SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITAN CITIES

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

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ABSTRACT

The Internet-based recruiting platforms become a primary recruitment channel in most companies. While such platforms decrease the recruitment time and advertisement cost, they suffer from an inappropriateness of traditional information retrieval techniques like the Boolean search methods. Consequently, a vast amount of candidates missed the opportunity of recruiting. The recommender system technology aims to help users in finding items that match their personnel interests; it has a successful usage in ecommerce applications to deal with problems related to information overload efficiently. In order to improve the e-recruiting functionality, many recommender system approaches have been proposed. This article will present a survey of e-recruiting process and existing recommendation approaches for building personalized recommender systems for candidates/job matching.

In the last years, job recommender systems have become popular since they successfully reduce information overload by generating personalized job suggestions. Although in the literature exists a variety of techniques and strategies used as part of job recommender systems, most of them fail to recommending job vacancies that fit properly to the job seekers profiles. Thus, the contributions of this work are twofold,

CONTENTS

LIST FIGURES

1. INTRODUCTION

1.1 PROJECT OVERVIEW:

With population growth, there are tons of flats and apartments which have been built in the rapid urbanization areas like in Nairobi, Kenya. This is due to rural to urban migration in a quest to make ends meet for most inhabitants. There are several issues faced by the inhabitants of the flats. One of them is the issue of the domestic solid waste disposal, which cause pollutions. Unlike landed houses, the flats' waste disposal bins are shared among residents which live in the same building, and thus, the bins tend to be filled very quickly. Thus, an unsystematic and inefficient disposal waste management may cause the bins to be always full with of garbage, and further littering from the residents will cause the garbage piles to be scattered outside the bins.

Besides, there are also problems regarding the attitudes of each inhabitant of the flats. There are cases where some irresponsible residents, who normally live at the higher levels of the building, littered or simply threw their domestic waste directly from the floor which they live into the bins.

Implementation of environmental conservation and management system is of no doubt the solution to the major problems that are currently faced when it comes to proper disposal of waste and management. Indiscriminate disposal of solid waste is a major issue in urban centers of most developing countries and it poses a serious threat to healthy living of the citizens. Access to reliable data on the state of solid waste at different locations within the city will help both the local authorities and the citizens to effectively manage the menace. In this paper, an intelligent solid waste monitoring system is developed using Internet of Things (IoT) and cloud computing technologies. The fill level of solid waste in each of the containers, which are strategically situated across the communities, is detected using ultrasonic sensors. A Wireless Fidelity (Wi-Fi) communication link is used to transmit the sensor data to an IoT cloud platform known as ThingSpeak. Depending on the fill level, the system sends appropriate notification message (in form of tweet) to alert relevant authorities and concerned citizen(s) for necessary action. Also, the fill level is monitored on ThingSpeak in real-time. The system performance shows that the proposed solution may be found useful for efficient waste management in smart and connected communities.

1.2 PURPOSE:

A waste management system is the strategy an organization uses to dispose, reduce, reuse, and prevent waste. Possible waste disposal methods are recycling, composting, incineration, landfills, bioremediation, waste to energy, and waste minimization.Using technology and innovation to optimize current systems will enable cities to become smarter, more efficient and save resources.

Due to the growing population, the amount of waste being produced is vast and rapidly increasing. The management of this waste is therefore a significant area for much-needed improvement.Smart waste management is characterized by the usage of technology in order to be more efficient when it comes to managing waste. This makes it possible to plan more efficient routes for the trash collectors who empty the bins, but also lowers the chance of any bin being full for over a week!

2. LITERATURE SURVEY

2.1 EXISTING PROBLEM:

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

2.   There are significant safety challenges facing the waste/recycling industry. They include chemical exposure, combustible dust explosions, machine guarding hazards, and exposure to powerful equipment with moving parts.

3.   Most recycling operations are affected sooner or later by poorly trained, undermotivated work staff. The fact is, many of these people have never been properly managed, and don't understand the expectations or even the basics of their job. That's why a reputable labor team supplier should always clearly explain job expectations and then actually manage workers.

4.   Waste management in cities is often times the most expensive item of investment as it involves both the collection of waste and its transportation for appropriate disposal. Poor waste management - ranging from nonexisting collection systems to ineffective disposal -causes air pollution, water and soil contamination. Open and unsanitary landfills contribute to contamination of drinking water and can cause infection and transmit diseases.

5.   When cities take a zero-waste approach – minimising, recovering, and treating waste, rather than disposing of waste in landfill or incinerators – they save money, protect the local environment, create jobs, build resilience, reduce emissions and promote community.

6.   Over the last couple of years, technologies have been created for smart waste management to improve the collection and disposal of waste. Waste bins equipped with sensors now provide data on waste disposal, allowing cities to save resources and costs. These are seemingly effective ways to manage waste yet it challenges are still rife.

7.   The waste management process begins with the disposal of waste into trash bins provided near the point of creation. Then the trash is picked up by trucks and sent over to the temporary collection sites. From these sites, the trash is sent for recycling. The implementation of this process seems easy enough, however, it is only a partial solution and creates other problems.

Some of the problems created are :-

➤ Misunderstanding of the operations of smart sensors

➤ Setting up the smart sensor

➤ Non-optimized truck routes

➤ Recycling

➤ Non-uniform waste distribution of waste in bins

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[12]   Tejashree Kadus1, Pawankumar Nirmal2, Kartikee Kulkarni3 Department of Mechanical Engineering MIT Academy of Engineering, Pune Savitribai Phule University

2.3 PROBLEM STATEMENT DEFINITION:

A problem statement is important to a process improvement project because it helps clearly identify the goals of the project and outline the scope of a project. It also helps guide the activities and decisions of the people who are working on the project. The problem statement can help a business or organization gain support and buy-in for a process improvement project. A good problem statement can be created by identifying and answering several questions related to the problem. This process involves identifying what the problem is, why it is a problem, when and where the problem was identified, who the problem impacts, how they are impacted by the problem and how much of an impact the problem has. Creating a problem statement to understand customer's point of view. The below shown block diagram is a perfect example for our topic

Fig1. Problem Statement

3. IDEATION & PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS:

Empathy maps are an efficient tool used by designers to not only understand user behaviour, but also visually communicate those findings to colleagues, uniting the team under one shared understanding of the user. Essentially, an empathy map is a square divided into four quadrants with the user or client in the middle. Each of the four quadrants comprises a category that helps us delve into the mind of the user. The four empathy map quadrants look at what the user says, thinks, feels, and does.

With the user at the centre and the categories in each of the four surrounding quadrants,
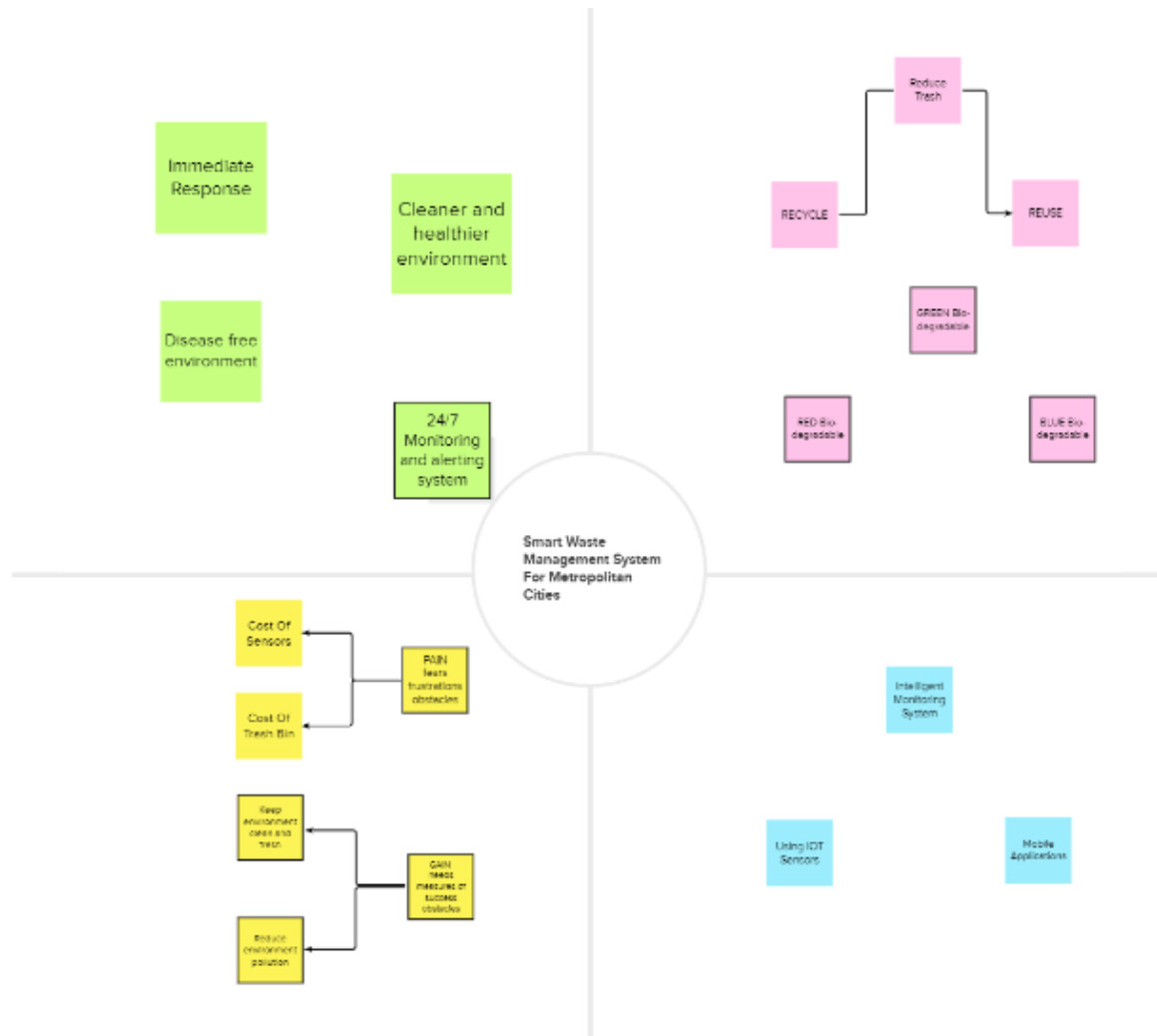An empathy map arranges all of your research about the user into an easytoread visual.

