**SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITAN CITIES**

**IBM NALAIYA THIRAN**

## PROJECT REPORT

***Submitted By***

**KARTHICK N -73771913132**

**KARTHI G -73771913131**

**ASHOK E -73771913108**

**MANOJ KUMAR S -73771913142**

**VINOTH KANNA V-73771913187**

***in partial fulfillment for the award of the degree of***

**BACHELOR OF ENGINEERING**

***in***

## ELECTRONICS AND COMMUNICATION ENGINEERING

**K.S.RANGASAMY COLLEGE OF TECHNOLOGY (AUTONOMOUS)**

**TIRUCHENGODE-637215**

**ANNA UNIVERSITY:CHENNAI 600 025**

**NOVEMBER 2022**

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**BONAFIDE CERTIFICATE**

Certified that this project report titled **“SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITAN CITIES”** is the bonafide work of **“KARTHICK N (1913132),ASHOK E(1913108),KARTHI G(1913131),VINOTH KANNA V(1913187),MANOJ KUMAR(1913142)”** who carried out the project work under my supervision.

|  |  |
| --- | --- |
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| **ASSISTANT PROFESSOR** | **ASSOCIATE PROFESSOR** |
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## SPOC HEAD OF THE DEPARTMENT

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At the outset, we express our heartfelt gratitude to **GOD,** who has been our strength to bring this project to light.

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# CHAPTER -1 INTRODUCTION

## PROJECT OVERVIEW

In the era of today, the smart city has become the trend and aim to be achieved by almost every country. To become a smart city, smart waste management is playing an important role in it. Smart waste management is the upgrade or optimization of traditional waste management with information technology. Waste management is the movements and actions that needed to direct waste from its beginning to last disposal. In simplest terms, it can be defined as the collection, transportation, and disposal of garbage, and other waste products. In this Smart Waste Management System, Internet of Things (IoT) was used for implementing the project. IoT is a recent technique which allow the interconnection of object with network. The plan of new idea in IT domain is maintaining things internet of mutual. IoT enables to interconnect endless of gadgets via web and it makes a rich circumstance by partner the contraptions with web and outcome them with ability to exchange as well as collect data. These sensors gather data regarding their environmental factors and send the data to the dependable through remote organization. The IoT makes an

upheaval in the field of mechanization.

Besides, the system includes Android mobile application that allow user to get the data. The reason to develop mobile application within this project is because the mobile communication technologies are diffusing around the planet faster than any other communication technology to date. Nowadays, almost every people have their own smartphone, the size of smartphone is relatively smaller and lighter compare to computer or laptop. In addition, the performance of smartphone getting better for now. Therefore, it is suitable to develop a mobile application for Smart Waste Management system.

## PURPOSE

This project IOT Garbage Monitoring system is a very innovative system which will help to keep the cities clean. This system monitors the garbage bins and informs about the level of garbage collected in the garbage bins via a web page. The Web Application is used to display the status of the level of garbage collected in the bins. Whereas a web page is built to show the status to the user monitoring it. The web page gives a graphical view of the garbage bins and highlights the garbage collected in colour’s in order to show the level of garbage collected. when the level of garbage collected crosses the set limit. Thus, this system helps to keep the city clean by informing about the garbage levels of the bins by providing graphical image of the bins via IBM IOT Platform. The idea struck us when we observed that the garbage truck use to go around the town to collect solid waste twice a day. Although this system was thorough it was very inefficient. For example, let's say street A is a busy street and we see that the garbage fills up really fast whereas maybe street B even after two days the bin isn't even half full. What our system does is it gives a real time indicator of the garbage level in a trashcan at any given time. Using that data, we can then optimize waste collection routes and ultimately reduce fuel consumption. It allows trash collectors to plan their daily/weekly pick up schedule.

# CHAPTER -2 LITERATURE SURVEY

## EXISTING PROBLEM

In today’s world there is no proper management and control system for proper garbage collection. Humans have a tendency to avoid their duty. People in the societies use to throw garbage in filled garbage containers and garbage authorities also do not collect the garbage timely. Hence it leads to various types of pollution and many serious health issues.

