CONTENTS

ABSTRACT

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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 net bin 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. The technology awards the user for keeping the surrounding clean and thus work hand in hand for the proper waste management in a locality. Smart net bin uses multiple technologies firstly the technology for measuring the amount of trash dumped secondly the movement of the waste and lastly sending necessary signals and connecting the user to the Wi-Fi system. The proposed system will function on client server model, a cause that will assure clean environment, good health, and pollution free society.

At present solid waste management is a major concern in the metropolitan cities of the developing and developed countries .As the population is growing, the garbage is also increasing . Thus huge unmanaged accumulation of garbage is polluting the environment, spoiling the beauty of the area and also leading to the health hazard . In this era of Internet ,IOT(Internet of Things) can be used effectively to manage this solid waste . In this paper, we have discussed the definition of Internet of Things and its elements ,testing and prototyping tool simulator and finally the study of various literatures available on smart waste management system using IOT.

1. INTRODUCTION

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.in most of the developed countries there are many efficient techniques which are used for the proper management of this waste, but in some countries especially the developing ones the careless attitude of people towards maintaining clean surroundings, along with this many issues such as no stringent laws for using the biodegradable materials, no proper environ policies ,no laws for sustainable development are the seed for the fatal results of waste management. 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.

Waste is a crucial issue, which needs to be addressed smartly. we segregate the waste at our homes for ease at processing and recycling. We observed trash vans come irregular to homes creating a despoliation of households. Due to this many civilians empty their overloaded dustbins in open spaces. This in turn increases environmental pollution.

1.1 ProjectOverview

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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.in most of the developed countries there are many efficient techniques which are used for the proper management of this waste, but in some countries especially the developing ones the careless attitude of people towards maintaining clean surroundings, along with this many issues such as no stringent laws for using the biodegradable materials, no proper environ policies ,no laws for sustainable development are the seed for the fatal results of waste management. 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.

1.2 Purpose

We amalgamate technology along with waste management in order to effectively create a safe and a hygienic environment. Smart waste management is about using technology and data to create a more efficient waste industry. Based on IoT (Internet of Things) technology, smart waste management aims to optimize resource allocation, reduce running costs, and increase the sustainability of waste services. 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. A good level of coordination exists between the garbage collectors and the information supplied via technology. This makes them well aware of the existing garbage level and instigate them whenever the bins reach the threshold level. They are sent with alert messages so that they can collect the garbage on time without littering the surrounding area. The fill patterns of specific containers can be identified by historical data and managed accordingly in the long term. In addition to hardware solutions, mobile applications are used to overcome the challenges in the regular waste management system, such as keeping track of the drivers while they are operating on the field. Thus, smart waste management provides us with the most optimal way of managing the waste in an efficient manner using technology.

2. LITERATURE SURVEY:

Mohammad Aazam, Marc St-Hilaire, Chung-Horng Lung, Ioannis Lambadaris (2016) provides the idea of sensors-based waste bins, capable of notifying waste level status. An automatic waste bin and make use of cloud computing paradigm to evolve a more robust and effective smart waste management mechanism. Waste management is linked to different stakeholders, including recyclers, importers and exporters, food industry, healthcare, research, environment protection and related organizations, and tourism industry Mohammad Aazam et al proposed Cloud SWAM, in which each bin is equipped with sensors to notify its waste level. Different bins for each category of waste, namely: organic, plastic/paper/bottle, and metal. In this way, each type of waste is already separated and through the status, it is known that how much of waste is collected and of what type. The availability of data stored in the cloud can be useful for different entities and stakeholders in different ways. Analysis and planning can start from as soon as waste starts gathering and up to when recycling and import/export related matters are conducted. The system Cloud SWAM provides Timely waste collection. Timely and efficient way of collecting waste leads to better health, hygiene, and disposal. The system provides shortest path to the location of waste bins. So the collectors can plan a better and fuel efficient route. Recycling and disposal by the system s uses separate smart bins for each type of waste. So the stakeholders will be able to see through the cloud and analyze type of waste and its magnitude. So they can do better arrangements and efficient ways of recycling can be adopted in a dynamic way. Resource management by Cloud SWAM is based on the waste generation trends of a particular city and/or area, resources can be effectively managed since the data is available live through the cloud. Food industry planning can done through the Cloud SWAM. Food industry can plan according to the trends of a certain locality. In this way, not only waste material can be minimized, but also, food trends and habits of an area can be coped in a much more operative way. Taxation With CloudSWAM keeping track of each kind of waste, better taxation and fine imposition can be performed on unnecessary waste generation. Big Data practices can be used to reduce waste generation and improve its management. Various healthcare stakeholders can take benefit from the gathered waste management data and foresee what type of diseases a particular locality is more prone to and how to prevent from certain types of insects and bugs from breeding. Waste-based energy production means generating energy from waste in the form of electricity or heat.

2.1 Existing problem

Waste management has become an alarming challenge in local towns and cities across the world. Often the local area bins are overflowing and the municipalities are not aware of it. This

affects the residents of that particular area in numerous ways starting from bad odour to unhygienic and unsafe surroundings. Poor waste management - ranging from non-existing collection systems to ineffective disposal -causes air pollution, water and soil contamination. Open and unsanitary areas contribute to contamination of drinking water and can cause infection and transmit diseases. Toxic components such as Persistent Organic Pollutants (POPs) pose particularly significant risks to human health and the environment as they accumulate through the food chain. Animals eating contaminated plants have higher doses of contaminants than if they were directly exposed. Precipitation or surface water seeping through waste will absorb hazardous components from landfills, agricultural areas, feedlots, etc. and carry them into surface and groundwater. Contaminated groundwater also poses a great health risk, as it is often used for drinking, bathing and recreation, as well as in agricultural and industrial activities.

2.2 References

PAPER 1:

TITLE: IoT Based Waste Management for Smart City

AUTHOR NAME: Parkash Tambare, Prabu Venkatachalam

PUBLICATION YEAR: 2016

DESCRIPTION:

In the current situation, we frequently observe that the trash cans or dust cans that are located in public spaces in cities are overflowing due to an increase in the amount of waste produced each day. We are planning to construct "IoT Based Waste Management for Smart Cities" to prevent this from happening because it makes living conditions for people unsanitary and causes unpleasant odours in the surrounding area. There are numerous trash cans scattered throughout the city or on the campus that are part of the proposed system. Each trash can is equipped with a low-cost embedded device that tracks the level of the trash cans and an individual ID that will enable it to be tracked and

identified.

PAPER 2:

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

PUBLICATION YEAR: 2016

DESCRIPTION:

Each bin in the Cloud SWAM system that Mohammad Aazam et al suggested has sensors that can detect the amount of waste inside. There are separate bins for organic, plastic/paper/bottle/glass, and metal waste. This way, each form of waste is already divided, and it is known how much and what kind of waste is collected thanks to the status. Different entities and stakeholders may benefit from the accessibility of cloud-stored data in different ways.

Analysis and planning can begin as soon as garbage is collected and continue through recycling and import/export-related activities. Timely garbage collection is provided via the Cloud SWAM system. A timely and effective method of waste collection improves health, hygiene, and disposal.

PAPER 3:

TITLE: Arduino Microcontroller Based Smart Dustbins for Smart Cities

AUTHOR NAME: K. Suresh, S. Bhuvanesh and B. Krishna Devan

PUBLICATION YEAR: 2019

DESCRIPTION:

In this paper, a technique for cleaning up our surroundings and environment is described. The Indian government just began work on a smart city initiative, and in order for these towns to be smarter than they already are, the garbage collection and disposal system must be improved upon. Self-Monitoring Automated Route Trash (SMART) dustbins are intended for use in

smart buildings such as colleges, hospitals, and bus stops, among other places. In this study, we have employed the PIR and Ultrasonic sensors to detect human presence, the Servomotor to open the dustbin lid, and the Ultrasonic sensor to detect the level of rubbish. Signals between two trash cans are transmitted using a communication module, and the GSM module sends the message to the operator.

PAPER 4:

AUTHOR NAME: Mohd Helmy Abd Wahab, Aeslina Abdul Kadir

PUBLICATION YEAR: 2014

DESCRIPTION:

Proposed a smart recycle bin that can handle the recycling of plastic, glass, paper, and aluminium cans. It generates a 3R card after automatically determining the value of the trash thrown away. The recycle system makes it possible to accumulate points for placing waste into designated recycle bins. By allowing the points to be redeemed for goods or services, such a system promotes recycling activities. The system keeps track of information on disposal procedures, materials disposed of, user identification, and points accrued by the user. To use the recycle bin, the user must tap his card to the designated RFID reader. Doors to recycling bins are opened, and rubbish is placed one by one.

PAPER 5:

TITLE: Waste Management Initiatives in India For Human Wellbeing

AUTHOR NAME: Dr. Raveesh Agarwal, Mona Chaudhary .

PUBLICATION YEAR: 2015

DESCRIPTION:

The objective of this paper is to examine the present methods used in

India for the welfare of its people in different waste management efforts. The other goal is to offer advice on how to make Indian municipalities' trash disposal procedures better. On secondary research, this essay is founded. The system is improved by looking at the reports that have already been written about waste management and the suggestions made for improvement by planners, NGOs, consultants, government accountability organisations, and important business leaders. It provides in-depth understanding of the various waste management programmes in India and identifies areas where waste management might be improved for societal benefit. The essay makes an effort to comprehend the crucial part that our nation's official waste management sector plays in the waste management process.

PAPER 6:

AUTHOR NAME: Fachmin F olianto, Yong Sheng Low and Wai Leong Yeow

PUBLICATION YEAR: 2015

DESCRIPTION:

A three-tier design is proposed for the smart bin system. Each Smartbin is equipped with an ultrasonic sensor that detects bin fullness and records readings and sensor statuses. The gateway nod, which is a part of every sensor cluster, receives the sensor reading and transmits it. To the backend server, it transmits the data. The back end server's analytics module examines the information that the bin subsystem has gathered. The analytics module examines fullness readings, compares against preset criteria, and creates events when a threshold is exceeded. The workstation receives data from the bin sub-system, and a graphical user interface displays useful data to users.

PAPER 7:

TITLE: Design and Development of Smart Waste Management System: AMobile App for Connecting and Monitoring Dustbin Using IoT

AUTHOR NAME: Na Jong Shen, Azham Hussain and Yuhanis Yusof

PUBLICATION YEAR: 2020

DESCRIPTION:

The Smart Waste Management Method is an extremely creative system that will advance the development of the Smart City. We frequently notice that the garbage cans placed in open areas of our city are always overstuffed. The result is filthy conditions in the city, and Malaysia's present waste management system is not optimised to address the issue. Additionally, the old method of physically checking the garbage in dustbins is a difficult operation that requires a lot more human labour and costs money.

PAPER 8:

AUTHOR NAME: Keerthana b et al.

PUBLICATION YEAR: 2017

DESCRIPTION:

Designed an internet of bins for trash management in India. When the garbage level reaches its peak, the smart TRASH management system, which uses sensor, microcontroller, and other modules, guarantees that the trash cans are properly emptied. If the waste quantity exceeds one of the two thresholds established for the bins, an alarm message is delivered to the vehicle that picks up the garbage. People may continue to put garbage bags in the bins until they exceed the threshold limit thanks to the technology. To empty the bin, it waits for the van to acknowledge it, and if it doesn't, it sends the message again until it approaches the threshold limit, at which point the bin is locked. When the bin gets locked it displays the message “Overloaded”.

Then the dustbin will be monitored for a specific time and when not cleared within a certain time limit, then a message will be sent to the higher

authority who can take appropriate action.

PAPER 9:

TITLE: IoT based smart garbage collection system

AUTHOR NAME: Rahul Kumar Borah, Sahana Shetty, Rahul Patidar, Anisha Raniwala and Kratee Jain

PUBLICATION YEAR: 2018

DESCRIPTION:

To create an effective and dynamic waste management system, the smart trash container is crucial. One of the most significant challenges for municipal organisations across the world is managing waste from its inception to transfer. Due to the daily growth in garbage, dustbins placed across finished urban areas and placed in open areas are overflowing, creating unsanitary circumstances for the residents. To maintain a crucial barrier from such a situation, we have proposed a remote strong waste management prototype for smart urban groups. This prototype enables common associations to remotely monitor the status of trash cans, complete web server, and profitably maintain urban areas clean by increasing the cost and time required for it.

PAPER 10:

TITLE: Smart City Waste Management System using IoT and Cloud Computing.

AUTHOR NAME: Aderemi A. Atayero, Segun I. Popoola, Rotimi Williams,
Joke A. Badejo and Sanjay Misra

PUBLICATION YEAR: 2021

DESCRIPTION:

Solid waste disposal without consideration is a significant problem in the metropolitan areas of most developing nations, and it seriously jeopardizes the residents' ability to live a healthy lifestyle. Both the local government and the populace will benefit from having access to trustworthy data on the situation

with solid waste at various points across the city. In this study, the Internet of Things (IoT) and cloud computing technologies are used to create an intelligent solid waste monitoring system.

Ultrasonic sensors are used to measure the solid waste fill levels in each of the containers, which are placed in strategic locations around the community. The sensor data is sent through a Wireless Fidelity (Wi-Fi) communication link to the Thing Speak IoT cloud platform.