Fig2. Empathy Map

3.2 IDEATION & BRAINSTORMING

Brainstorming is a method design teams use to generate ideas to solve clearly defined design problems. Brainstorming is a method of generating ideas and sharing knowledge to solve a particular commercial or technical problem, in which participants are encouraged to think without interruption. Brainstorming is a group activity where each participant shares their ideas as soon as they come to mind. At the conclusion of the session, ideas are categorised and ranked for follow-on action.

When planning a brainstorming session it is important to define clearly the topic to be addressed. A topic which is too specific can constrict thinking, while an ill-defined topic will not generate enough directly applicable ideas. The composition of the brainstorming group is important too. It should include people linked directly with the subject as well as those who can contribute novel and unexpected ideas. It can comprise staff from inside or outside the organisation.
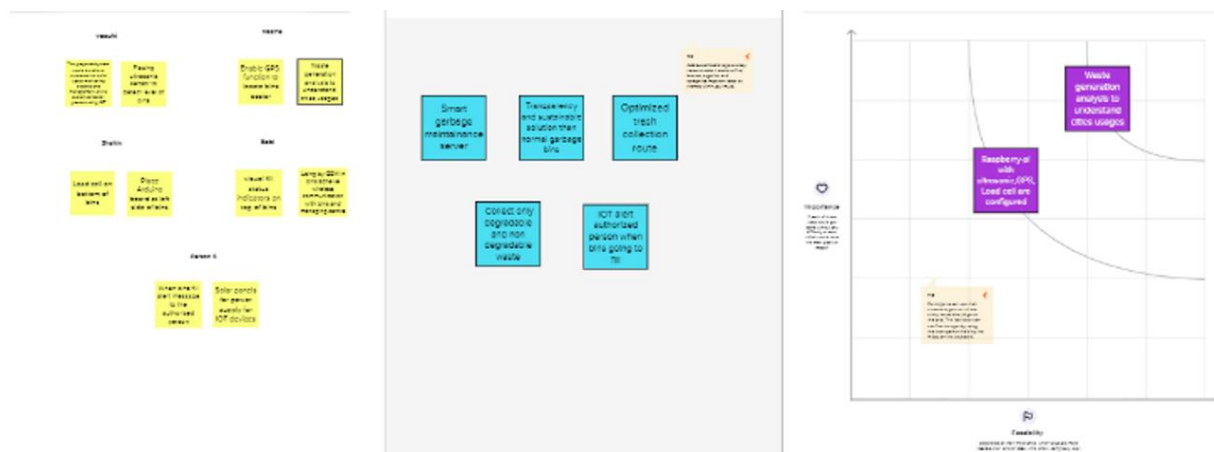
Fig3.Brainstorming

3.3 PROPOSED SOLUTION:

Proposed Solution means the technical solution to be provided by the Implementation agency in response to the requirements and the objectives of the Project.

3.3Tabulation

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 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.

3.4 PROBLEM SOLUTION FIT:

Problem-Solution Fit - this occurs when you have evidence that customers care about certain jobs, pains, and gains. At this stage you've proved the existence of a problem and have designed a value proposition that addresses your customers' jobs, pains and gains.

Define CS, fit into CC	**1. CUSTOMER SEGMENT(S)** CS Municipality and Local authorities of Metropolitan cities of India are the customers.	**6. CUSTOMER CONSTRAINTS** CC 1. Lack of infrastructure 2. Cost 3. Limitation of technology 4. Lack of participation in waste segregation	**5. AVAILABLE SOLUTIONS** AS 1. Central point for managing daily operations. 2. Identification, track & control the infrastructure of smart waste management.	Explore AS, differentiate
Focus on JBP, tap into BE, understand RC	**2. JOBS-TO-BE-DONE / PROBLEMS** J&P 1. Avoid fixed routine for waste collection 2. Avoid overflowing of bins 3. Proper Segregation of wastes	**9. PROBLEM ROOT CAUSE** RC 1. Increased population growth and urbanization leads to escalation of wastes 2. Lack of waste disposal due to this the garbage end up in the roads and surroundings	**7. BEHAVIOUR** BE 1. Sensors are used to sense the amount of waste in the trash 2. People must wait until the next day for the garbage to be cleared by the truck drivers	Focus on JBP, tap into BE, understand RC
Identify strong TR & EM	**3. TRIGGERS** TR To make the environment disaster free and clean and to save the people for some toxic wastes. **4. EMOTIONS: BEFORE / AFTER** EM Before: People get irritated on seeing the wastes that end up on the roads After: After the cleaning of trash people feel pleasant and secure	**10. YOUR SOLUTION** SL 1. Regular monitoring of waste disposals 2. Creating an app for monitoring the location, weight, and level of garbage cans 3. Solar power usage	**8.CHANNELS of BEHAVIOUR** CH 8.1 ONLINE 1. We can monitor in live 2. People can give complaints and feedback about the work 8.2 OFFLINE Taking necessary action on collecting the garbage regularly	

Fig.4 Problem Solution Fit

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 filllevels of bins monitored by smart sensors. In addition to the % of filllevel, based on the historical data, the tool predicts when the bin will become full, one of the functionalities that are not included even in the best waste management software. Sensors recognize picks as well; so you can check when the bin was last collected. With real-time data and predictions, you can eliminate the overflowing bins and stop collecting half-empty ones.

FR-3	Expensive bins.	We help you identify bins that drive up your collection costs. The tool calculates a rating for each bin in terms of collection costs. The tool considers the average distance depobin discharge in the area. The tool assigns bin a rating (1- 10) and calculates distance from depobin discharge.
FR-4	Adjust bin distribution.	Ensure the most optimal distribution of bins. Identify areas with either dense or sparse bin distribution. Make sure all trash types are represented within a stand. Based on the historical data, you can adjust bin capacity or location where necessary.
FR-5	Eliminate unefficient picks.	Eliminate the collection of half-empty bins. The sensors recognize picks. By using realtime data on filllevels and pick recognition, we can show you how full the bins you collect are. The report shows how full the bin was when picked. You immediately se e any inefficient picks below 80% full.
FR-6	Plan waste collection routes.	The tool semi-automates waste collection route planning. Based on current bin filllevels and predictions of reaching full capacity, you are ready to respond and schedule waste collection. You can compare planned vs. executed routes to identify any inconsistencies.

4.2 NON FUNCTIONAL REQUIREMENTS:

4.2 Tabulation

FR No.	Non-Functional Requirement	Description
NFR-1	Usability	IOT device verifies that usability is a special and important perspective to analyse user requirements, which can further improve the design quality. In the design process with user experience as the core, the analysis of users' product usability can indeed help designers better understand users' potential needs in waste management, behaviour and experience
NFR-2	Security	Use a reusable bottles Use reusable grocery bags Purchase wisely and recycle Avoid single use food and drink containers.
NFR-3	Reliability	Smart waste management is also about creating better working conditions for waste collectors and drivers. Instead of driving the same collection routes and servicing empty bins, waste collectors will spend their time more efficiently, taking care of bins that need servicing.

