbins have limited memory size.

10.CONCLUSION

A Smart Waste Management system that is more effective than the one in use now is achievable by using sensors to monitor the filling of bins. Our conception of a "smart waste management system" focuses on monitoring waste management, offering intelligent technology for waste systems, eliminating human intervention, minimizing human time and effort, and producing a healthy and trash□free environment. The suggested approach can be implemented in smart cities where residents have busy schedules that provide little time for garbage management. If desired, the bins might be put into place in a metropolis where a sizable container would be able to hold enough solid trash for a single unit. The price might be high.

11. FUTURE SCOPE

There are several future works and improvements for the proposed system, including the following:

1. Change the system of user authentication and atomic lock of bins, which would aid in protecting the bin from damage or theft.

2. The concept of green points would encourage the involvement of residents or end users, making the idea successful and aiding in the achievement of collaborative waste management efforts, thus fulfilling the idea of Swachh Bharath.

3. Having case study or data analytics on the type and times waste is collected on different days or seasons, making bin filling predictable and removing the reliance on electronic components, and fixing the coordinates.

4. Improving the Server's and Android's graphical interfaces

12. APPENDIX:

SOURCE CODE:

```
#include <WiFi.h>//library for wifi
#include <PubSubClient.h>//library for MQtt
#define ECHO_GPIO 12
#define TRIGGER_GPIO 13
#define MAX_DISTANCE_CM 100 // Maximum of 5 meters
#include "Ultrasonic.h"
Ultrasonic ultrasonic(13, 12);
int distance;
void callback(char* subscribetopic, byte* payload, unsigned int
payloadLength);
//-------credentials of IBM Accounts------
#define ORG "brn0h9"//IBM ORGANITION ID
#define DEVICE_TYPE "esp32"//Device type mentioned in ibm watson IOT
Platform
```

```
#define DEVICE_ID "2019504512"//Device ID mentioned in ibm watson IOT
Platform
#define TOKEN "4JZT2WJbfNSUO+eRmF" //Token
String data3;
float h, t;
//-------- Customise the above values --------
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";//
Server Name
char publishTopic[] = "iot-2/evt/Data/fmt/json";// topic name and type
of event perform and format in which data to be send
char subscribetopic[] = "iot-2/cmd/command/fmt/String";// cmd REPRESENT
command type AND COMMAND IS TEST OF FORMAT STRING
char authMethod[] = "use-token-auth";// authentication method
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;//client id
//-----------------------------------------
WiFiClient wifiClient; // creating the instance for wificlient
PubSubClient client(server, 1883, callback ,wifiClient); //calling the
predefined client id by passing parameter like server id,portand
wificredential
void setup()// configureing the ESP32
{
Serial.begin(115200);
delay(10);
Serial.println();
wificonnect();
mqttconnect();
}
void loop()// Recursive Function
{
distance = ultrasonic.read(CM);
Serial.print("Distance in CM: ");
Serial.println(distance);
PublishData(distance);
delay(10000);
if (!client.loop()) {
mqttconnect();
}
```

```
delay(1000);
}
/*.....retrieving to
Cloud.....*/
void PublishData(float temp) {
mqttconnect();//function call for connecting to ibm
/*
creating the String in in form JSon to update the data to ibm cloud
*/
String payload = String(temp,2);
Serial.print("Sending payload: ");
Serial.println(payload);
if (client.publish(publishTopic, (char*) payload.c_str())) {
Serial.println("Publish ok");// if it sucessfully upload data on the
cloud then it will print publish ok in Serial monitor or else it will
print publish failed
} else {
Serial.println("Publish failed");
}
}
void mqttconnect() {
if (!client.connected()) {
Serial.print("Reconnecting client to ");
Serial.println(server);
while (!!!client.connect(clientId, authMethod, token)) {
Serial.print(".");
delay(500);
}
initManagedDevice();
Serial.println();
}
}
void wificonnect() //function defination for wificonnect
{
Serial.println();
Serial.print("Connecting to ");
WiFi.begin("Wokwi-GUEST", "", 6);//passing the wifi credentials to
establish the connection
```

```
while (WiFi.status() != WL_CONNECTED) {
delay(500);
Serial.print(".");
}
Serial.println("");
Serial.println("WiFi connected");
Serial.println("IP address: ");
Serial.println(WiFi.localIP());
}
void initManagedDevice() {
if (client.subscribe(subscribetopic)) {
Serial.println((subscribetopic));
Serial.println("subscribe to cmd OK");
} else {
Serial.println("subscribe to cmd FAILED");
}
}
void callback(char* subscribetopic, byte* payload, unsigned int
payloadLength)
{
Serial.print("callback invoked for topic: ");
Serial.println(subscribetopic);
for (int i = 0; i < payloadLength; i++) {
//Serial.print((char)payload[i]);
data3 += (char)payload[i];
}
Serial.println("data: "+ data3);
if(data3=="lighton")
{
Serial.println(data3);
}
else
{
Serial.println(data3);
}
data3="";
}
```

Wokwi Link:

https://wokwi.com/projects/348234599030063698

GitHub Link:

https://github.com/IBM-EPBL/IBM-Project-541-1658306265

Project Demo Link:

https://www.youtube.com/watch?v=id_lIDJlb7M