2.3 Problem Statement Definition:

Table 2.3.1 Problem Statement Statement

Problem Statement (PS)	**I am (Customer)**	**I'm trying to**	**But**	**Because**	**Which makes me feel**
PS-1	Municipal corporation authority	Get notified when the trash cans are full and be made aware of where the full cans are located.	Don't have the facilities at the moment	There is no tool available to determine the level of bins.	Frustrated
PS-2	Individual working for a private limited corporation	Get rid of the example of a surplus of waste	The trash cans are always filled	I occupy a metropolitan where there is a city is invariably crowd.	Worried

3. IDEATION & PROPOSED SOLUTION :

3.1 Empathy Map Canvas

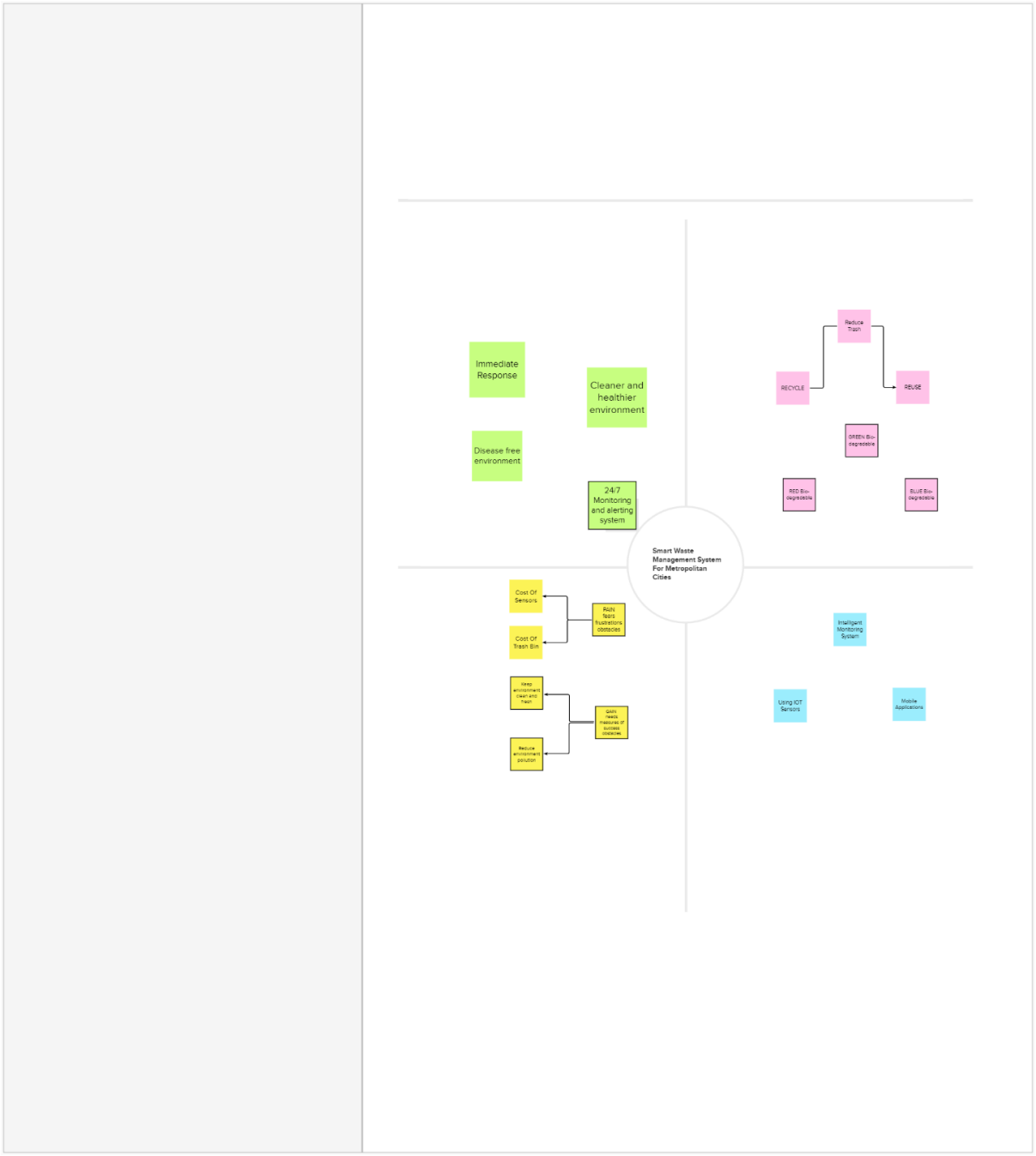
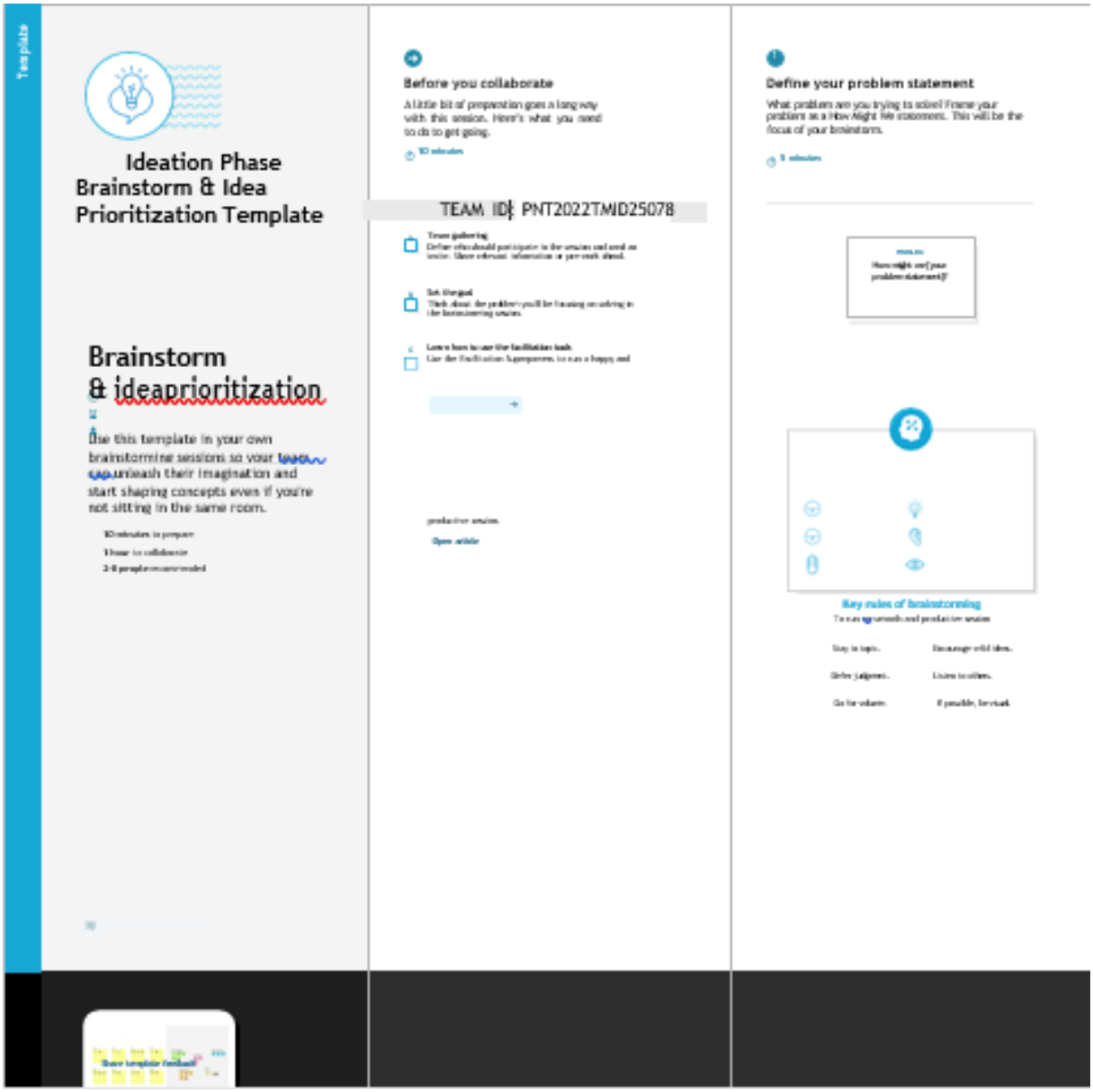
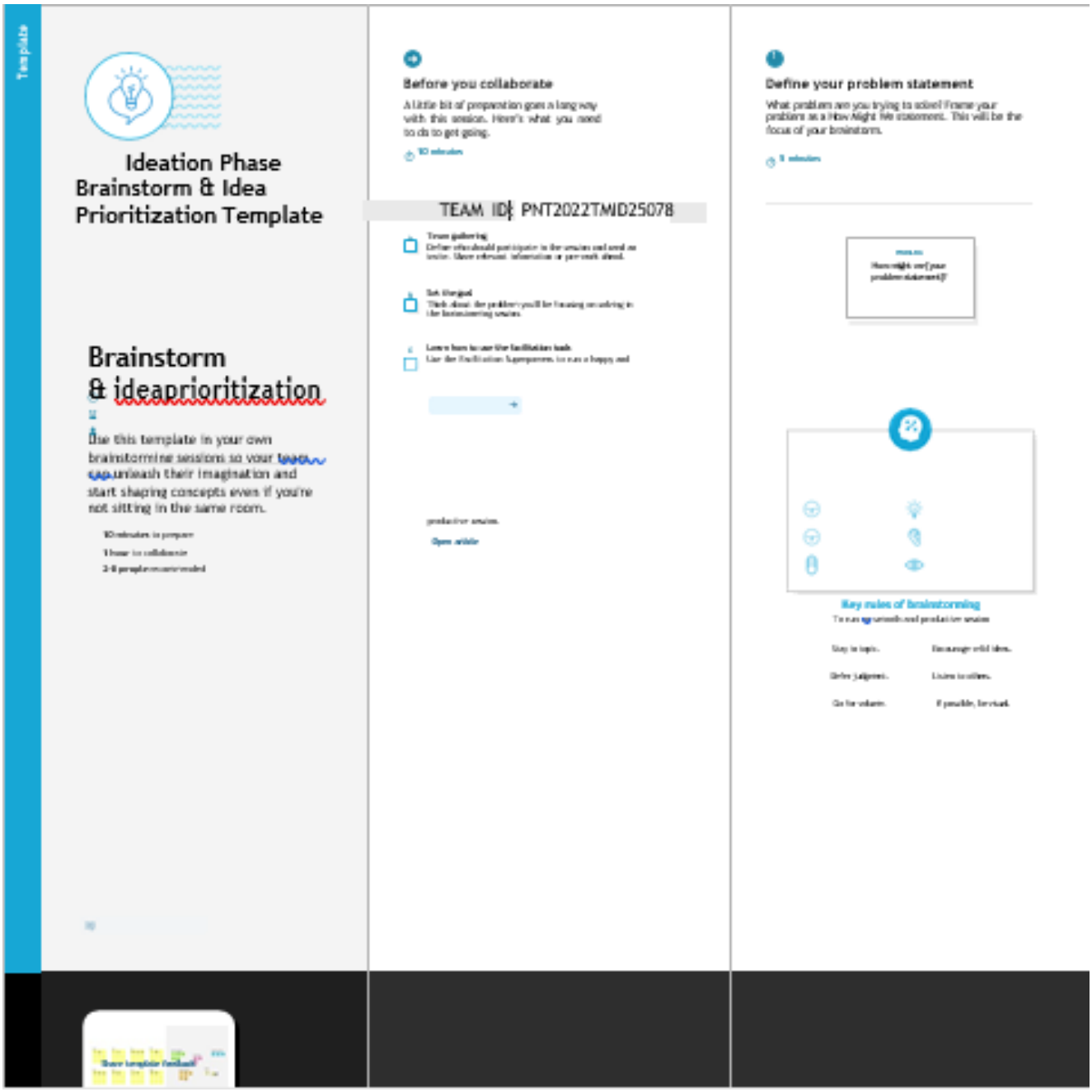