## REFERENCES

1. IoT Based Smart Waste Management System: India prospective

Name of the Author: Rishabh Kumar,Singhvi, Roshan Lal Lohar, Ashok Kumar, Ranjeet Sharma,Lakhan Dev Sharma,Ritesh Kumar Saraswat.

IEEE Journal: 978-1-7281-12534/19/$31.00 ©2019IEEE

Year: 2019

1. Waste Management System Using IoT:

Name of the Author: Mohammed Adam, Mohammed Elnour Okasha, Omer Mohammed Tawfeeq, Mohammed Awad Margan, Bakri Nasreldeen.

IEEE Journal: 978-1-5386-41231/18/$31.00 ©2018IEEE

Year: 2019

1. An IoT enabled Smart Waste Management System in concern with Indian Smart Cities:

Name of the Author: Pooja Devi, Wajge Shubham Ravindra,Sai Prakash S.K.L.V IEEE Journal: 978-1-5386-35704/18/$31.00 ©2018IEE Year: 2019

1. IoT assisted Waste Collection and Management system using QR codes:

Name of the Author: Aparna, Bhumijaa, Avila, Thenmozhi, Rengarajan Amirtharaja IEEE Journal: 978-1-7281- 58754/21/$31.00 ©2021 IEEE.

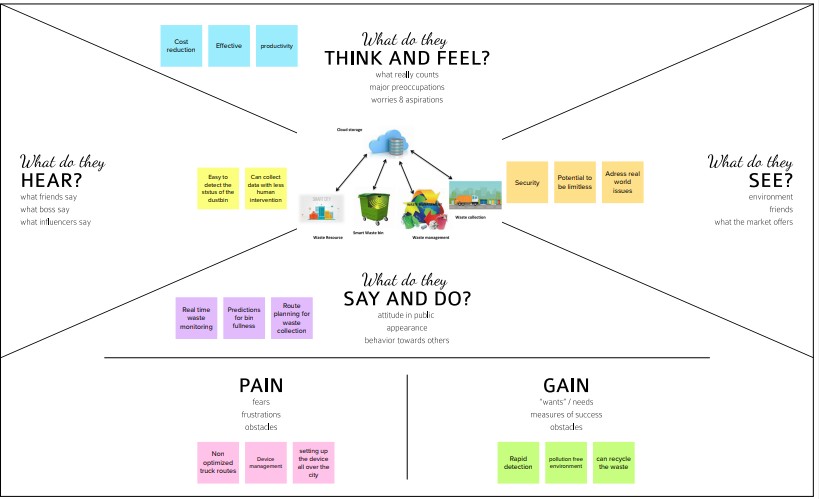
Year: 2019

# CHAPTER -3

**IDEATION AND PROPOSED SOLUTION**

## EMPATHY MAP CANVAS

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user’s behaviours and attitudes. It is a useful tool to helps teams better understand their users. Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user’s perspective along with his or her goals and challenges.