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

5. PROJECT DESIGN

5.1 DATA FLOW DIAGRAM:

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

A smart waste management platform uses analytics to translate the data gather in your bins into actionable insights to help you improve your waste services. You can receive data on metric such as:The first test conducted is the situation where the garbage bin is empty

➤ or its garbage is level very low

  Then, the bin is filled with more garbage until its level has surpassed the first
➤ threshold value, which is set to 80% the first warning SMS is being sent, as depicted

  The first notification SMS sent by the system
➤once the waste reaches the level of 85% full

  The second notification SMS sent by the system, indicating that bin is atleast
➤ 95% full and the garbage needs to be collected immediately Locations prone to overflow

➤ The number of bins needed to avoid overflowing waste

➤ The number of collection services that could be saved

➤ The amount of fuel that could be saved

➤ The driving distance that could be saved The Data Flow Graph of our proposed solution is shown below:
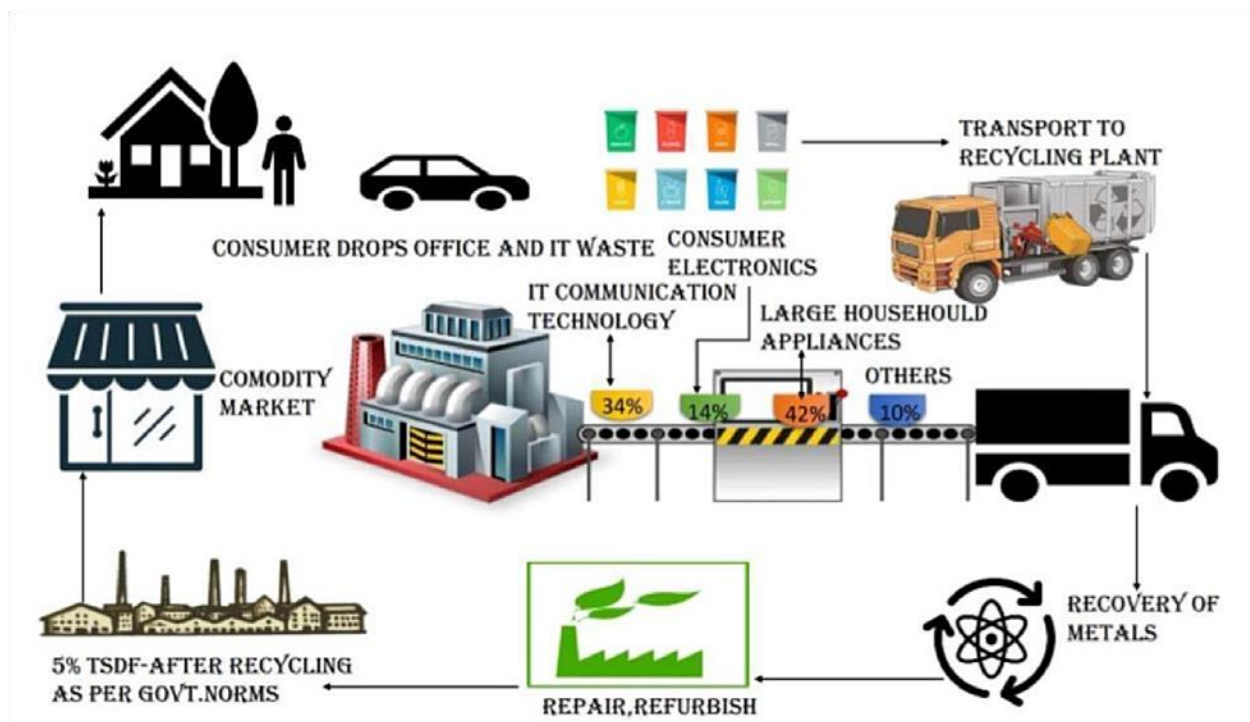
Fig5. Data Flow Diagram

5.2 SOLUTION & TECHNICAL ARCHITECTURE

Solution 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:

- Find the best tech solution to solve existing business problems.
- Describe the structure, characteristics, behavior, and other aspects of the software to project stakeholders.
- Define features, development phases, and solution requirements.
- Provide specifications according to which the solution is defined, managed, and delivered.
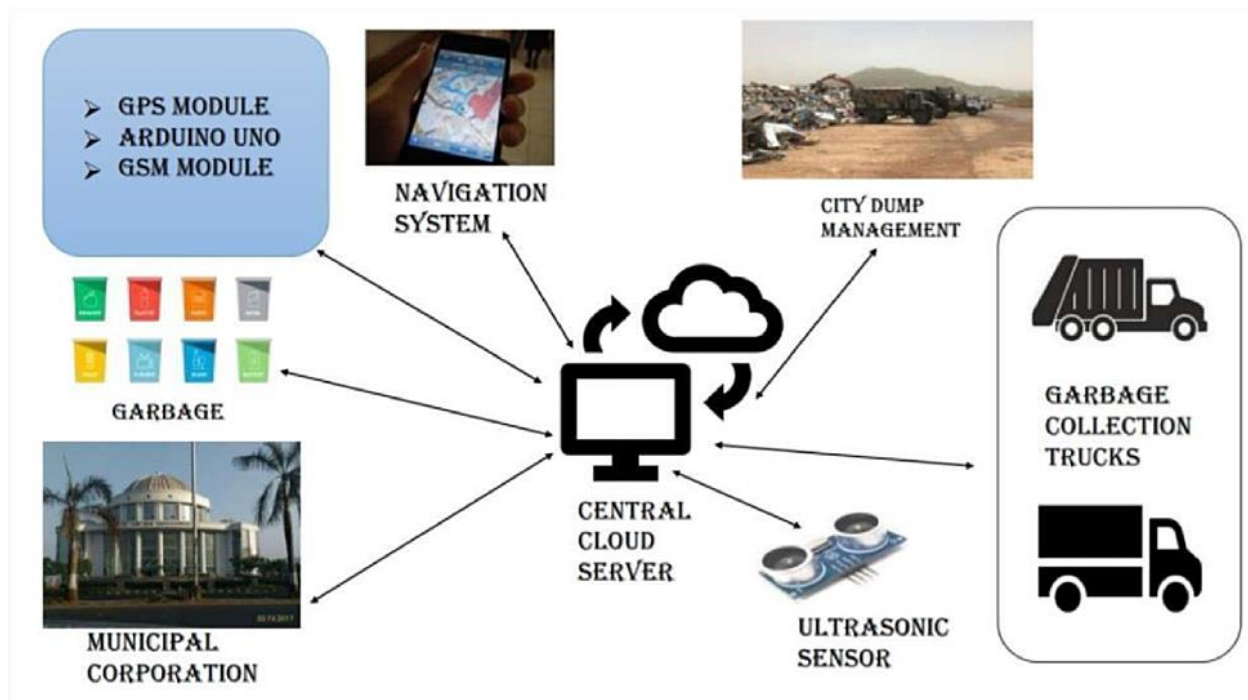
Fig6.Solution Architecture

For Technical Architecture

Technical architecture—which is also often referred to as application architecture, IT architecture, business architecture, etc.—refers to creating a structured software solution that will meet the business needs and expectations while providing a strong technical plan for the growth of the software application through its lifetime. IT architecture is equally important to the business team and the information technology team.

Technical architecture includes the major components of the system, their relationships, and the contracts that define the interactions between the components. The goal of technical architects is to achieve all the business needs with an application that is optimized for both performance and security. IT architects plan for things they know are coming in the future and for things they don't yet envision or dream. Taking the time to design the architecture at the start will prevent major design changes, code refactoring, and expensive rework later in the project.
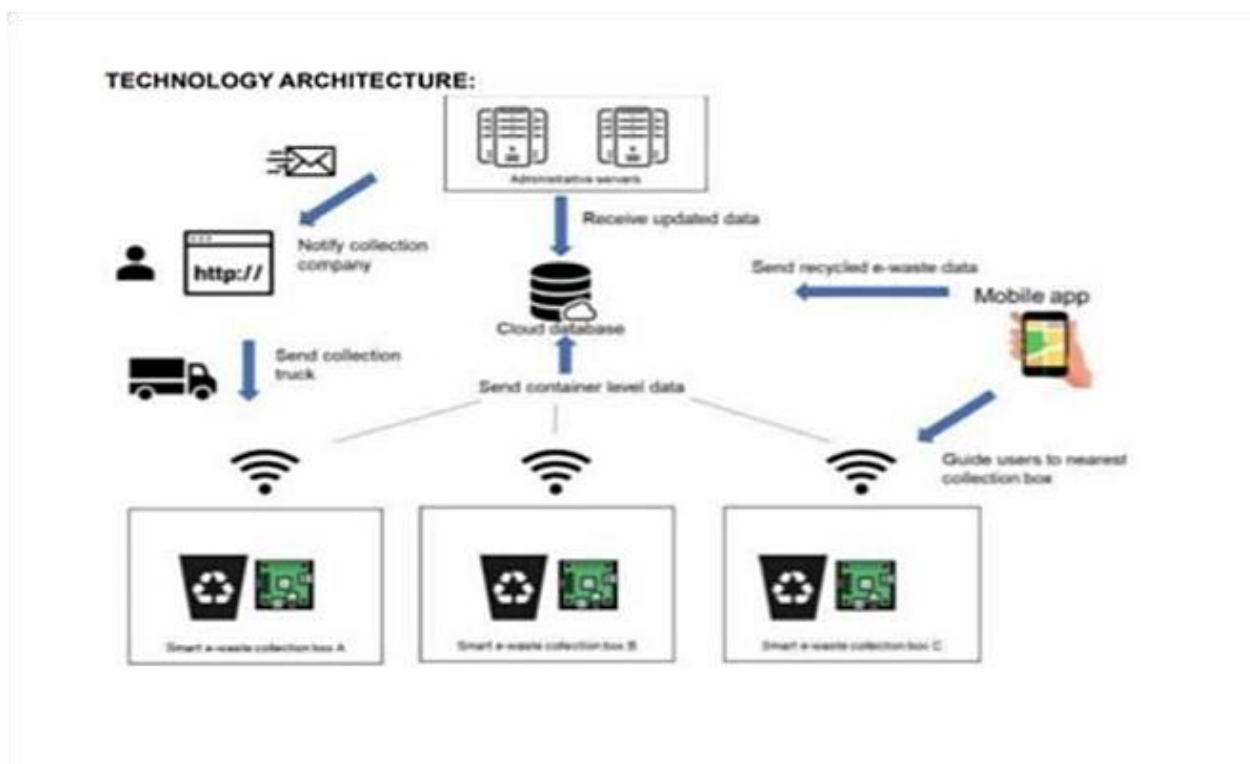
Fig7.Technical Architecture