Figure 3.1.1 Empathy Map Canvas

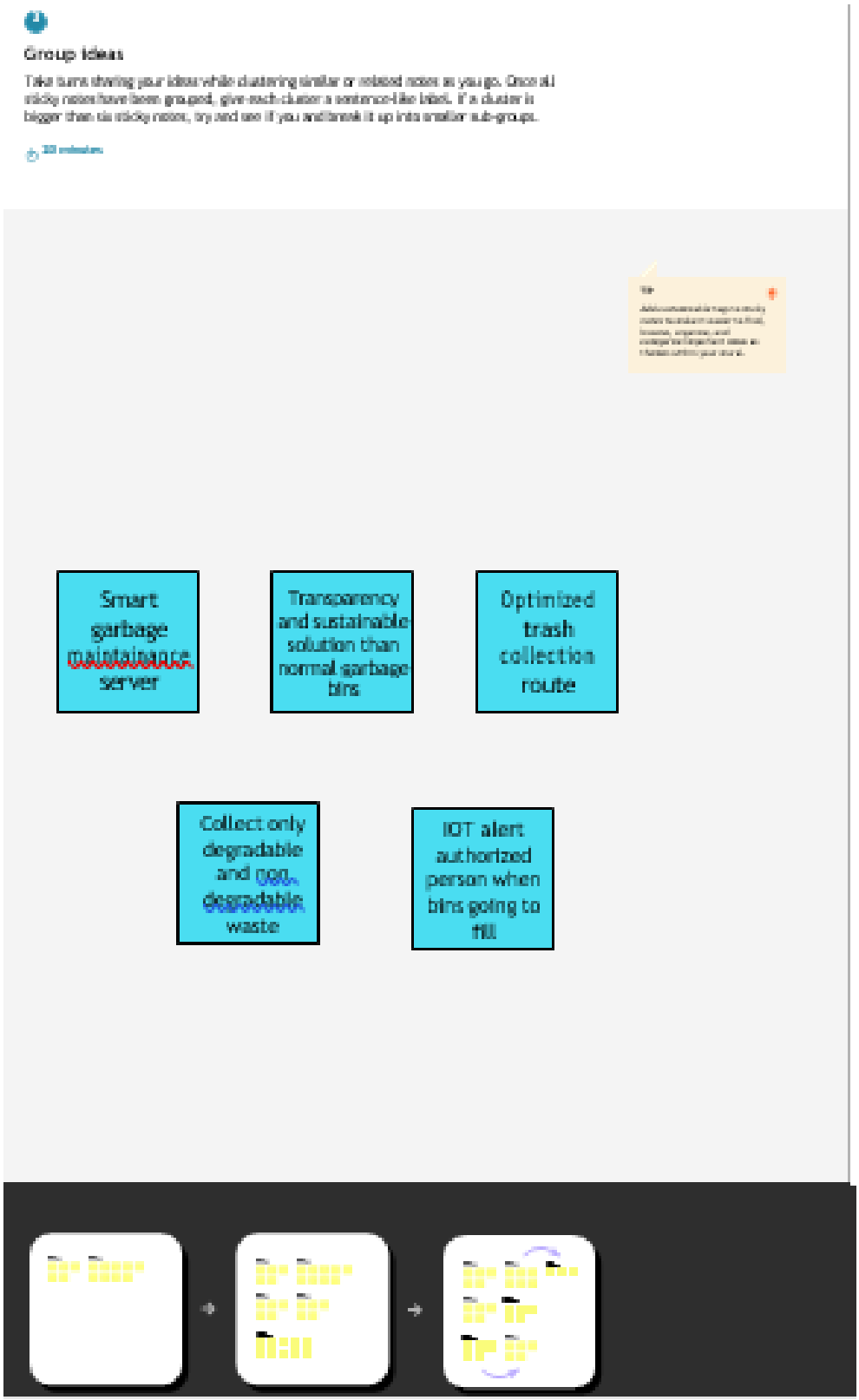
3.2 Ideation & Brainstorming



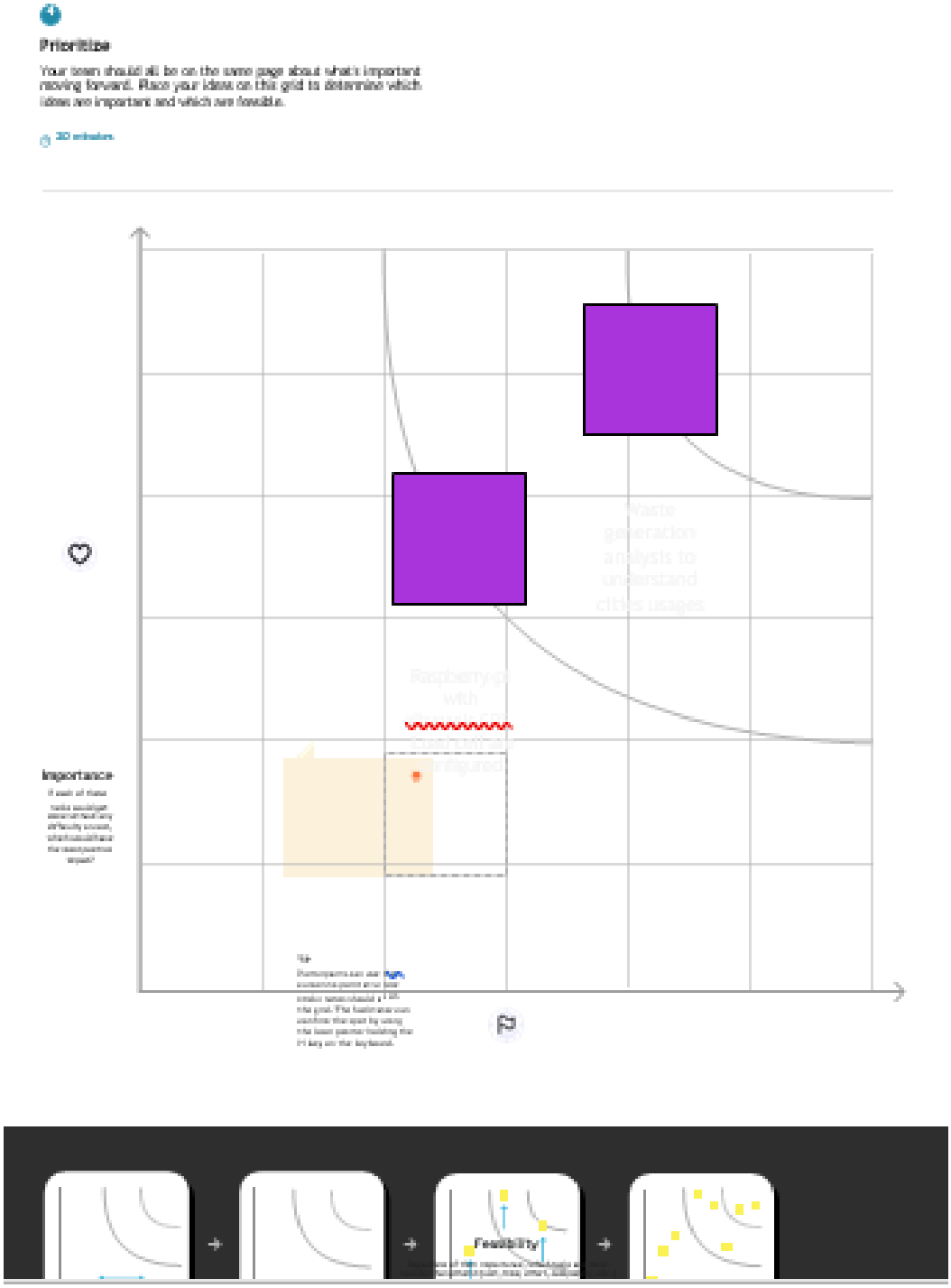
3.2.1 Figure deation & Brainstroming



3.2.2 Figure deation & Brainstroming



3.2.3 Figure deation & Brainstroming



3.2.4 Figure deation & Brainstroming

Figure 3.2.5 deation & Brainstroming

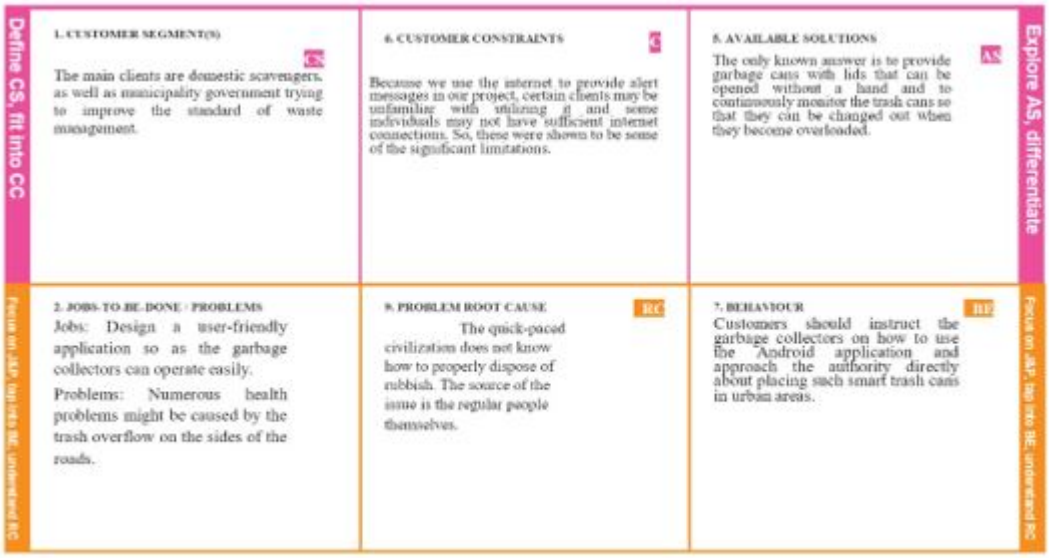
3.3 Proposed Solution

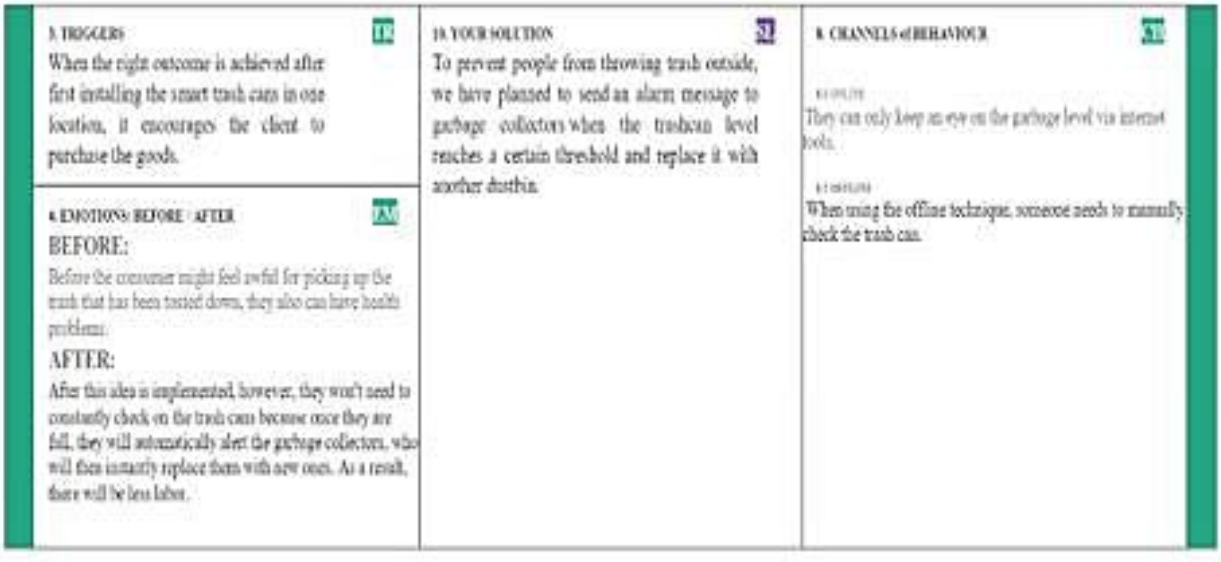
Table 3.3.1 Proposed Solution

S. No	Parameter	Description
1.	Problem Statement (Problem to be solved)	1. The manual monitoring of wastes in trash cans is a laborious operation that requires additional time, money, and human labor 2. Unsafe trash disposal is generating problems for people. 3. Bad odor all around the place from uncollected trash or rubbish.
2.	Idea / Solution description	1. This procedure uses a cloud connection and non-bio degradable wastes and an ultrasonic sensor to determine the level of a rubbish container 2. By developing an app, the company of a certain neighborhood inside a large metropolis will be able to check the trash cans to see if they are full or not.
3.	Novelty / Uniqueness	1. In contrast to the traditional ways for collecting trash cans, this strategy instructs us to utilize the transportation only when necessary. 2. Keeping an eye on the trash cans easier and less labor-intensive for humans.
4.	Social Impact / Customer Satisfaction	1. People can experience a clean atmosphere. 2. Reduces the amount of labor required from humans for waste disposal. 3. For a municipal corporation to monitor the cleanliness of different areas of the city, this proposal will be quite helpful.
5.	Business Model (Revenue Model)	1. By cutting back on unneeded transportation costs to pointless locations, this lowers a significant amount of fuel costs for city businesses. 2. This initiative intends to assist municipal corporation. 3. Provide a sanitary atmosphere.

3.4 Problem Solution fit

Table 3.4.1 Problem Solution Fit Solution Fit





4. REQUIREMENT ANALYSIS

4.1 Functional Requirements

Following are the functional requirements of the proposed solution.

Table 4.1.1 Following are the functional requirements of the proposed solution

	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Real time bin monitoring.	The Dashboard shows statistics on the amount of fill in bins as it is being tracked by smart sensors. The application also forecasts when the bin will fill up based on past data in addition to the percentage of fill level, which is one of the features that even the finest waste management software lacks. As picks are also recognized by the sensors, you can determine when the bin was last emptied. You can get rid of the overflowing bins and cease collecting half-empty ones using real-time data and forecasts.
FR-2	Eliminate inefficient picks.	Get rid of the collection of half-empty trash cans. Picks are recognized by sensors. We can demonstrate to you how full the bins you collect are using real-time data on fill-levels and pick recognition.
FR-3	Plan waste collection routes.	Route planning for rubbish pickup is semiautomated using the tool. You are prepared to act and arrange for garbage collection based on the levels of bin fill that are now present and forecasts of approaching capacity. To find any discrepancies, compare the planned and actual paths.
FR-4	Adjust bin distribution.	Ensure the best possible bin distribution. Determine which regions have a dense or sparse distribution of bins. Ensure that each form of waste has a representative stand. You can make any required adjustments to bin position or capacity based on past data.
FR-5	Expensive bins.	We assist you in locating containers that increase collection prices. The tool determines a collection cost rating for each bin. The tool takes local average depo-bin discharge into account. The tool determines the distance from depo-bin discharge and rates bins (1–10).
FR-6	Detailed bin inventory.	On the map, you can see every monitored bin and stand, and you can use Google Street View at any time to visit them. On the map, bins or stands appear as green, orange, or red circles. The Dashboard displays information about each bin, including its capacity, trash kind, most recent measurement, GPS position, and pick-up schedule.

4.2 Non-Functional requirements

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

Table 4.2.1 Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Usability is a unique and significant perspective to examine user needs, which may further enhance the design quality, according to IoT devices. Analyzing how well people interact with a product may help designers better understand customers' prospective demands for waste management, behavior, and experience in the design process when user experience is at the Centre.
NFR-2	**Security**	Utilize recyclable bottles. Utilize reusable shopping bags. Spend responsibly and recycle Eat and drink in limited-use containers.
NFR-3	**Reliability**	Creating improved working conditions for garbage collectors and drivers is another aspect of smart waste management. Waste collectors will use their time more effectively by attending to bins that require service rather than travelling the same collection routes and servicing empty bins.
NFR-4	**Performance**	The Smart Sensors assess the fill levels in bins (along with other data) numerous times each day using ultrasonic technology. The sensors feed data to Senone's Smart Waste Management Software System, a robust cloud-based platform with datadriven daily operations and a waste management app, using a variety of IoT networks (NB-IoT, GPRS). As a consequence, customers receive data-driven decision-making services, and garbage collection routes, frequency, and truck loads are optimized, resulting in at least a 30% decrease in route length.
NFR-5	**Availability**	By creating and implementing robust hardware and gorgeous software, we enable cities, companies, and nations to manage garbage more intelligently.
NFR-6	**Scalability**	Using smart trash bins allows us to scale up and monitor the rubbish more efficiently while also reducing the number of bins needed in towns and cities.

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.

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:

a. The first test conducted is the situation where the garbage bin is empty or its garbage level is very low