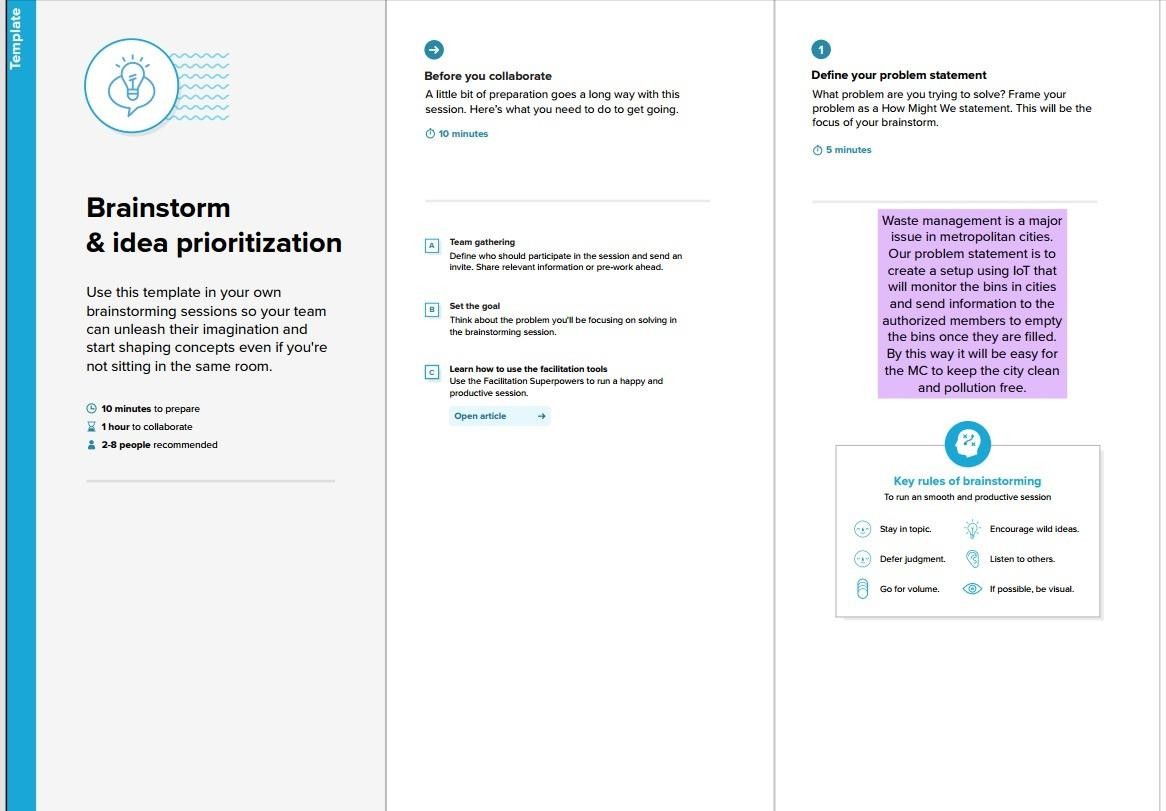
## Figure 3.1.1 Empathy map

* 1. **IDEATION AND BRAINSTROMING**

Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem- solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all participants are encouraged to collaborate, helping each other develop a rich number of creative solutions.

## Step-1: Team Gathering, Collaboration and Select the Problem Statement

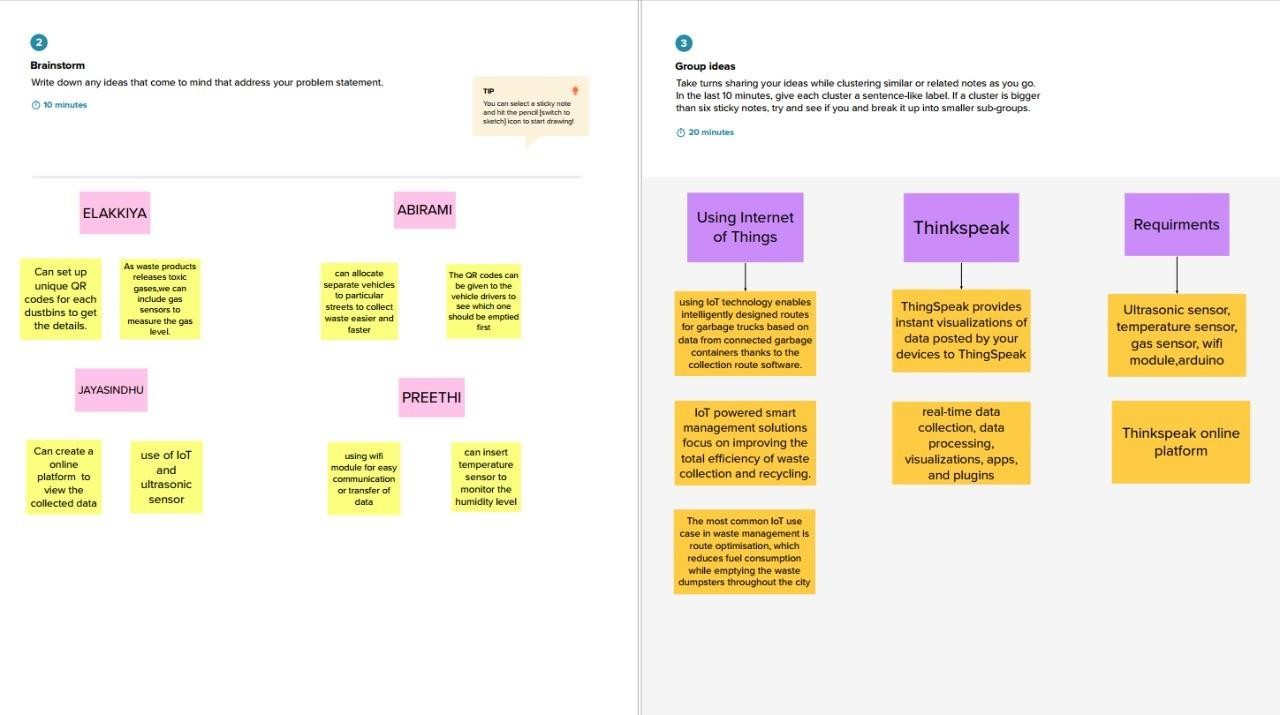
This step includes the formation of a team, collaborating with the team by collecting the problems of the domain we have taken and consolidating the collected information into a single problem statement.