5.3 USER STORIES:

A user story is an informal, general explanation of a software feature written from the perspective of the end user. Its purpose is to articulate how a software feature will provide value to the customer. It's tempting to think that user stories are, simply put, software system requirements. But they're not.

A key component of agile software development is putting people first, and a user story puts end users at the center of the conversation. These stories use non- technical language to provide context for the development team and their efforts. After reading a user story, the team knows why they are building, what they're building, and what value it creates. User stories are one of the core components of an agile program. They help provide a user-focused framework for daily work — which drives collaboration, creativity, and a better product overall.
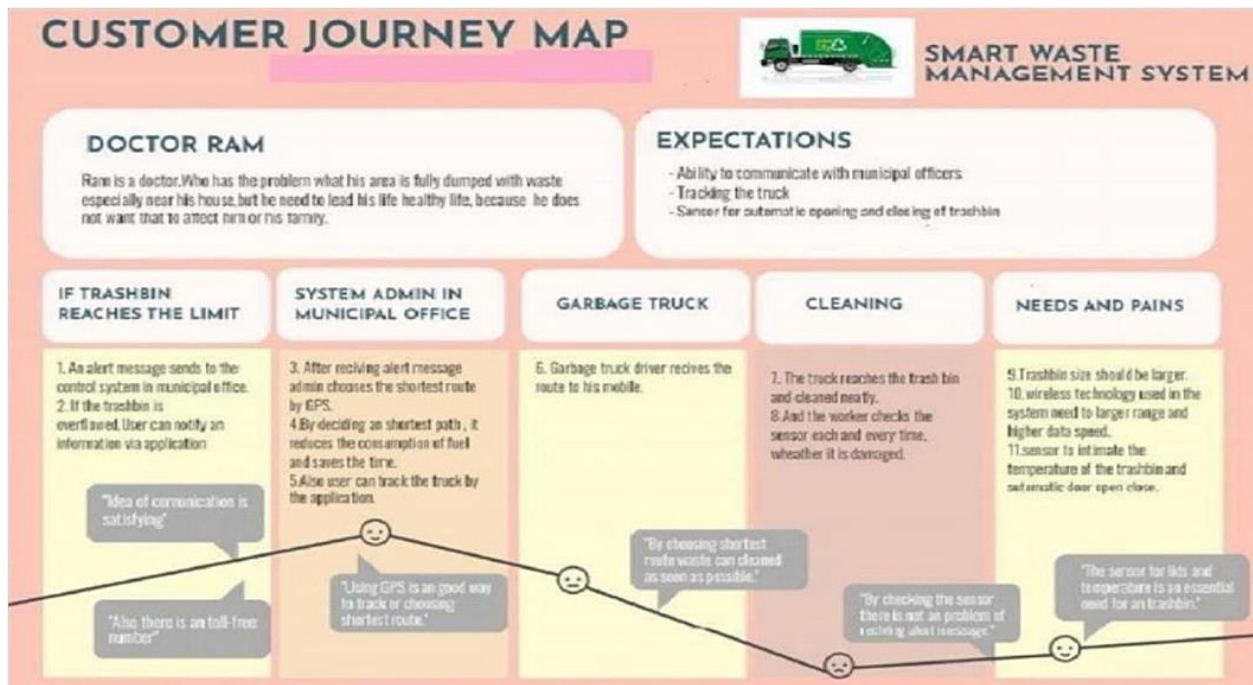
Fig8.Customer Journey

6. PROJECT PLANNING & SCHEDULING

6.1 SPRINT PLANNING & ESTIMATION:

6.1 Tabulation

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	Bharath

Sprint-1	Login	USN-2	As a Co-Admin, I'll control the waste level by monitoring them vai real time web portal. Once the filling happens, I'll notify trash truck with location of bin with bin ID	10	High	Jenis
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	Nancy Beula
Sprint-3	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	20	Medium	Srikanth

Sprint-4	Dashboard	USN-5	As a Municipality officer, I'll make sure everything is proceeding as planned and without any problems	20	High	Sanjay

6.2 SPRINT DELIVERY SCHEDULE:

6.2 Tabulation

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

6.3 REPORTS FROM JIRA:
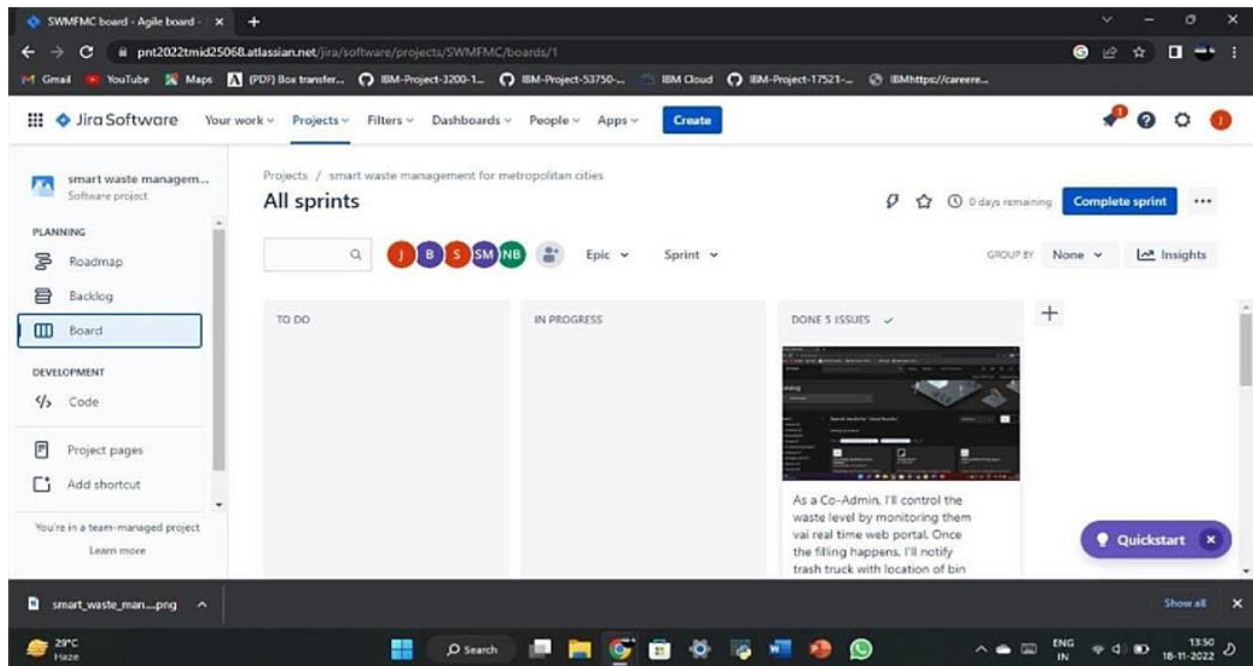
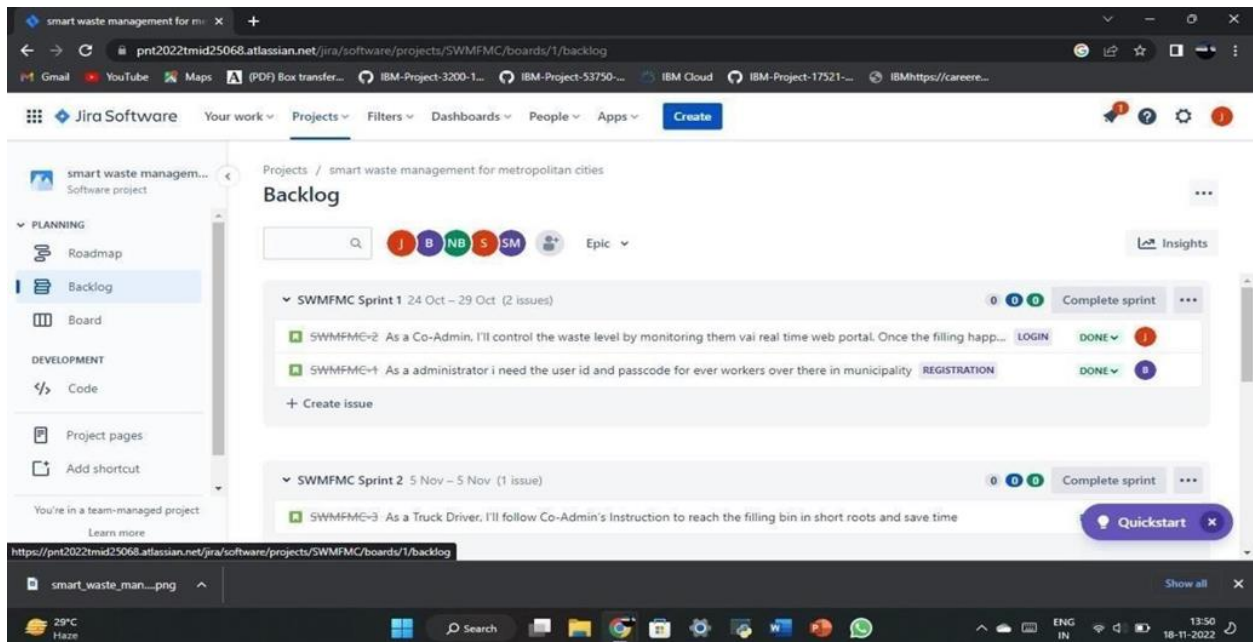Fig9. Sprint Assigned Page