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

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

d. The second notification SMS sent by the system, indicating that bin is at least 95% full and **the garbage needs to be collected immediately**

e. Locations prone to overflow

f. The number of bins needed to avoid overflowing waste

g. The number of collection services that could be saved

h. The amount of fuel that could be saved

i. The driving distance that could be saved

5.1 DATA FLOW DIAGRAM:

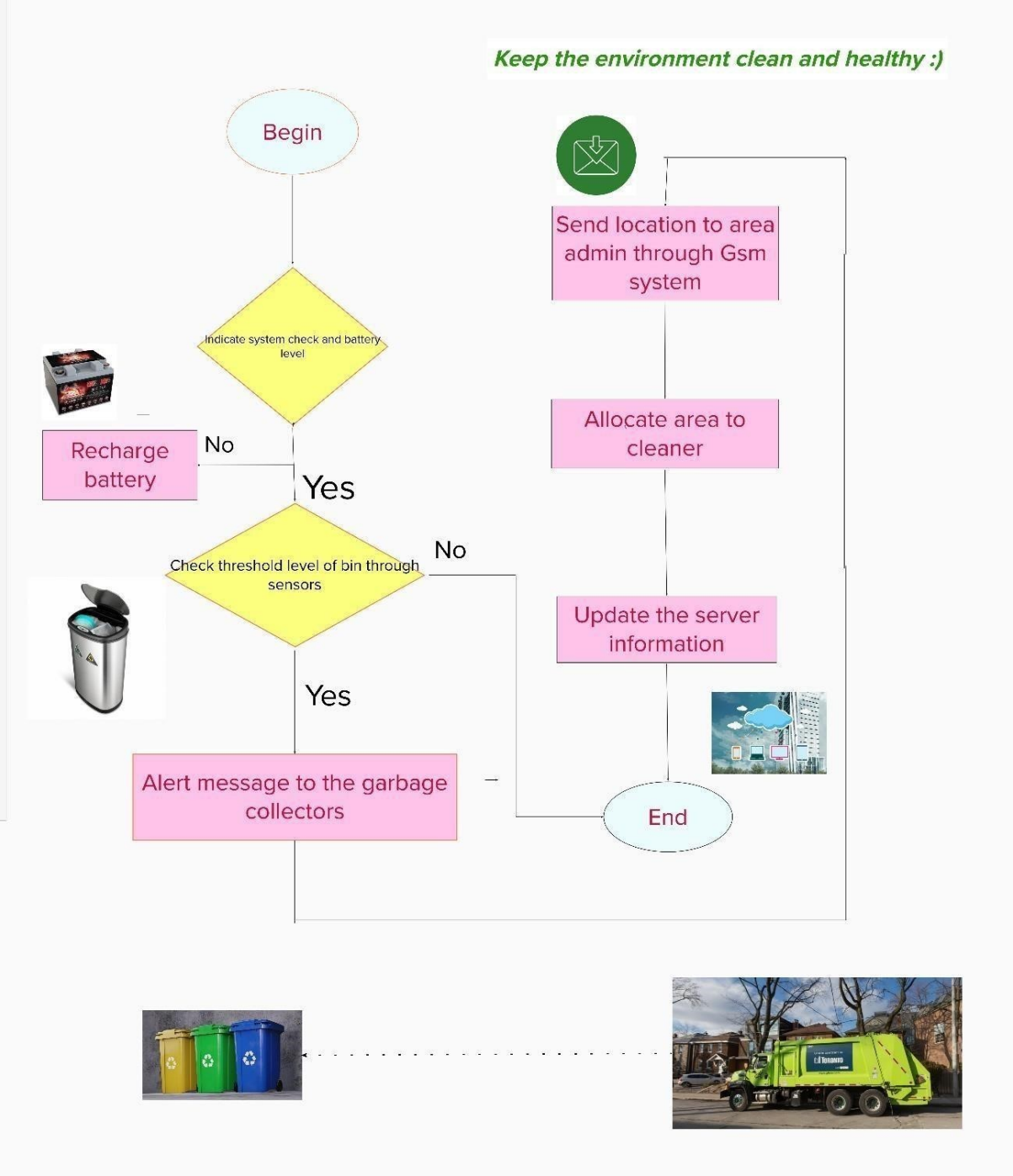


Figure 5.1.1 Data Flow Diagram

5.2 Solution & Technical Architecture

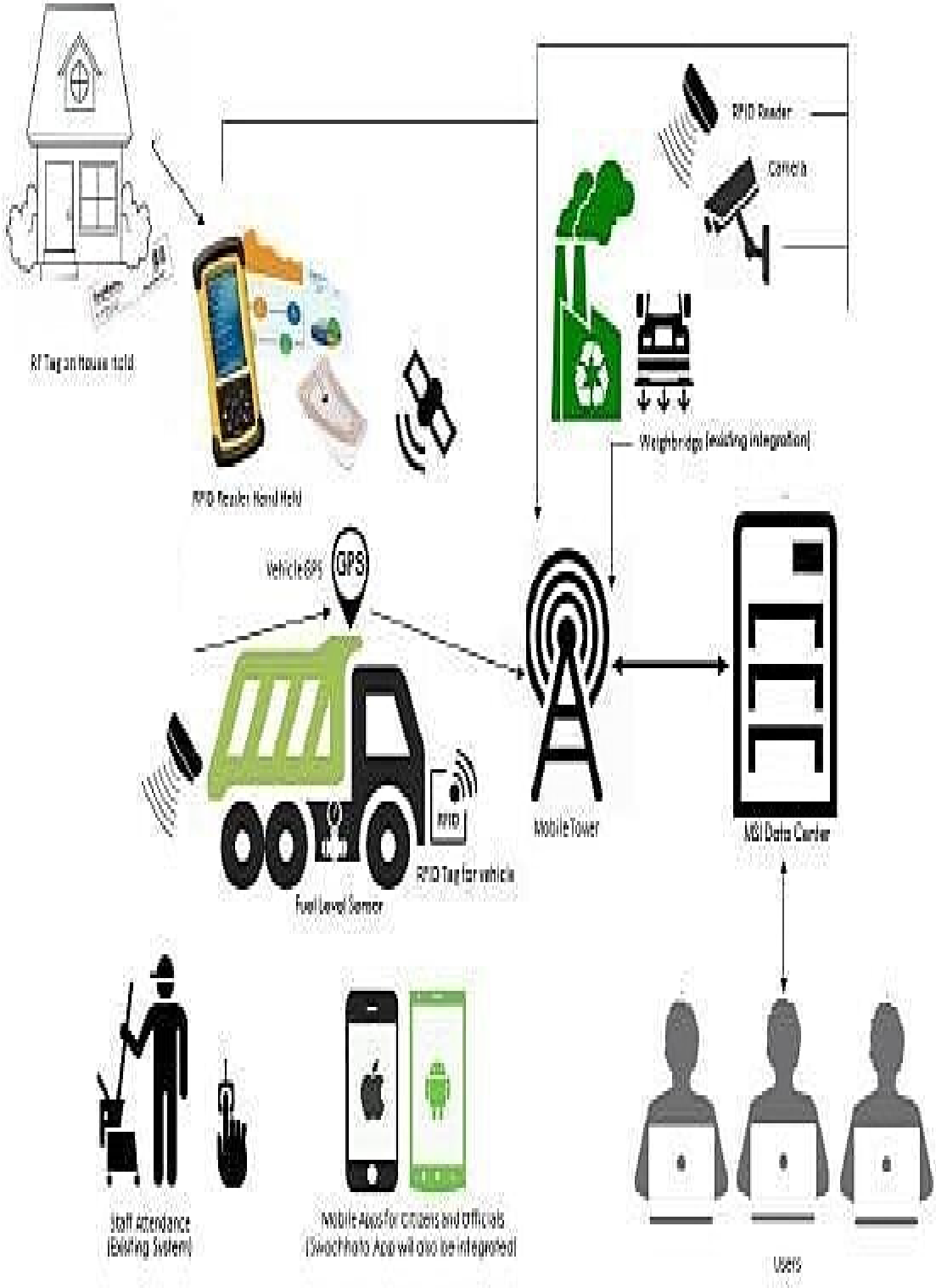


Figure 5.2.1 Solution & Technical Architecture

Table-1: Components & Technologies:

Table 5.2.2 Components & Technology

S.no	Component	Description	Technology
1.	User Interface	Mobile Application	HTML, CSS, JavaScript.
2.	Application Logic	Logic for a process in the application	Java
3.	Database	Data Type, Configurations etc.	MySQL
4.	Cloud Database	Database Service on Cloud	IBM Cloud
5.	File Storage	File storage requirements	Local Filesystem and IBM cloud
6.	Infrastructure (Server / Cloud)	Application Deployment on Cloud Local Server Configuration	Local and Cloud Foundry

Table-2: Application Characteristics:

Table 5.2.3 Components & Technology

S.no	Characteristics	Description	Technology
1.	Open-Source Frameworks	GitHub	Internet hosting service
2.	Security Implementations	Application security: Veracode.	Network automation
3.	Scalable Architecture	It provides the room for expansion more database of smart bins added additionally can be updated.	Cloud storage
4.	Availability	As the system control is connected to web server it is available 24*7 and can be accessed whenever needed.	Server
5.	Performance	Performance is high it uses 5mb caches	Wireless Sensor Network

5.3 User Stories

Use the below template to list all the user stories for the product.

Table 5.3.1 Use the below template to list all the user stories for the product.

-

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Admin	Login	USN-1	As an administrator, I assigned user names and passwords to each employee and managed them.	I can control my online account and dashboard.	Medium	Sprint-1
Co-Admin	Login	USN-2	As a Co-Admin, I'll control the waste level monitor. If a garbage filling alert occurs, I will notify the trash truck of the location and rubbish ID.	I can handle the waste collection.	High	Sprint-1
Truck Driver	Login	USN-3	As a Truck Driver, I'll follow Co Admin's instruction to reach the filled garbage.	I can take the shortest path to reach the waste filled route specified.	Medium	Sprint-2
Local Garbage Collector	Login	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	I can collect the trach, pull it to the truck, and send it out.	Medium	Sprint-3
Municipali ty officer	Login	USN-5	As a Municipality officer, I'll make sure everything is proceeding as planned and without any problems.	All of these processes are under my control.	High	Sprint-4

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.	29th AUGUST 2022
Prepare Empathy Map	Prepare Empathy Map Canvas to capture the user Pains & Gains, Prepare list of problem statements	6 SEPTEMBER 2022
Ideation	List the by organizing the brainstorming session and prioritize the top 3 ideas based on the feasibility & importance.	12 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.	24 SEPTEMBER 2022
Solution Architecture	Prepare solution architecture document.	30 SEPTEMBER 2022

Table 6.1.1 Sprint Planning & Estimation

6.2Sprint Delivery Schedule

Table 6.2.1 Sprint Delivery Schedule

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Use the below template to create product backlog and sprint schedule

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Software setup and database collection	USN-1	Initial setup of software required to build the project and database collection.	20	High	Akshaya M
Sprint-2	Establishing connections of ESP module with other sensors required	USN-2	Software connections of ESP module with other required sensors.	20	High	Akshaya E
Sprint-3	Cloud and IOT Watson setup	USN-3	Establishing cloud setup to fetch database and connecting with IOT Watson platform.	20	High	Arivumozhi S G
Sprint-4	Software Testing	USN-4	Finally, testing the output of project through software simulation.	20	High	Kiruthika J

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		29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022		05 Nov 2022

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-3	20	6 Days	07 Nov 2022	12 Nov 2022		12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022		19 Nov 2022

Velocity:

Average velocity for Sprint:

AV= 20/6=3.3

6.3 Reports from JIRA

Figure 6.3.1 Reports from JIIRA

Jira Software Screenshots:

ROADMAP

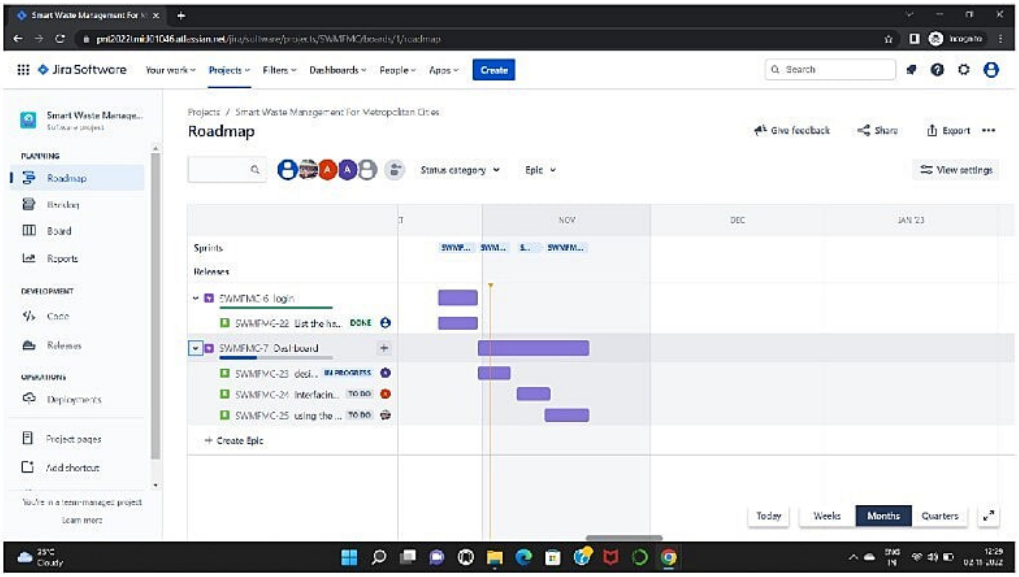
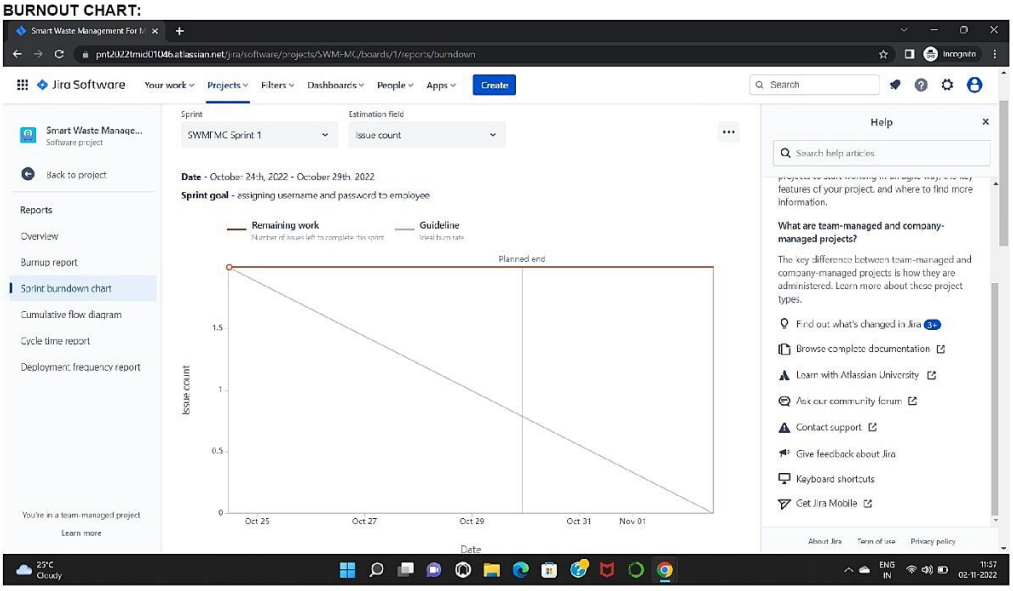


Figure 6.3.2 Reports from JIIR

BURNOUT CHART:



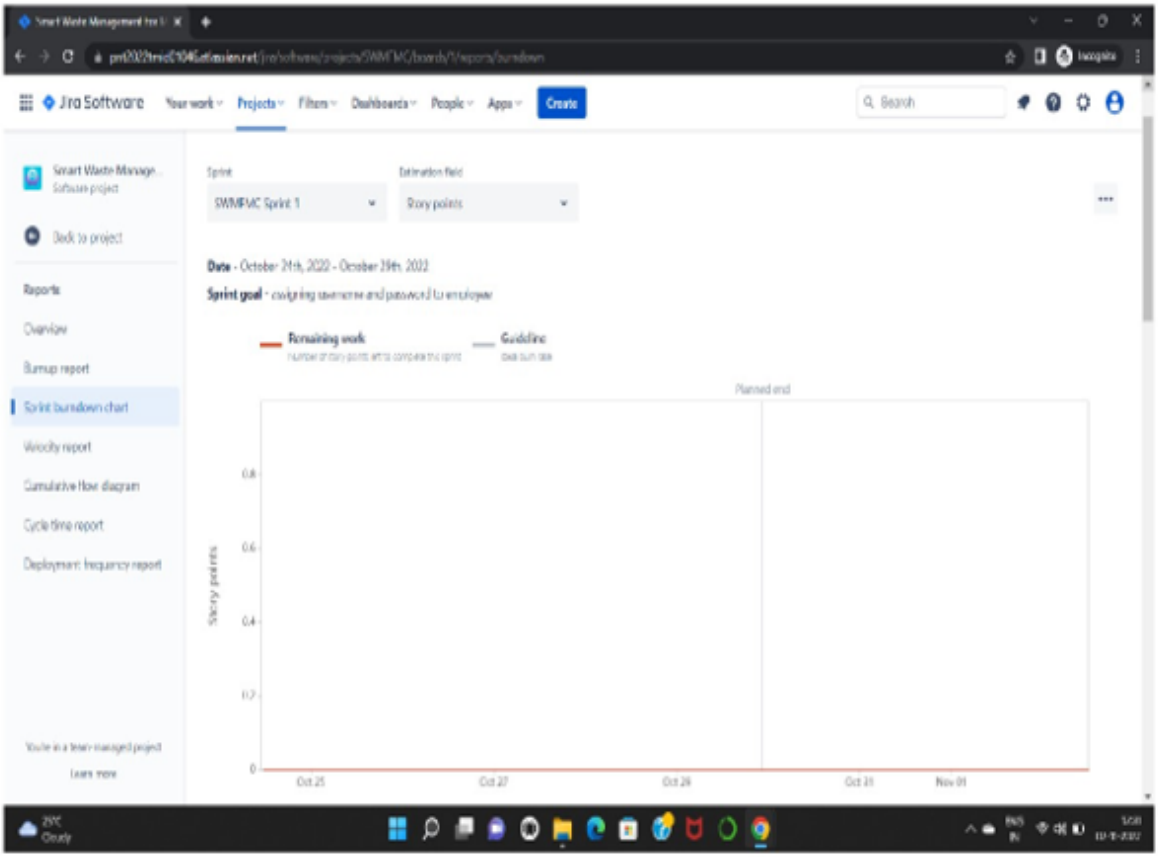


Figure 6.3.3 Reports from JIIRA

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

7.1 Feature 1 – location tracker

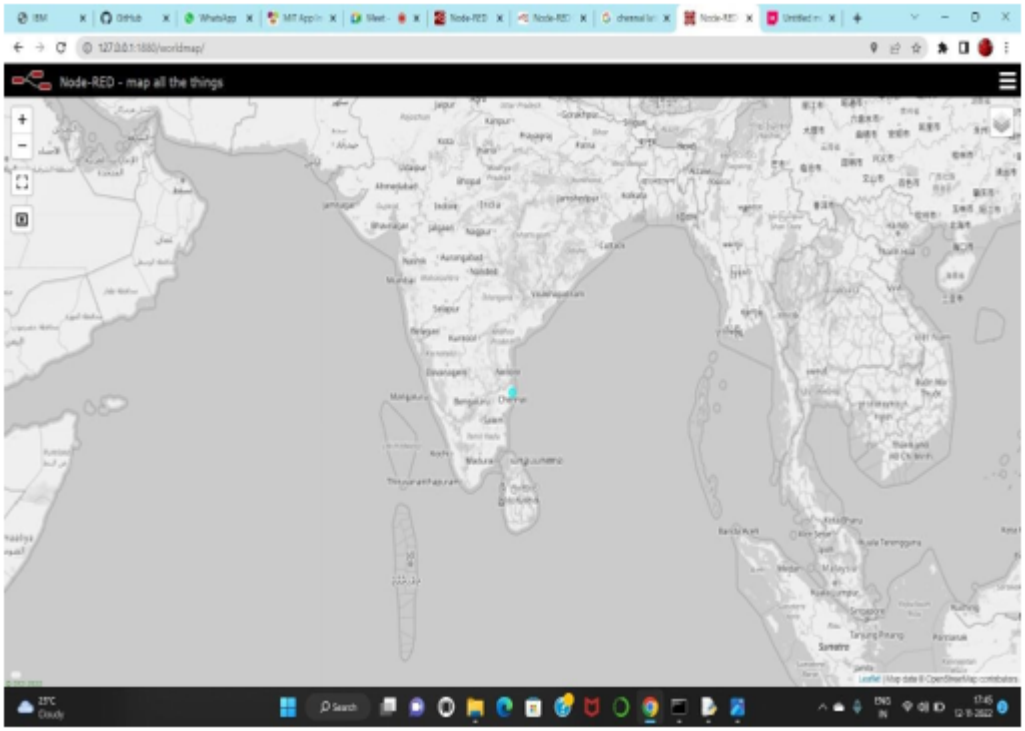


Figure 7.1.1 Location Tracker

7.2 Feature 2 - Live Update On Collected Data

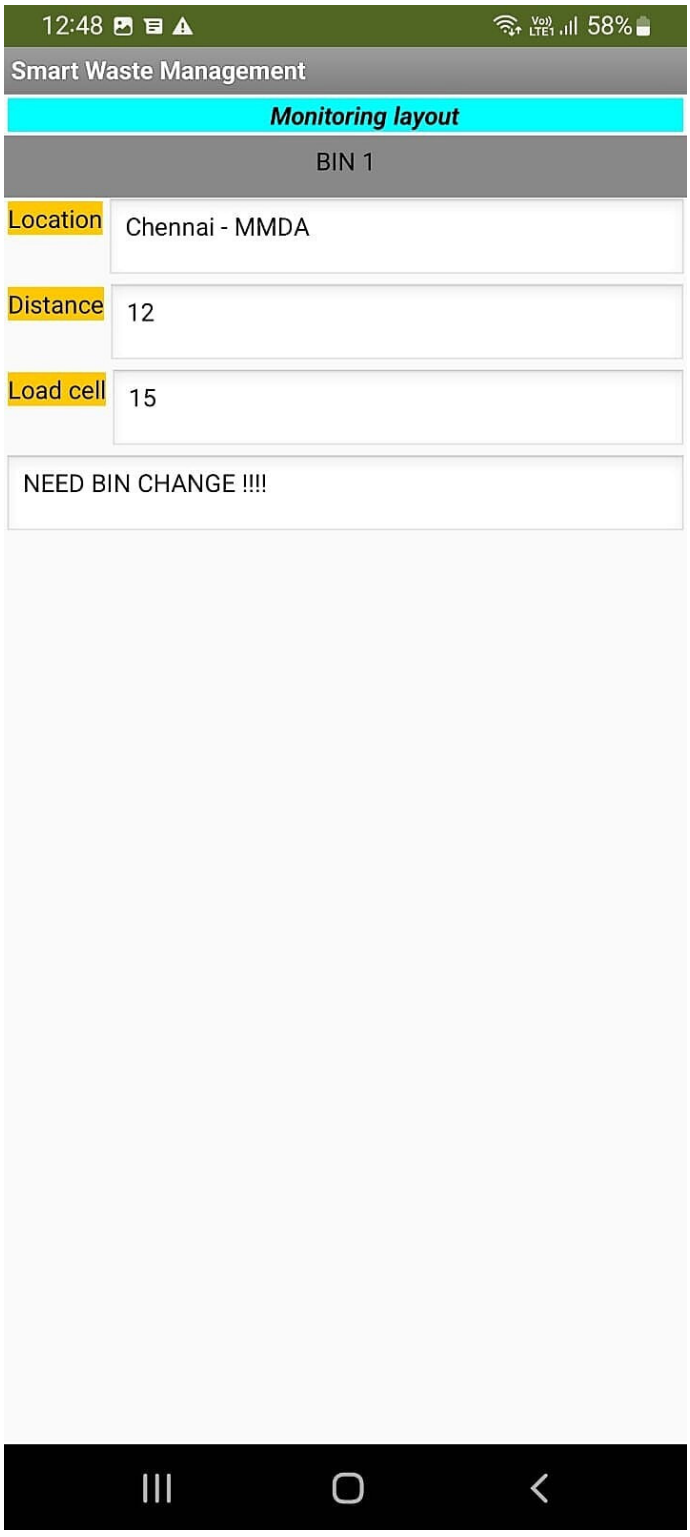
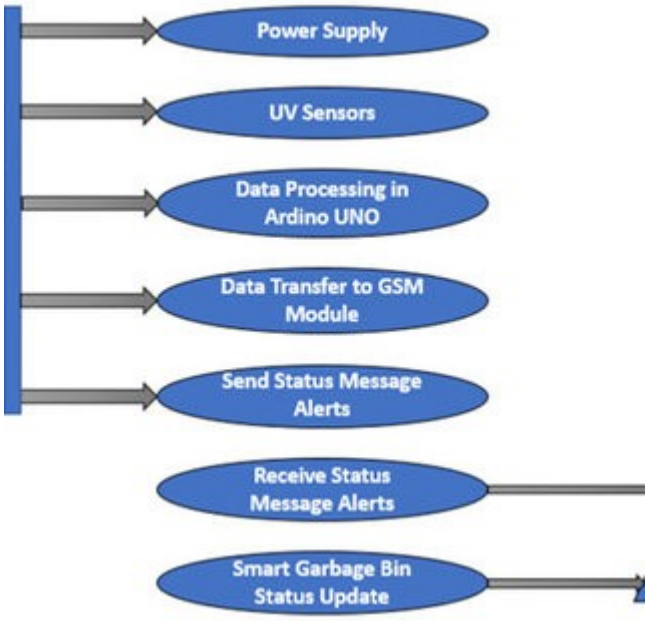


Figure 7.2.1 Live Update On Collected Data

8.TESTING

8.1TESTING CASES:

Figure 8.1.1 TESTING CASES



Test case description	Required input	Information and related requirements	Test case status indicating pass or fail
The user or concerned service provider should register with the required details	User input details for registration	User Name, Email ID, Phone Number, and Security Password	Pass
The user or concerned service provider tried to log in to the monitoring portal with registered details	User login details	User Name, Security Password	Pass or Fail
Monitoring website portal indicating home, user, SGB status	User monitoring home screen should be display	The developed prototype for Smart Garbage Bin must be kept 'ON.'	Pass

Figure 8.1.2 TESTING CASES

8.2 User Acceptance Testing

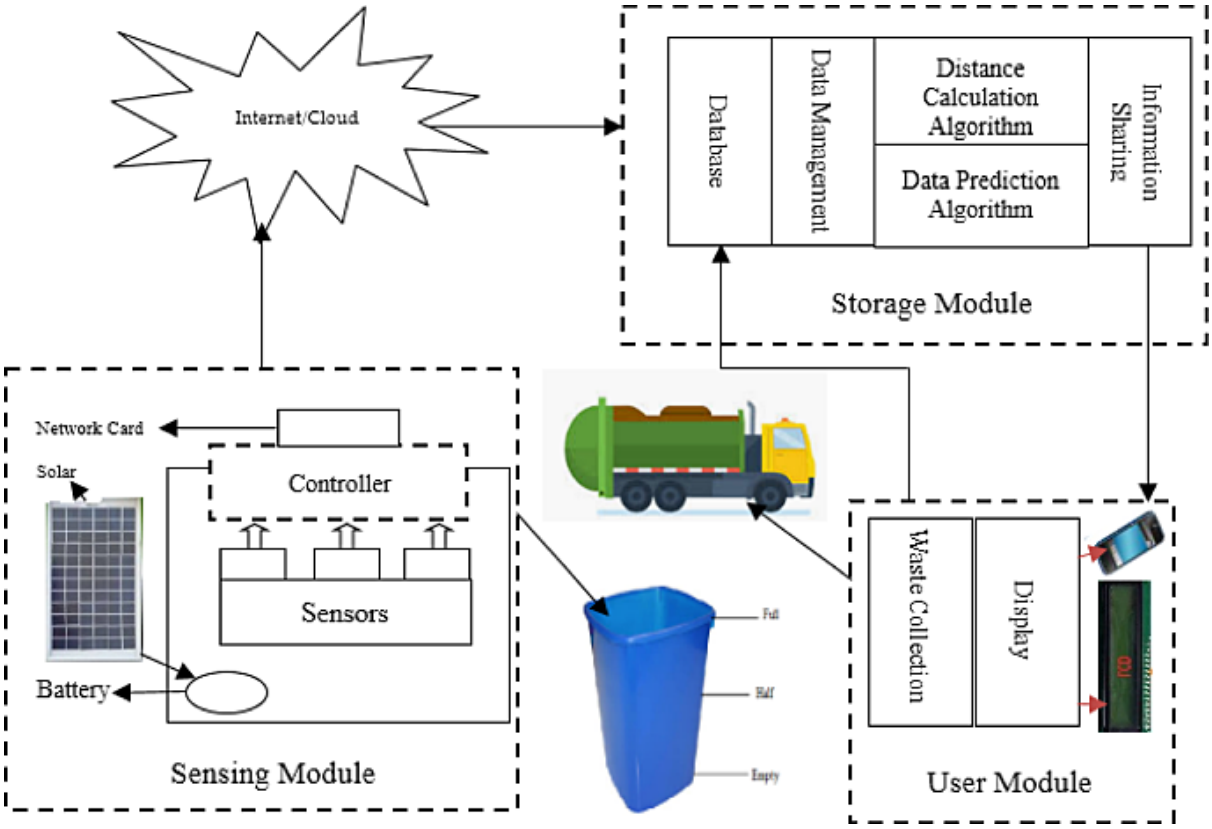


Figure 8.2.1 User Acceptance Testing

9. RESULTS

9.1 Performance Metrics

Figure 9.1.1 Performance Metrics

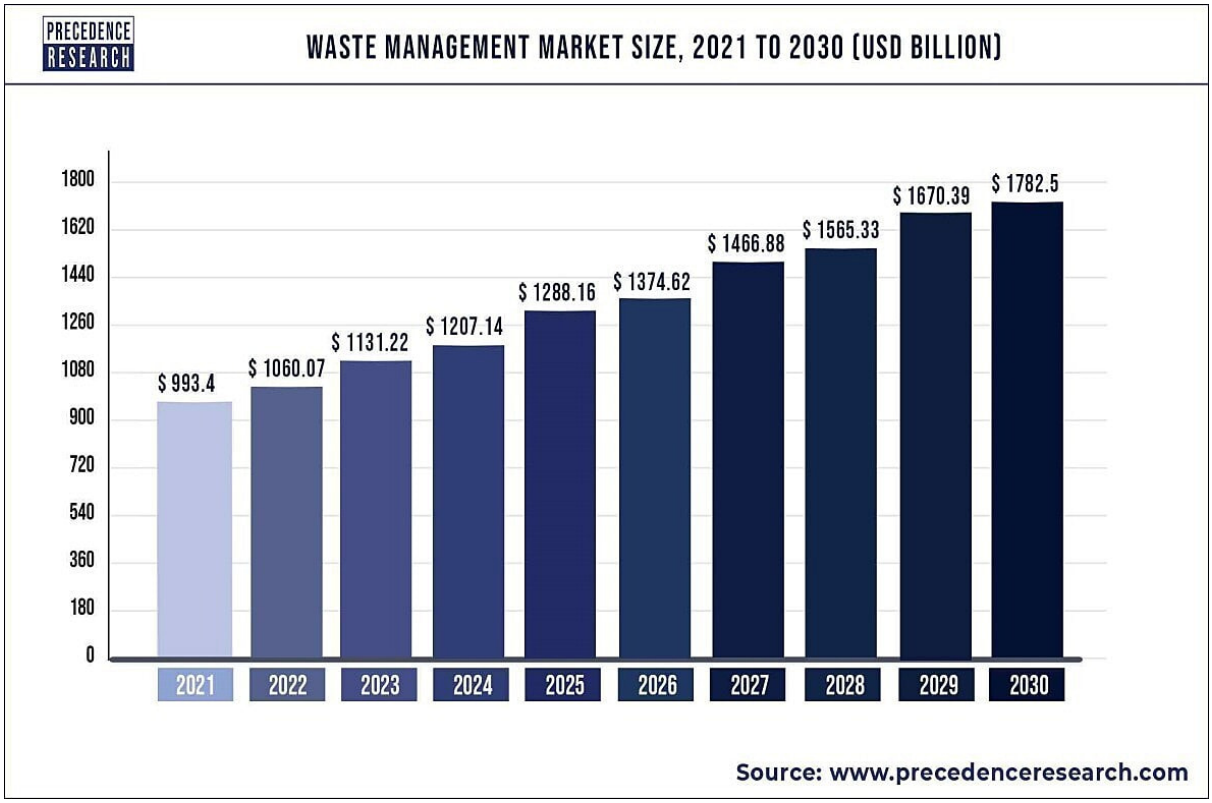


Figure 9.1.2 Performance Metrics

10.ADVANTAGES & DISADVANTAGES

ADVANTAGES :