## Figure 3.2.1 Team Gathering

**Step 2: Brainstorm, Idea Listing and Grouping**

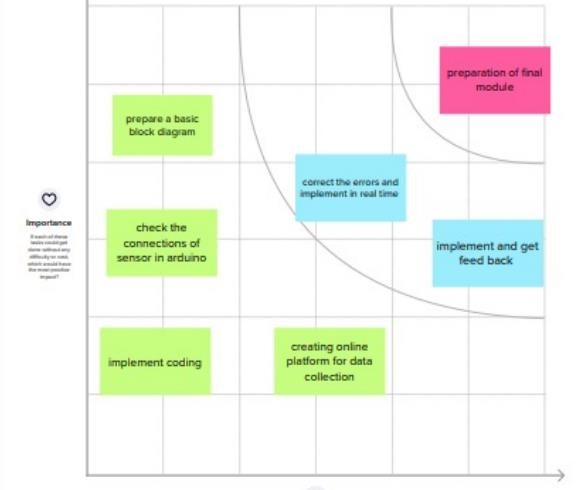
This step of ideation includes the listing of individual ideas by teammates to help with the problem statement framed. All the individual ideas have been valued and made individual clusters.Then discussed as a team and finally made an ideation Cluster A and concluded with the most voted ideas from all the clusters together and Cluster B with the least needed ideas.



## Fig:3.2.2 Idea listing and grouping

**Step 3: Idea Prioritization**

This step includes the process of listing necessary components to come up with the working solution and making a hierarchy chart by prioritizing the components based on importance, say from the higher being backend and lower being the user interfacing components.



## Fig:3.2.3 Idea Prioritization

* 1. **PROBLEM STATEMENT**

Our problem statement is to create a web application using Internet of things that will monitor the bins in cities and send the information on the bin’s data to the authorized members so that they can empty the bins on time.

**Idea / Solution description:**

The technology used here is IoT. By using Watson IoT platform, the bins data is generated. By using the node red, dashboard is created to receive the data. Then a web application is created using the MITAPP Inventor to receive the location and data in mobile device.