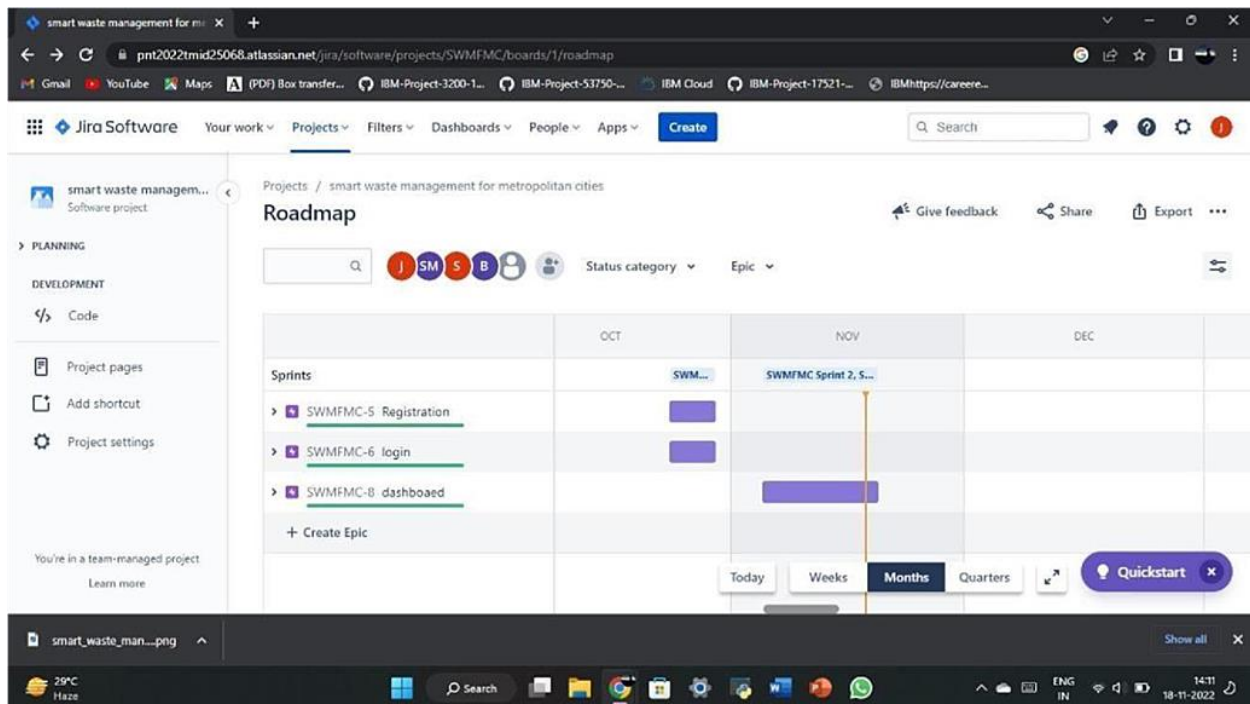Fig10. First Road Map

Fig11. Road Map After Tasks Done

7. CODING & SOLUTIONING

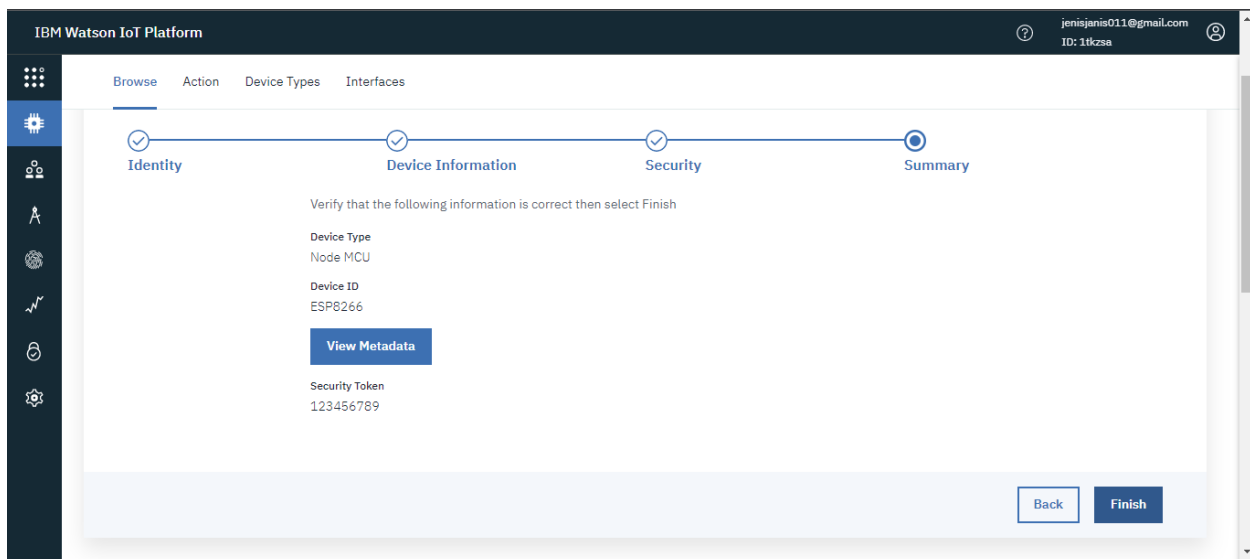## 7.1 FEATURE 1

IBM WATSON IOT PLATFORM

Fig12.IBM Waston IOT Plarform

29

The very first process in this project section is to develop the IBM IoT Platform. This IoT platform is the core formula for all the conection process. As the only way of connecting several applications is the basic work of the cloud platform.The process of signing in to the cloud process is the large process which carriesverfication segments too. After creating the Cloud Profile, lets move to device creation part.

Device Creation:

Now the next step is to create a device, we have created a device with following details