1. Time Saving
2. Cost Saving
3. Sustainability
4. Improving efficiency
5. Transparency
6. Meet the increasing demand for sustainable solution

DISADVANTAGES:

1. Process is not always cost-effective.
2. The resultant product has a short life
3. Needs More Global Buy-In
4. The sites are often dangerous
5. Sensor nodes used in the dustbins have limited memory size.
6. **It** is related to the usage of the ultrasonic sensor. Trash is non-uniformly distributed inside the container. Simple distance measurement leads to false fill level measurement. Although several software procedures were proposed to increase the accuracy of this sensor, unfortunately, results remain poor. By using multiple sensors, the fill level can be determined more precisely, however, the cost of the system also increases. So, this is usually not a commercially preferred solution.
7. The current solution is that it is partial and incomplete. The waste management cycle starts with the garbage being produced, then it gets disposed at the local trash bins or other garbage collection points. Afterward, it is being collected by a garbage collecting company and brought to garbage depot where it is being sorted and sent for recycling, destruction (burning), or storage. Complete waste management should be involved in trash bin fill level measurement, route optimization of the trucks, and contribution to the recycling process by easing out the sorting process, which is currently manual and slow. Current smart waste management services do not offer any solution with regard to the recycling process.

11. CONCLUSION

In the system advocated above, the fusion of sensors, identification technology, and internet connectivity will lead to a uniquely smart disposal trash bin. Together with the cloud, these trash bins would become irreplaceable elements in the waste management cycle where the collection, transportation, storage, and recycling of waste could be automated. The use of RFID technology in waste collection services not only increases the efficiency of waste management through automation but also increases environmental responsibility which is one of the pillars of the Metropolitan City.

12. FUTURE SCOPE:

1. The moisture sensor can be implemented hand in hand with the other sensors and the compartments for segregating the dry and wet waste can be created which will solve the issues related to waste segregation.

2.There are four tiers to waste management to reduce its environmental impact: pollution prevention and source reduction; reuse or redistribution of unwanted, surplus materials; treatment, reclamation, and recycling of materials within the waste; and disposal through incineration, treatment, or land burial.

3.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.

4.Total of approximately 143,449 MT of municipal waste is generated daily. However, only 35,062 tons of waste is treated. A report from MNRE says that **waste generation is expected to reach 300 million tons annually by the year 2047**.

13. APPENDIX

Source code:

```
#include  <cstdlib>
#include  <time.h>
#include<WiFi.h> #include
<PubSubClient.h>#define
ORG "zuhtbq"
#define DEVICE_TYPE
"Rasp"#define DEVICE_ID
"12345"
#define TOKEN "12345678"
#definespeed 0.034
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";
char publishTopic[] = "iot-2/evt/data/fmt/json";
char authMethod[] = "use-token-auth";
char token[]= TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
WiFiClient wifiClient;
PubSubClient client(server, 1883, wifiClient);
int weight= 0;
String location = "Coimbatore";
String status = "";
void setup() {
Serial.begin(99900);
wifiConnect();
mqttConnect();
}
void loop() {
srand(time(0));
int p;
weight = random(0,80);
if(weight > 0 && weight <
25){p = 0;
}
else if(weight > 25 && weight
< 50){p = 1;
}
else{
p = 2;
```

```
}
switch (p)
{case 0:
status =
"Low";break;
case 1:
status =
"Half";break;
case 2:
status =
"Full";break;
}
String payload = "{";
payload+="\"Weight
\":"; payload+=weight;
payload+=",";
payload+="\"Loaction\
":";
payload+="Coimbatore
"; payload+=",";
payload+="\"Status\":\""+status+"\
"}";Serial.println(payload);
if(client.publish(publishTopic, (char*) payload.c_str()))
{
Serial.println("Publish OK");
}
else{
Serial.println("Publish failed");
}
delay(1000);
if (!client.loop())
{
mqttConnect();
}
}
```

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

OUTPUT:

Figure output: 13.1.1

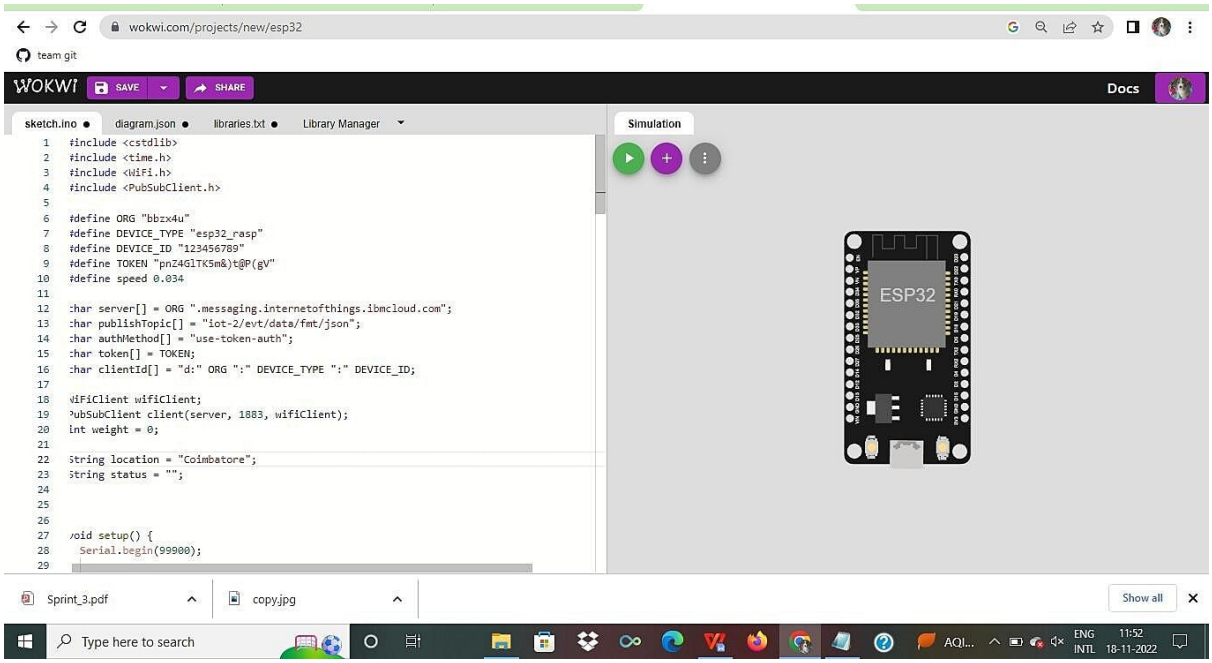


Figure output: 13.1.2

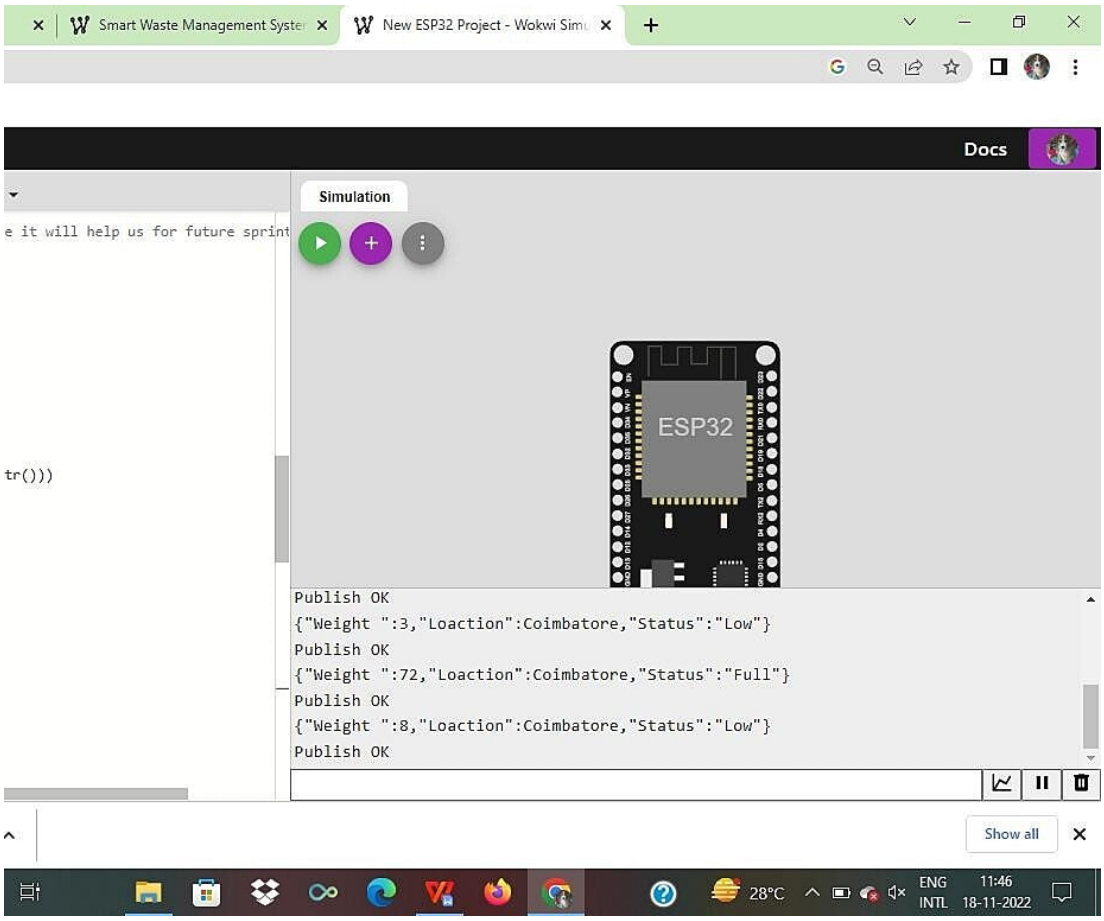
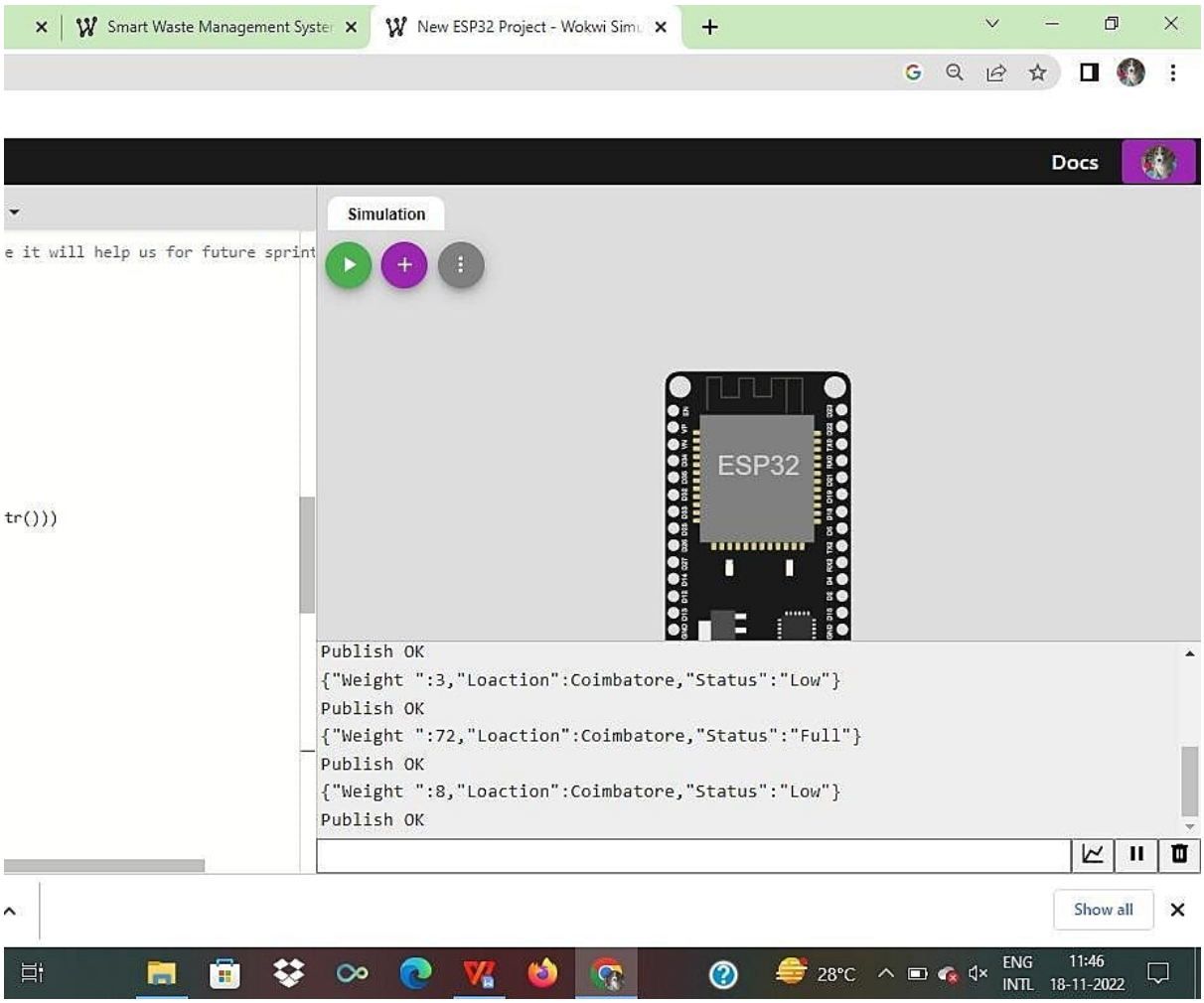
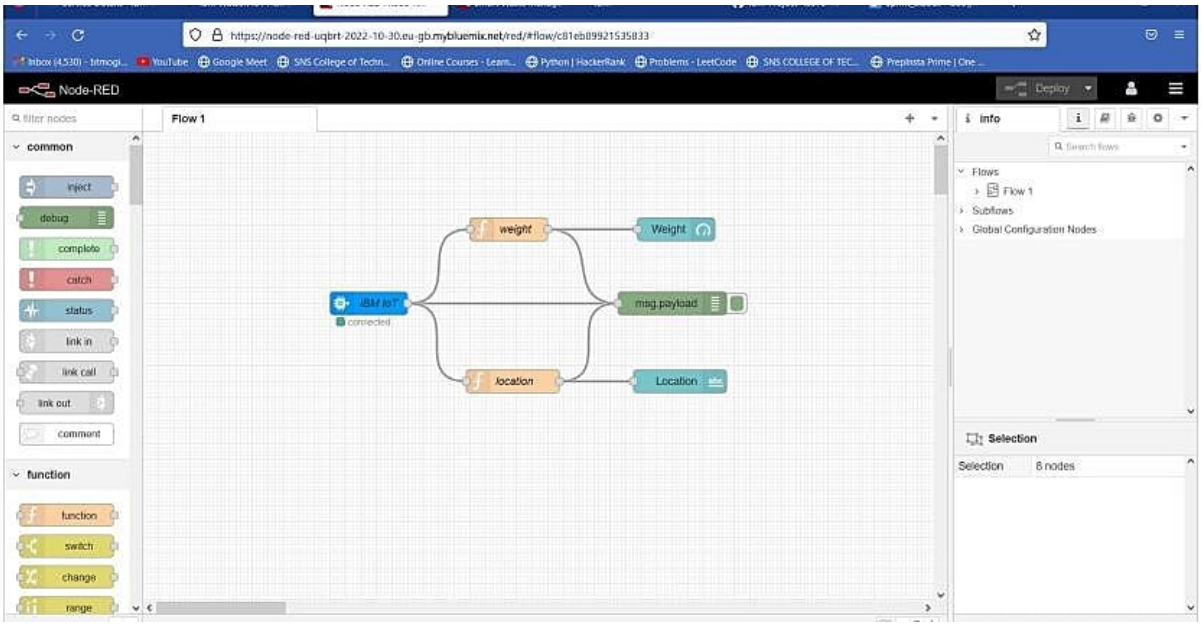