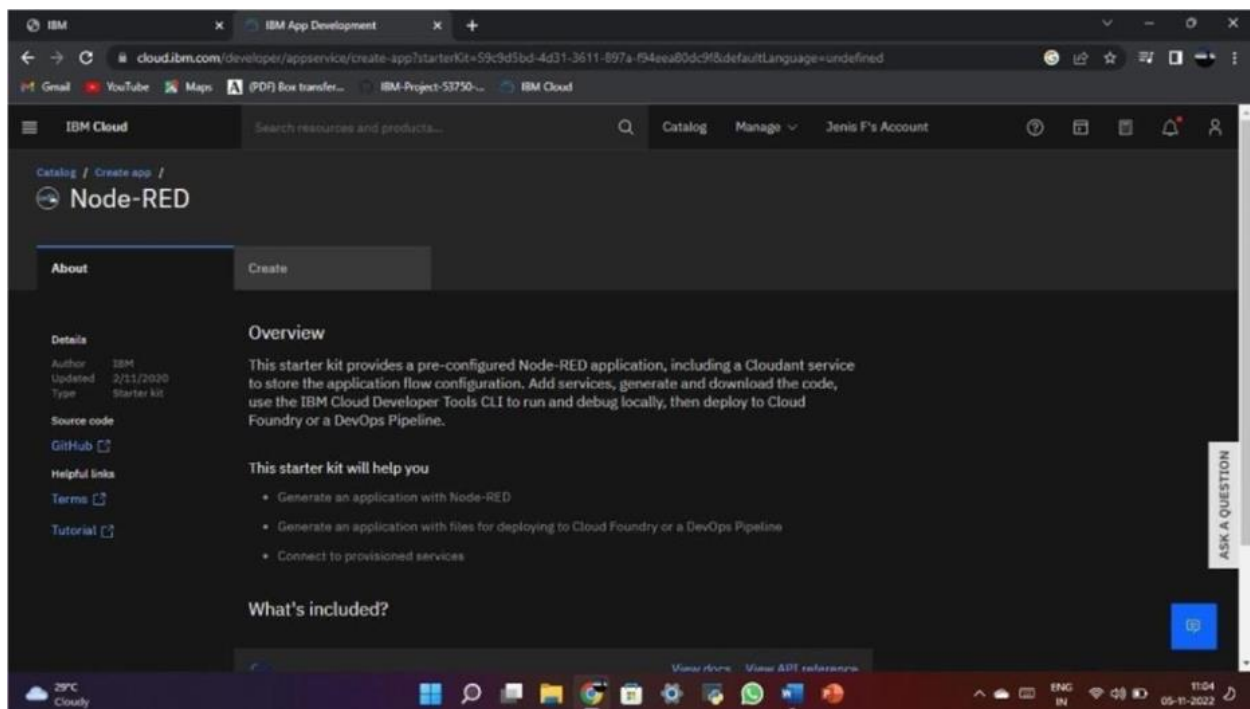Device Type : 123

Device Id : 1234567

Fig13.Created Device

NODE-RED SERVICE

After registering to the IBM IoT Platform and created the device, now we move on to the Node-Red Service, in this here we can create the Web user interface and the Web Application by designing the circuit. Our Node-Red Circuit designing are as follows.

The first step is to install the IBM IOT block from the node-red service and we have set four functions namely, bin value , latitude, longitude, location these four functions processess bin value with

corrseponding location of that bin, whenever the value get maximum. And the four functions are connected to the msg.payload button. At seperately the functions are designed in the wave of chart,where the bin value are designed in the level chart. After this, we set one button "alert message". This button is pressed by the user whenever the bin get full that time the message is go to the python code as to empty the bin immediately.

Now for connecting to web we use "http" extention. And also, for connection to the Application we use MIT app application with get option function in Node-Red. The
Node-Red website is copied and added "/sensor" to review the output. For simulating the Node-Red Service, there appears "Deploy" button.
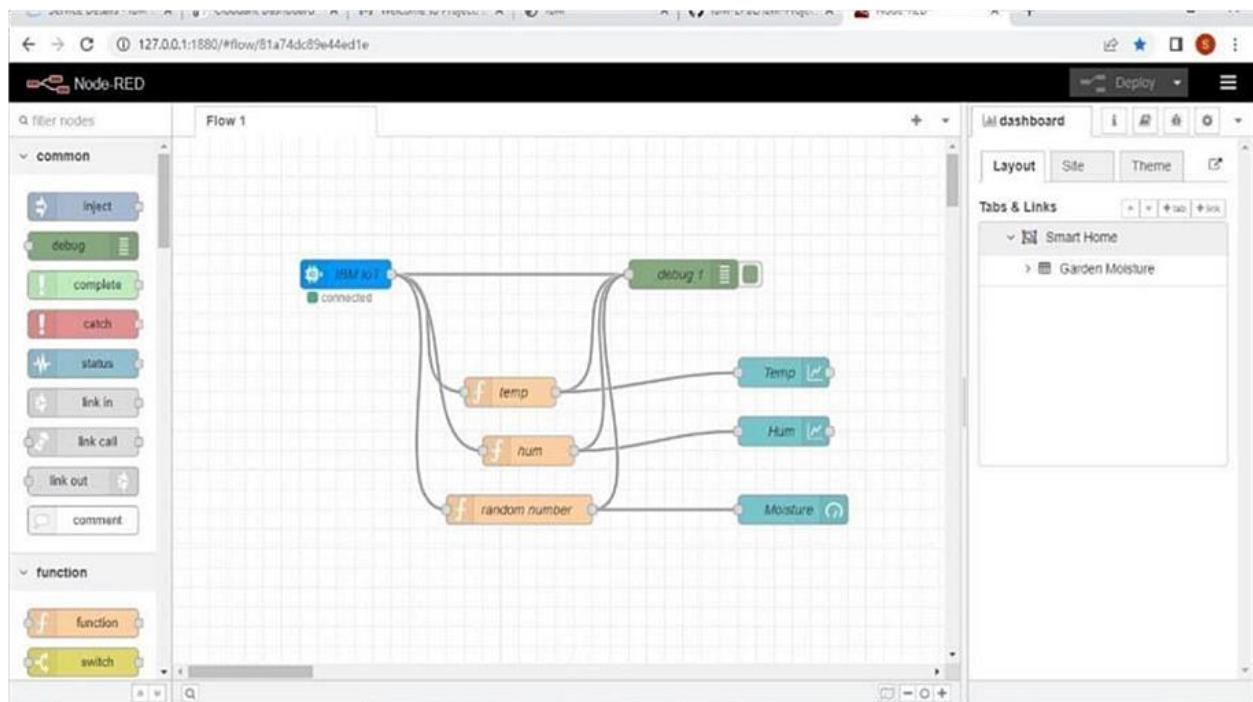

Fig14. Node-Red Circuit Design

USER INTERFACE

After the successful simulation of the Node-Red Service, User Interface is created. OurWeb UI includes a dashboard which has a bin level meter and the location of the particular bin and a alert message button.

7.2 FEATURE 2

PYTHON CODE

    Our Python Code is very Simple and easy to understand. The programs carries our device detalis and the requirements of the project are kept defined. All conditions are made properly and the output is done successfully.

CODE:

```
#IBM Watson IOT  Platform #pip install wiotpsdk import wiotp.sdk.devic e import time import random
myConfig
= {
 "identity": {
 "orgId": "fa4qjp",
 "typeId": "123",
 "deviceId":"1234567"
 },
 "auth": {
 "token": "12345678"
 }
}
def myCommandCallback(cmd):

    print("Message received from IBM IoT Platform: %s" % cmd.data['command'])


    m=cmd.data['command']



  client = wiotp.sdk.device.DeviceClient(config=myConfig, logHandlers=None)


  client.connect()



   while True

latitude=random.uniform(27.2046,125.25)     longitude=random.uniform(77.4977,100.1526)
binlevel=random.randint(10,100)        if binlevel >= 90:
```

myData={'latitude':latitude, 'longitude':longitude,'binlevel':binlevel}   client.publishEvent(eventId="status", msgFormat="json", data=myData, qos=0, onPublish=None

##print("Published data Successfully: %s", myData) print("!!!!!!!!!BIN IS FULL!!!!!!!!!! ",myData)
 client.commandCallback =
myCommandCallback time.sleep(2) else   print("BIN IS IN NORMAL
LEVEL")
   time.sleep(2) client.disconnect()

8. TESTING

8.1 TEST CASES:

•   Login Page (Functional)
•   Login Page (UI)
•   Add Expense Page (Functional)

1.Purpose of Document
        The purpose of this document is to briefly explain the test coverage and open issues of the Smart Fashion Recommender Application project at the time of the release to User Acceptance Testing (UAT)
2.Defect Analysis
         This report shows the number of resolved or closed bugs at each severity level, and how they were resolved

8.1.2 Tabulation

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
Subtotal	**11**	**4**	**2**	**2**	**19**
Duplicate	**1**	**1**	**2**	**0**	**4**

External	2	3	0	1	6
Fixed	10	2	3	20	35
Not Reproduce d	0	0	2	0	2
Skipped	0	0	2	1	3
Won't Fix	0	5	2	1	8
Totals	24	15	13	25	77

3.Test Case Analysis

This report shows the number of test cases that have passed, failed, and untested

8.1.3 Tabulation

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	5	0	1	4
Security	3	0	0	3

Outsource Shipping	**2**	**0**	**0**
			2
Exception Reporting	**11**	**0**	**2**
			9

8.2 USER ACCEPTANCE TESTING:

As the completion of the application develeopment , the app should give as much support to the user. The developer must make sure of the avoidance of the disability in working of application by the user. All the appearance of the app should able to be configurable to the user. The usage of the application must satisfy   the user at 100%. All the specifications must be simple and easy to use.
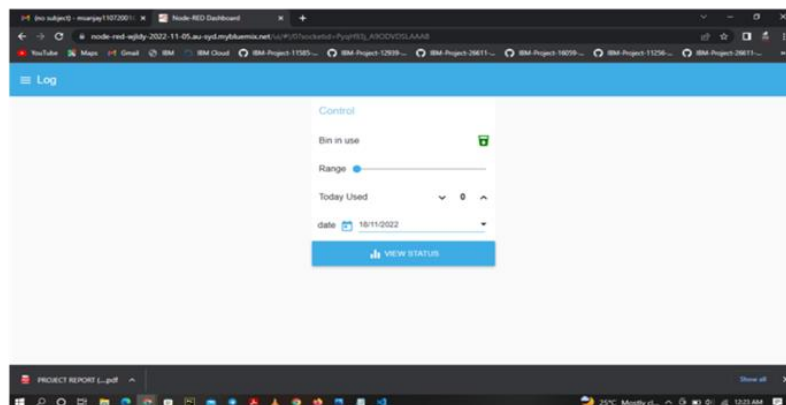

Figure16:Bin Status

9. RESULTS

9.1 PERFORMANCE METRICS:

The performance and the working of the code is ver quick and the results appears in quick succession. Our code is linked with the most used IBM Watson IT Platform which works with much perfection. This cloud platform is very secure to use and configure easily. As the code is simulated within seconds the result appears. We have done lot of works using this IoT platform which is very simple and

good user friendly platform. Below we display our connected IoT platform which delivers the results as the code is run.