Figure output: 13.1.3



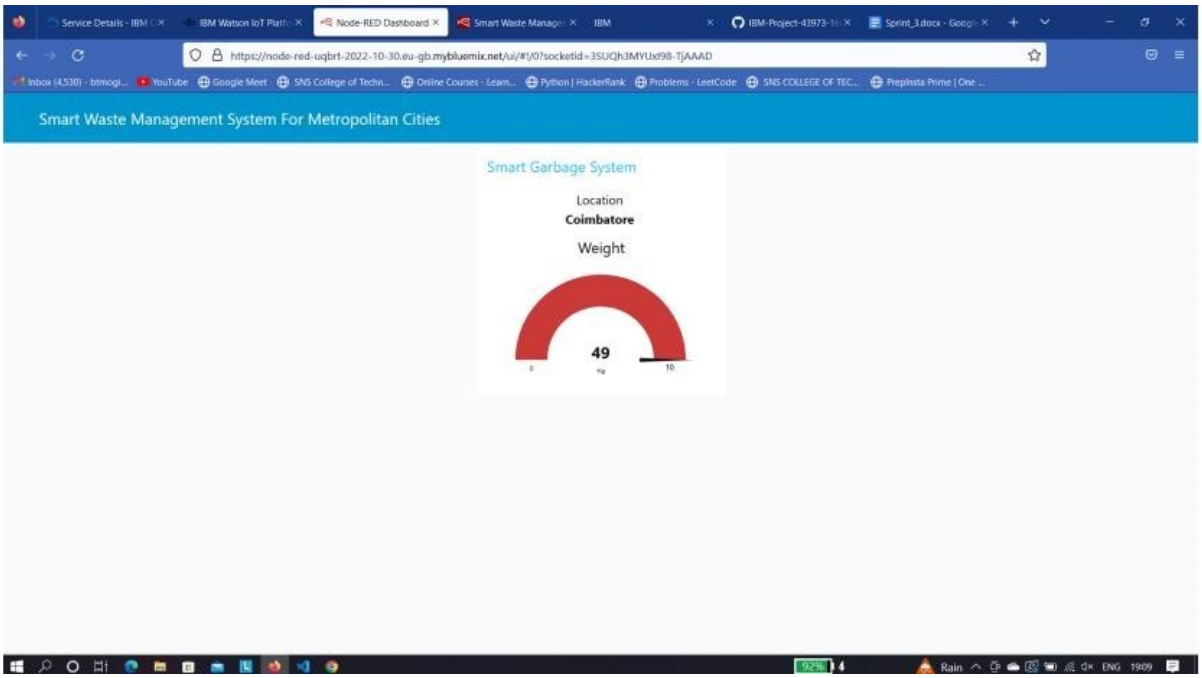
NODE - RED CONNECTION:

Figure output: 13.1.4



WEB UI:

Figure output: 13.1.5



HTML CODE :

```
<!DOCTYPE html>
<html lang="en">
 <head>
  <meta charset="UTF-8" />
  <meta name="viewport" content="width=device-width, initial-scale=1.0" />
  <title>Smart Waste Management System</title>
<!-- Bootstrap 4 CSS CDN -->
  <link rel="stylesheet" href="https://cdnjs.cloudflare.com/ajax/libs/twitter-
   bootstrap/4.5.2/css/bootstrap.min.css" /> <!-- Fontawesome CSS CDN -->
  <link rel="stylesheet" href="https://cdnjs.cloudflare.com/ajax/libs/font-
  awesome/5.14.0/css/all.min.css" />
  <link rel="stylesheet" href="css/style.css" />
 </head>
 <body class="bg-info">
  <div class="container">
<!-- Login Form Start -->
   <div class="row justify-content-center wrapper" id="login-box">
    <div class="col-lg-10 my-automyShadow">
     <div class="row">
      <div class="col-lg-7 bg-whitep-4">
       <h1 class="text-center font-weight-bold text-primary">Sign in</h1>
       <hr class="my-3" />
       <form action="#" method="post" class="px-3" id="login-form">
<div class="input-group input-group-lg form-group">
<div class="input-group-prepend">
<span class="input-group-text rounded-0"><i class="far fa-envelope fa-lg fa-
fw"></i></span> </div>
<input type="email" id="email" name="email" class="form-control rounded-0"
```

```
placeholder="E-Mail"required /> </div>
<div class="input-group input-group-lg form-group">

<div class="input-group-prepend">
<spanclass="input-group-text rounded-0"><i class="fas fa-key fa-lg fa-fw"></i></span>
</div>
        <input type="password" id="password" name="password" class="form-
control rounded-0" minlength="5" placeholder="Password" required
autocomplete="off"/>
</div>
<div class="form-group clearfix">
<div class="custom-control custom-checkbox float-left">
<input type="checkbox" class="custom-control-input" id="customCheck" name="rem"
/>
<label class="custom-control-label" for="customCheck">Remember me</label> </div>
<div class="forgot float-right">
<a href="#" id="forgot-link">Forgot Password?</a> </div>
</div>
<div class="form-group">
<input type="submit" id="login-btn" value="Sign In" class="btn btn-primary btn-lg btn-
block myBtn" />
</div>
      </form>
     </div>
     <div class="col-lg-5 d-flex flex-column justify-content-center
      myColor p-4"> <h1 class="text-center font-weight-bold text-
      white">Welcome Friend!</h1>
      <hr class="my-3 bg-lightmyHr" />
      <p class="text-center font-weight-bolder text-light lead">Start your initiative to
      make your environment clean</p>
      <button class="btn btn-outline-light btn-lg align-self-center font-weight-bolder mt-4
      myLinkBtn" id="register-link">Sign Up</button>
     </div>
    </div>
   </div>
```

```
        </div>
<!-- LoginForm End -->
        <!-- Registration Form Start -->
        <div class="row justify-content-center wrapper" id="register-box" style="display:
        none;">
         <div class="col-lg-10 my-automyShadow">
          <div class="row">
           <div class="col-lg-5 d-flex flex-column justify-content-center myColorp-4">
            <h1 class="text-center font-weight-bold text-white">Welcome Back!</h1>
            <hr class="my-4 bg-light myHr" />
            <p class="text-center font-weight-bolder text-light lead">To stay connected
            Pleaselogin with your personal info.</p>
            <button class="btn btn-outline-light btn-lg font-weight-bolder mt-4 align-self-center
            myLinkBtn" id="login-link">Sign In</button>
           </div>
           <div class="col-lg-7 bg-whitep-4">
            <h1 class="text-center font-weight-bold text-primary">CreateAccount</h1>
            <hr class="my-3" />
            <form action="#" method="post" class="px-3" id="register-form">
    <div class="input-group input-group-lg form-group">
    <divclass="input-group-prepend">
    <spanclass="input-group-text rounded-0"><i class="far fa-user fa-lg fa-fw"></i></span>
    </div>

    <input type="text" id="name" name="name" class="form-control rounded-0"
    placeholder="Full Name" required/> </div>
    <div class="input-group input-group-lg form-group">
    <div class="input-group-prepend">
    <spanclass="input-group-text rounded-0"><i class="far fa-envelope fa-lg fa-
    fw"></i></span> </div>
    <input type="email" id="remail" name="email" class="form-control rounded-0"
    placeholder="E-Mail"required /> </div>
    <div class="input-group input-group-lg form-group">
```

```
<div class="input-group-prepend">
<span class="input-group-text rounded-0"><i class="fas fa-key fa-lg fa-fw"></i></span>
</div>
        <input type="password" id="rpassword" name="password" class="form-
control rounded-0" minlength="5" placeholder="Password" required />
</div>
<div class="input-group input-group-lg form-group">
<divclass="input-group-prepend">
<span class="input-group-text rounded-0"><i class="fas fa-key fa-lg fa-fw"></i></span>
</div>
        <input type="password" id="cpassword" name="cpassword" class="form-control
rounded-0" minlength="5" placeholder="ConfirmPassword" required />
</div>
<div class="form-group">
<div id="passError" class="text-danger font-weight-bolder"></div>
</div>
<div class="form-group">
<input type="submit" id="register-btn" value="Sign Up" class="btn btn-primary btn-lg btn-block
myBtn" />
</div>
        </form>
       </div>
      </div>
     </div>
    </div>
<!-- Registration Form End -->
            <!-- ForgotPassword Form Start -->
            <div class="row justify-content-center wrapper" id="forgot-box"
            style="display: none;">
             <div class="col-lg-10 my-automyShadow">
              <div class="row">
               <div class="col-lg-7 bg-whitep-4">
                <h1 class="text-center font-weight-bold text-primary">ForgotYour
                Password?</h1>
                <hr class="my-3" />
```

```
        <p class="lead text-center text-secondary">To reset your password, enter the registered e-mail adddress and we will send you password reset instructions on your e-mail!</p>
        <form action="#" method="post" class="px-3" id="forgot-form">
<divid="forgotAlert"></div>
<div class="input-group input-group-lg form-group">
<div class="input-group-prepend">
<span class="input-group-text rounded-0"><i class="far fa-envelope fa-lg"></i></span> </div>
<input type="email" id="femail" name="email" class="form-control rounded-0" placeholder="E-Mail"required />
</div>
<divclass="form-group">
<input type="submit" id="forgot-btn" value="Reset Password" class="btn btn-primary btn-lg btn-block myBtn" /> </div>

        </form>
       </div>
       <div class="col-lg-5 d-flex flex-column justify-content-center myColorp-4">
        <h1 class="text-center font-weight-bold text-white">Reset Password!</h1>
        <hr class="my-4 bg-light myHr" />
       <button class="btn btn-outline-light btn-lg font-weight-bolder myLinkBtn align-self-center" id="back link">Back</button>
       </div>
      </div>
     </div>
    </div>
<!-- Forgot PasswordForm End -->
    </div>
<!-- jQuery CDN -->
    <script src="https://cdnjs.cloudflare.com/ajax/libs/jquery/3.5.1/jquery.min.js"></script>
    <script src="js/script.js"></script>
   </body>  </html>
```

CSS CODE :

```
@import
url("https://fonts.googleapis.com/css?family=Maven+Pro:400,500,600,700,800,900&disp
lay=swap");

* { margin: 0; padding: 0;
            box-sizing:
            border-box;
            font-family:
            "Maven
 Pro", sans-serif;
}
.wrapper
{ height:100vh;}
.myColor
{ background-image: linear-gradient(to right, #324bf350%, #f9d423 150%);
}
.myShadow {
 box-shadow: 0
 10px rgba(0, 0,
 0, 0.5);
}
.myBtn { border-radius: 50px;
 font-weight: bold; font-size: 20px;
 background-image: linear-
 gradient(to right, #0acffe 0%,
 #495aff 100%);border: none;
}
.myBtn:hover { background-image: linear-gradient(to right, #495aff 0%, #0acffe 100%);
}
```

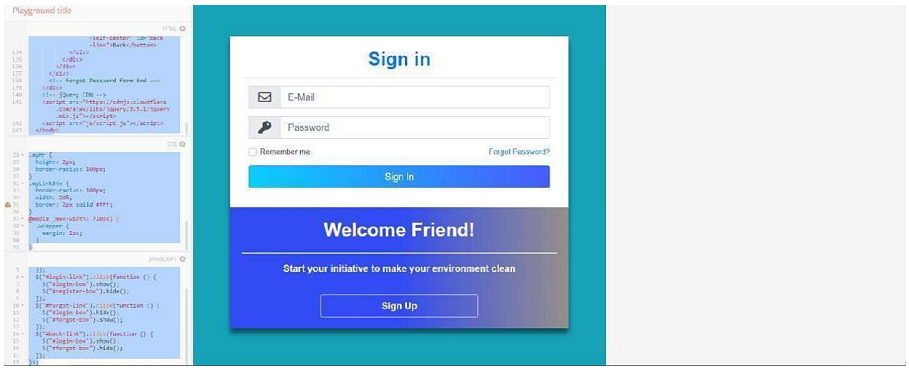
```
.myHr { height: 2px; border-radius:
100px;
}
.myLinkBtn { borderradius:
 100px; width:50%; border:
            2px
 solid #fff;
}
@media (max-width: 720px) {
 .wrapper { margin: 2px;
```