10. ADVANTAGES & DISADVANTAGES

ADVANTAGES:

By having a more convenient route garbage trucks spend less time on the road, therefore, congestion in smart cities can be decreased. With the huge increase in waste, more resources are allocated to waste collection and handling. If unnecessary collections are eliminated, public spending on waste management can be reduced. An optimized route and system for waste collection will eliminate this risk as well as improving air quality and minimizing CO_2 emissions. Smart cities are all about using resources efficiently – achieving more by using less input. By routes being monitored, the opportunity of the misuse of owned assets is eliminated. Moreover, cities are encouraged to be transparent with their citizens by showing how waste is being managed. Smart cities infrastructure and intelligent waste solutions have the potential to lead the shift towards a more sustainable future.

DISADVANTAGES:

There may be several disadvantages such as increasing cost of the dustbin. For example, if there are three different levels then three sensors has to be placed; one sensor for each level. Also rough action and usage of the user may cause damages to the sensors.Some trash bins are overfilled while others are underfilled by the trash collection time. Overfilled trash bins create unhygienic conditions.

Truck routes result in excessive fuel usage and environmental pollution and all collected trash is combined which complicates sorting at the recycling facility.

11. CONCLUSION

The behaviour of generating garbage is too dangerous not only for today's generation, but also for future generations. It is critical to educate people and encourage them to practise Recycle, Reuse, and Reduce instead of producing waste. Waste disposal should be a priority for municipalities and governments.
 This project is very effective in managing waste in any big city. Rather than using conventional periodic collection methods here priority system is used to the city is clean all the time without any overflowing dumpsters. It has been tested and verified properly to make sure all the different parts work together for a smooth function of the whole system.

12. FUTURE SCOPE

Waste Management in India is basically all those activities, which are required to manage waste from its beginning to the final disposal. Waste Management majorly includes things like the collection, transport, treatment, and the ultimate disposal of waste with a high level of monitoring and regulation.

To sum up, Waste management's future includes turning waste into energy, IoTenabled practices, improvement in monitoring systems, data collection, and much more technology-based advancements.