JS CODE:

```
$(function () {
$("#register-link").click(function () {
  $("#login-box").hide();
  $("#register-box").show();
});
$("#login-link").click(function () {
  $("#login-box").show();
  $("#register-box").hide();
});
$("#forgot-link").click(function () {
```

```
        $("#login-box").hide();

        $("#forgot-box").show();

      });

      $("#back-link").click(function () {

        $("#login-box").show();

        $("#forgot-box").hide();
});
  });
```

OUTPUT:



Source Code:

```
#include <WiFi.h> // library for wifi
#include <PubSubClient.h>  //
libraryfor 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 watsoniot platform#defineDEVICE_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 inwhich  data to be send
char topic[] = "iot-2/cmd/led/fmt/String"; // cmd Representtype and command
is test format of stringschar authMethod[] = "use-token-auth";
// authentication method char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
//Client id WiFiClient wifiClient;                                //
creating instance for wificlientPubSubClient client(server, 1883,
wifiClient);
#define ECHO_PIN 12
#define TRIG_PIN13float
dist;
void setup()
```

```
{
Serial.begin(11520
0);
pinMode(LED_B
UILTIN,
OUTPUT);pinMod
e(TRIG_PIN,
OUTPUT);
pinMode(ECHO_P
IN, INPUT);
//pir pin
pinMode(34, INPUT);
//ledpins pinMode(23, OUTPUT); pinMode(2, OUTPUT);
pinMode(4, OUTPUT);pinMode(15, OUTPUT);
lcd.init(
);
lcd.back
light();
lcd.setC
ursor(1,
0);
lcd.print
("");
wifiCon
nect();
mqttCon
nect();
}
float readcmCM()
{
digitalWrite(
```

```
TRIG_PIN,
LOW);
delayMicrose
conds(2);
digitalWrite(
TRIG_PIN,
HIGH);delay
Microseconds
(10);
digitalWrite(
TRIG_PIN,
LOW);
int duration =
pulseIn(ECHO_PIN,
HIGH);return duration
* 0.034 / 2;
} void loop(){
lcd.clear();
publish
Data();
delay(50
0);if
(!client.l
oop())
{
mqttConnect();                          // functioncall to connect to IBM
}
}
/*_____retrieving to cloud_____
*/void wifiConnect()
{
```

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

```
}
else
{
Serial.println("subscribe to cmd FAILED");
}
}
void publishData()
{
float cm = readcmCM();
if(digitalRead(34))                    //pir motion detection
{
Serial.println("
Motion
Detected");
Serial.println("
Lid Opened");
digitalWrite(1
5, HIGH);
if(digitalRead(
34)== true)
{
if(cm <= 60)                           //Bin level detection
{
digitalWrite(2, HIGH);
Serial.println("High Alert!!!,Trash bin is
aboutto 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("S
ending
payload: ");
Serial.println(
payload);
if (client.publish(publishTopic, (char*)payload.c_str()))                    // if data is uploaded to cloud
successfully,prints publishok 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();
}
```

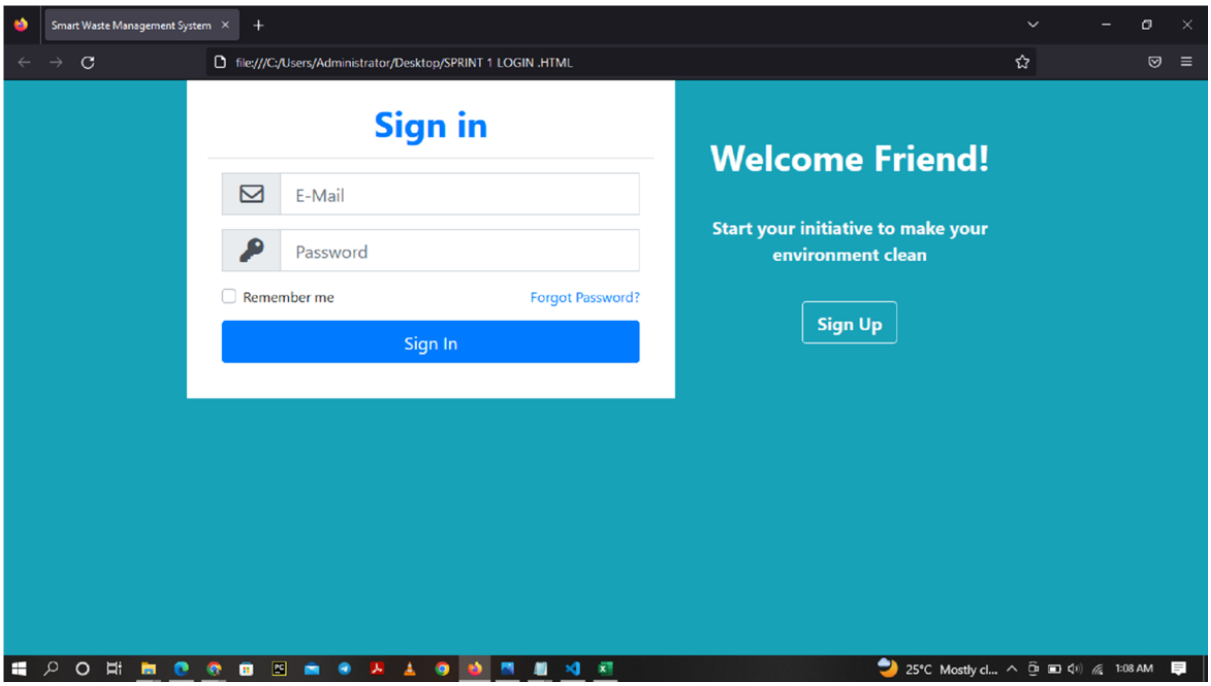


Figure output: 13.1.6 Login

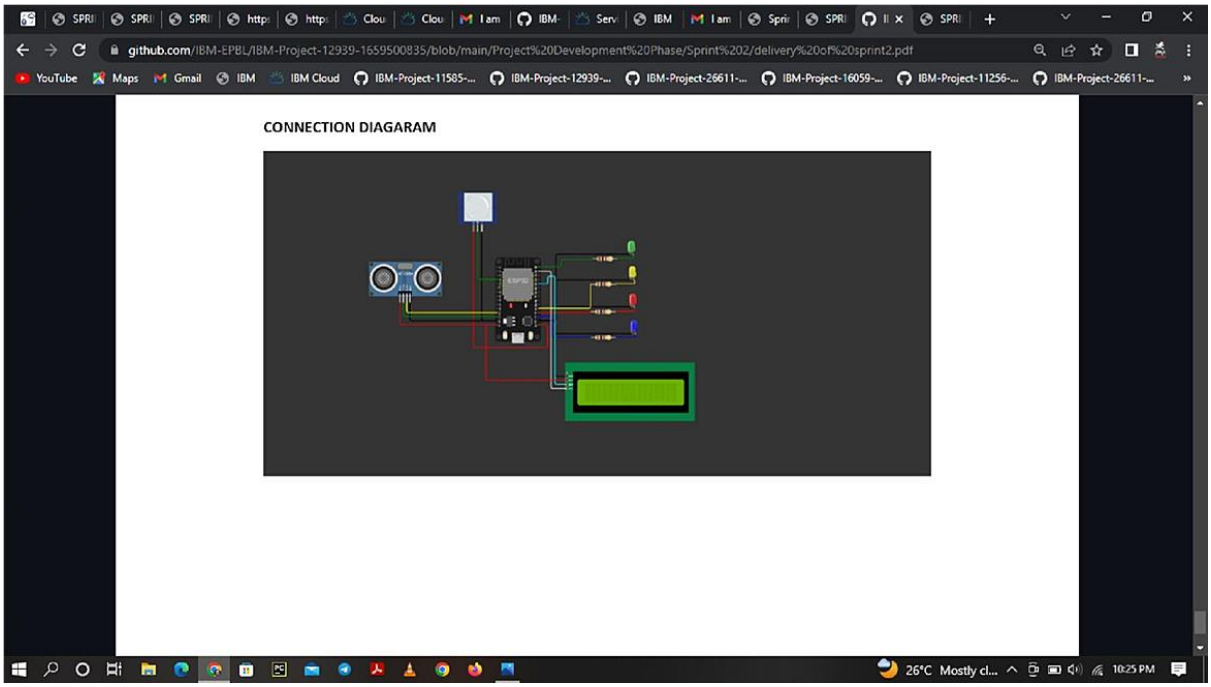


Figure output :13.1.7 Connecction Diagram

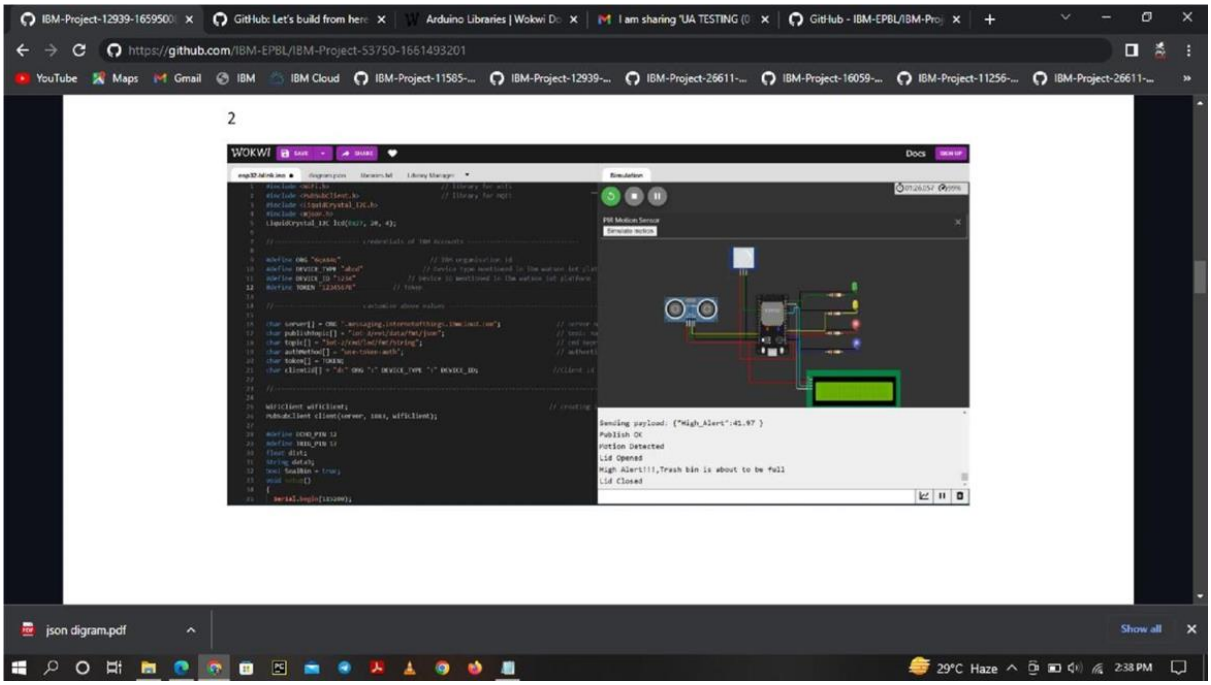


Figure output :13.1.8 Output

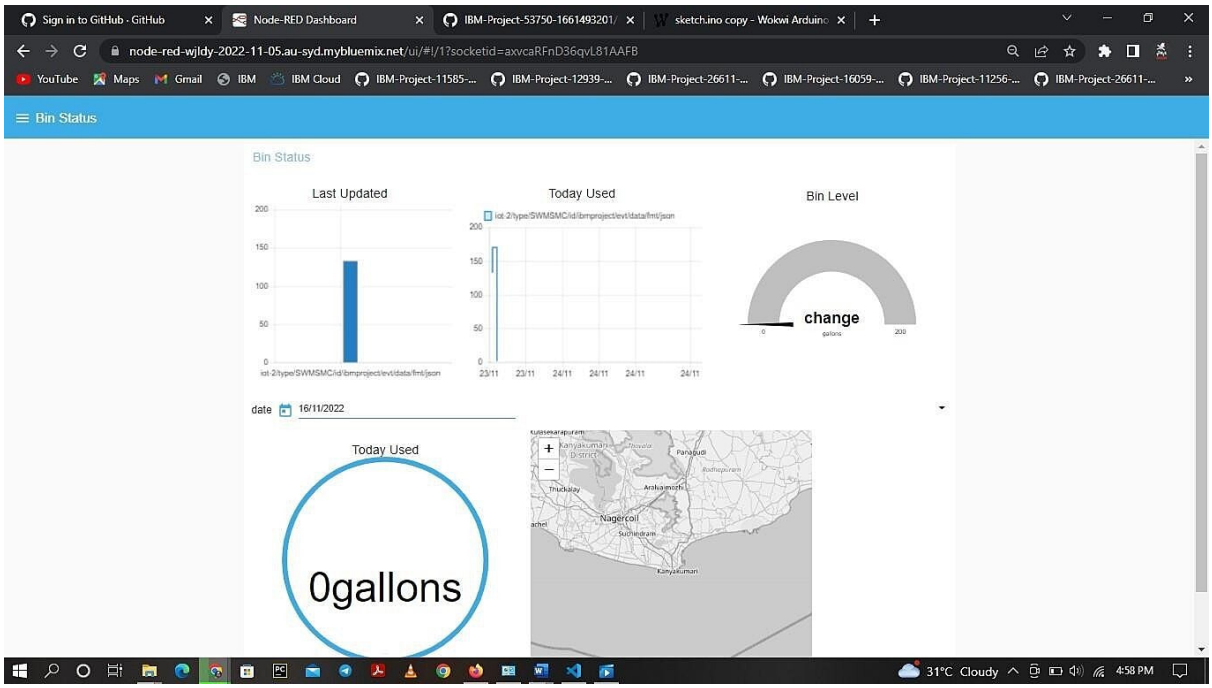


Figure 13.1.9 Figure Node Output

GITHUB LINK : https://github.com/IBM-EPBL/IBM-Project-53683-1661488930

PROJECT DEMO LINK :

https://drive.google.com/file/d/1L2anzVnnkXmcyDrZlngiud6no17__dtZ/view?usp=drivesdk