13. APPENDIX
SOURCE CODE

```
#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 "9gbe4w"                 // IBM organisation id
#define DEVICE_TYPE "SWMSMC" // Device type mentioned in ibm watson iot platform
#define DEVICE_ID "ibmproject"       // Device ID mentioned in ibm watson iot platform
#define TOKEN "sUNA41tG6-Pq)0rk5X"          // Token
//----------------------- customise 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 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 pin

pinMode(34, INPUT);

//ledpins   pinMode(23, OUTPUT);   pinMode(2, OUTPUT);   pinMode(4, OUTPUT);

pinMode(15, OUTPUT);

lcd.init();   lcd.backlight();

lcd.setCursor(1, 0);

lcd.print("");

wifiConnect();

mqttConnect();

}

float readcmCM()

{

digitalWrite(TRIG_PIN, LOW);

delayMicroseconds(2);

digitalWrite(TRIG_PIN, HIGH);

delayMicroseconds(10);

digitalWrite(TRIG_PIN, LOW);

int duration = pulseIn(ECHO_PIN, HIGH);

return duration * 0.034 / 2;

} void loop(){

lcd.clear();

publishData();   delay(500);

if (!client.loop())

{

mqttConnect();                          // function call to connect to IBM

}

}

/* --------------------------------retrieving to cloud---------------------------------------------------*/

void wifiConnect()

{
```

```cpp
Serial.print("Connecting to ");
Serial.print("Wifi");
WiFi.begin("Wokwi-GUEST", "", 6);
while (WiFi.status() != WL_CONNECTED)
{
delay(500);
Serial.print(".");
}
Serial.print("WiFi connected, IP address: ");
Serial.println(WiFi.localIP());
}
void mqttConnect()
{
if (!client.connected())
{
Serial.print("Reconnecting MQTT client to ");
Serial.println(server);
while (!client.connect(clientId, authMethod, token))
{
Serial.print(".");
delay(500);
}
initManagedDevice();
Serial.println();
}
}
 void initManagedDevice()
{
if (client.subscribe(topic))
{
Serial.println("IBM subscribe to cmd OK");
}
else
{
```

```cpp
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);
if(digitalRead(34)== true)
{
if(cm <= 60)                          //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 > 60 && cm < 120)
{
digitalWrite(4, HIGH);
Serial.println("Warning!!,Trash is about to cross 50% of bin level");
digitalWrite(2, LOW);
digitalWrite(23, LOW);
}
else if(cm > 120)
{
digitalWrite(23, HIGH);
```

```
Serial.println("Bin is available");
digitalWrite(2,LOW);
digitalWrite(4, LOW);
}
delay(10000);
Serial.println("Lid Closed");
}
Else
{
Serial.println("No motion detected");
digitalWrite(2, LOW);
digitalWrite(15, LOW);
digitalWrite(4, LOW);
digitalWrite(23, LOW);
}
}
else
{
digitalWrite(15, LOW);
}
if(cm <= 60)
{
digitalWrite(21,HIGH);
String payload = "{\"High_Alert\":"; payload += cm; payload += " }";
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 else prints publish failed
{
 Serial.println("Publish OK");
}
}
else if(cm <= 120)
```

```
{
digitalWrite(22,HIGH);
String payload = "{\"Warning\":"; payload += cm ; payload += " }";
Serial.print("\n");
Serial.print("Sending payload: "); Serial.println(payload);
if(client.publish(publishTopic, (char*) payload.c_str()))
{
 Serial.println("Publish OK");
}
else
{
Serial.println("Publish FAILED");
}
}
Else
{
Serial.println();
}
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();
}
```
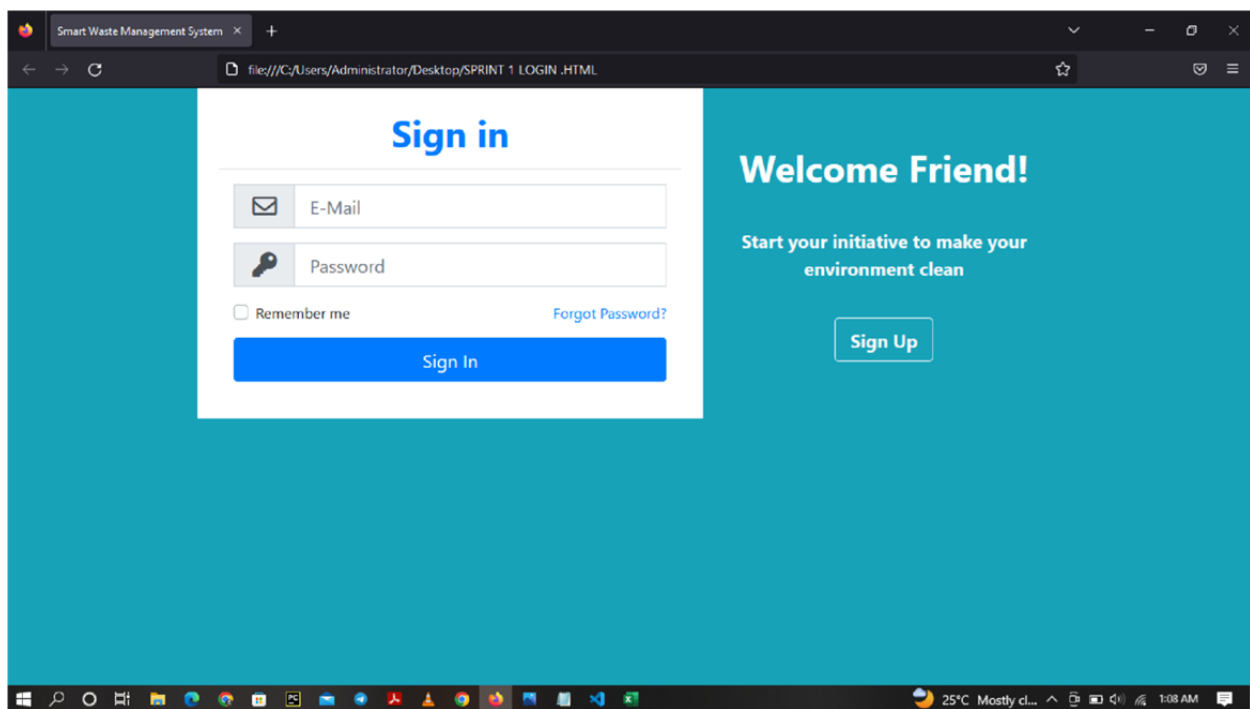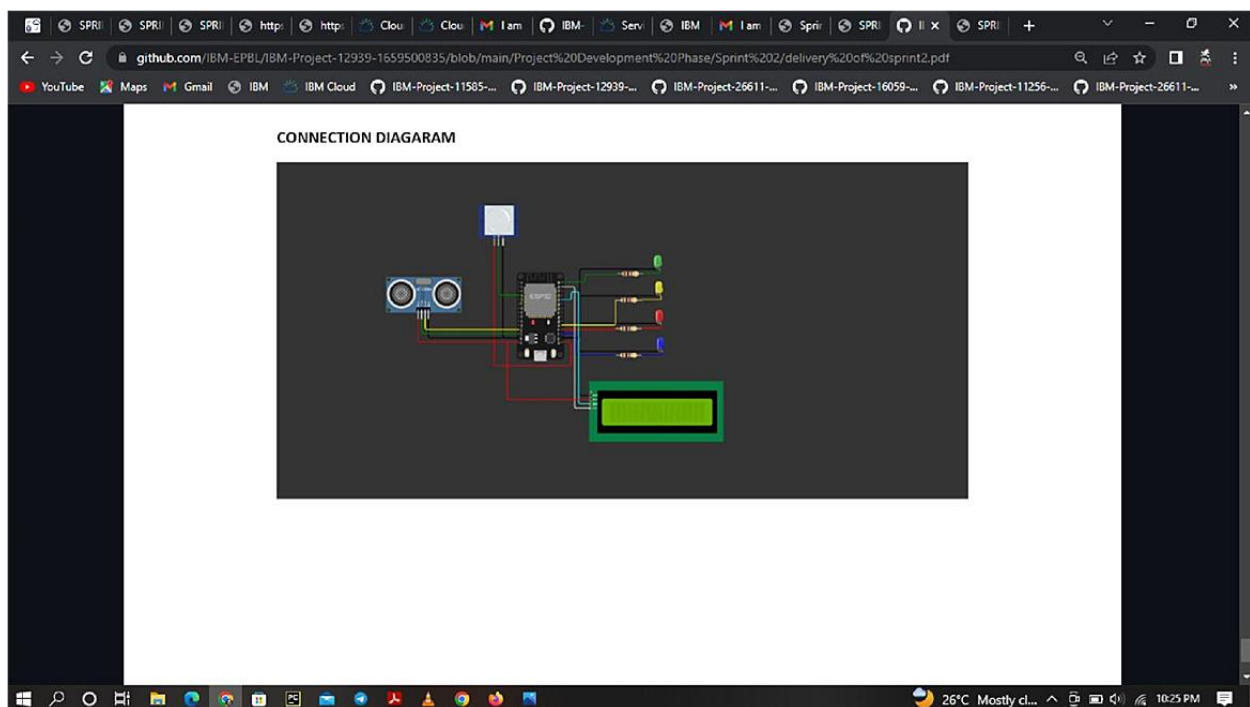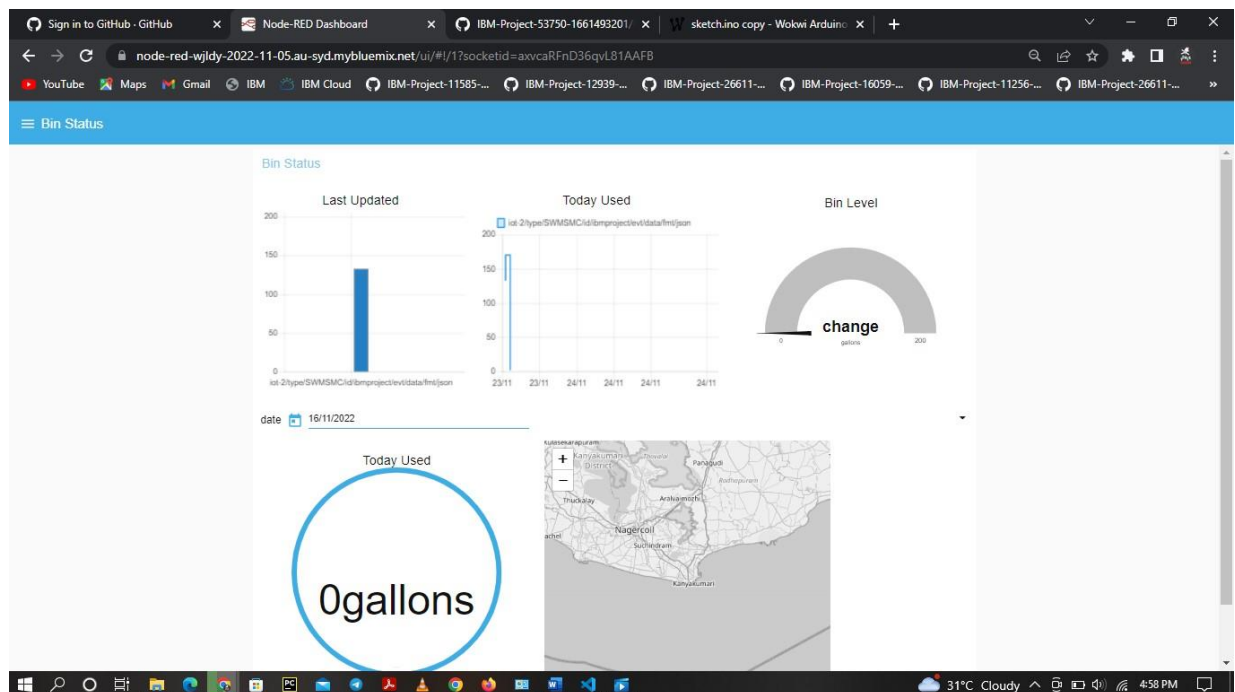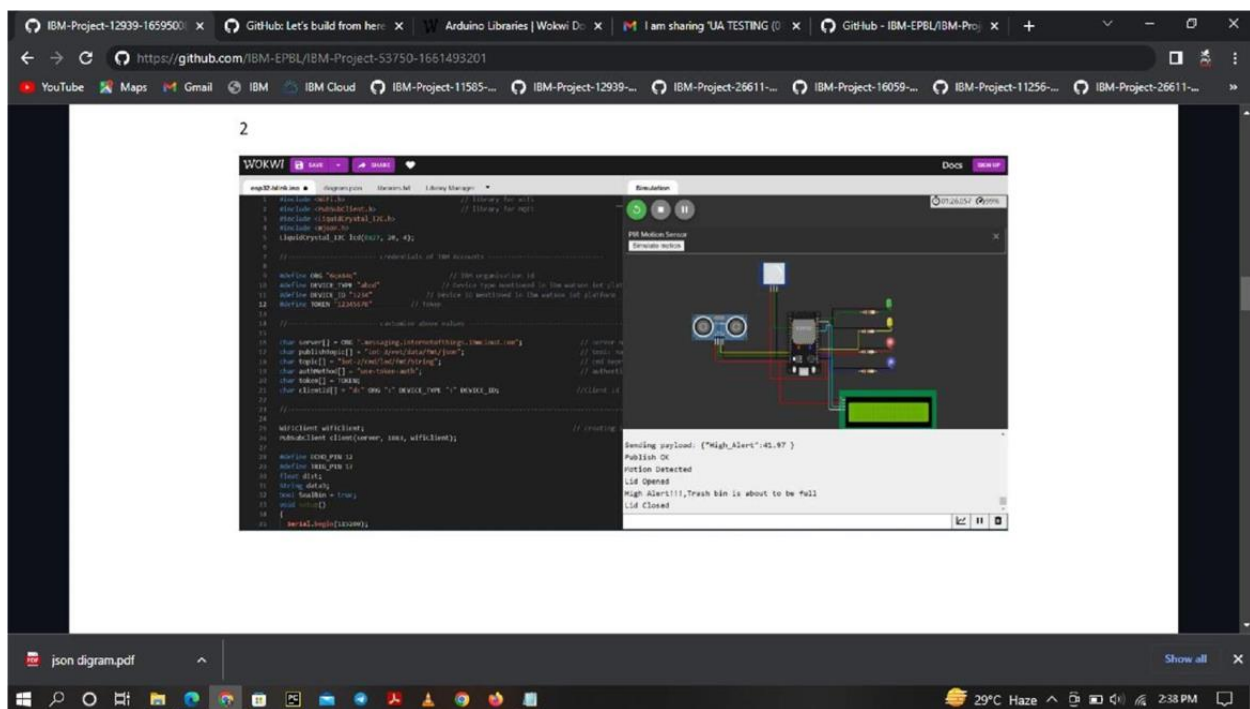
Fig15.login

Fig16.Connection Diagram

Fig 17.Output

Figure 20:Node Output

GITHUB LINK :   https://github.com/IBM-EPBL/IBM-Project-537501661493201

PROJECT DEMO LINK :

https://youtu.be/LjVT24DbmZs