**Novelty / Uniqueness:**

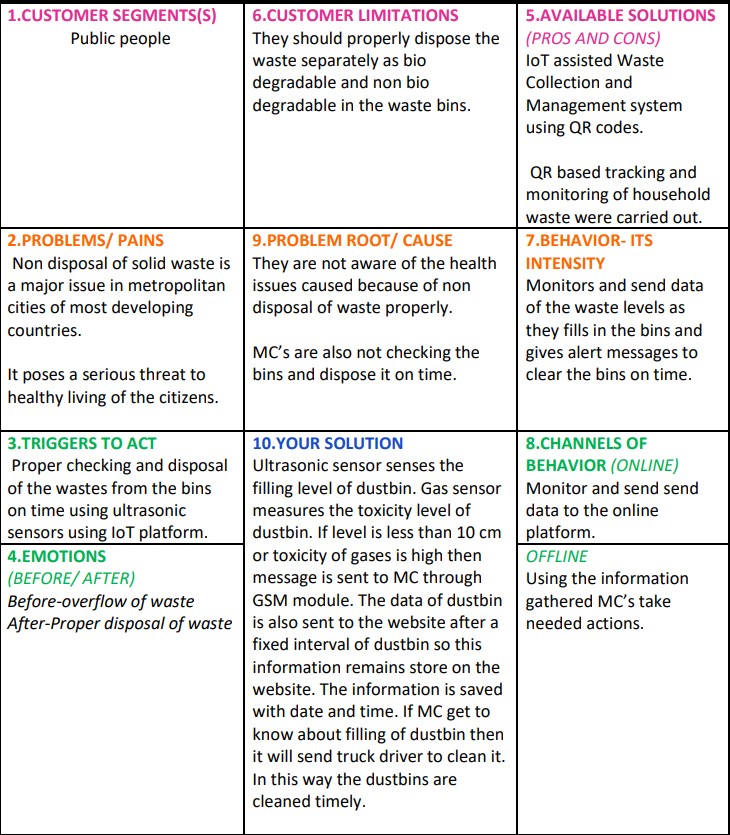
The web application created is cost efficient and very useful for the monitoring of the bin’s status.

**Social Impact / Customer Satisfaction**

It is very cost efficient and easy to use. It is also very useful in keeping the environment clean and free of pollution.

## PROBLEM SOLUTION FIT

The Problem-Solution Fit simply means that you have found a problem with your customer and that the solution you have realized for it solves the customer’s problem. It helps entrepreneurs, marketers and corporate innovators identify behavioural patterns and recognize what would work and why.



**Table 3.4.1 Problem Solution Fit**

**CHAPTER - 4 REQUIREMENTS ANALYSIS**

## FUNCTIONAL REQUIREMENT

IBM IoT Platform-to generate the data of the bins.

Node-red- to connect the IoT Platform and create a dashboard. Dashboard- to receive the bins data.

MITAPP inventor- to create a mobile application.

## NON-FUNCTIONAL REQUIREMENT Usability:

The Web application’s usability facilitates Use, to make it easier for the users to get the information generated by the IoT platform to monitor and decide based on that information.

## Reliability:

The probability the application will perform a required function without failure under static conditions for a specified period.

## Availability:

The web application is available over all conditions and can give us the monitored bin status without any failure.

**Scalability:**

In Feature, we can upgrade the system with the smallest routes for the trucks, so that the time to remove the waste will be reduced.

# CHAPTER - 5 PROJECT DESIGN

## DATA FLOW DIAGRAM

Collect data from the smart waste bins

send data to the central

receiver

If Full

Check level of bins

display level of bins

display level of bins

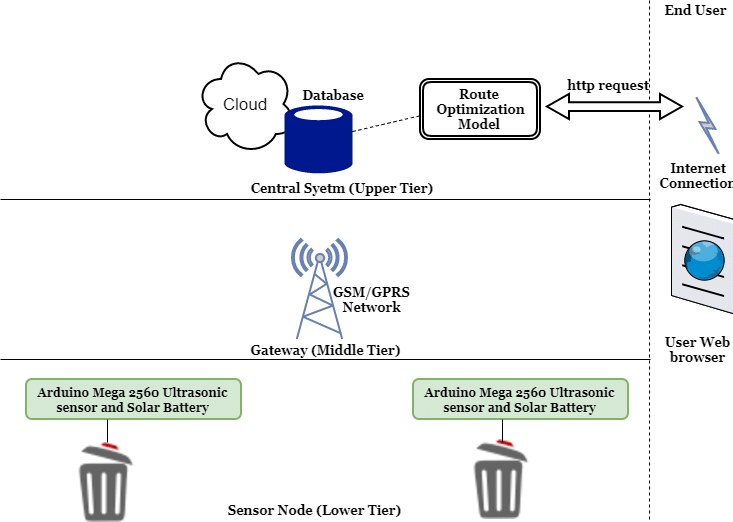
Send waste collector at that

location

**Figure 5.1.1 Data flow Diagram**

## SOLUTION AND TECHNICAL ARCHITECTURE

The solution architecture includes the components and the flow we have designed to deliver the solution.



## Figure 5.2.1 Solution and Technical Architecture

* 1. **USER STORIES**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **User Type** | **Functional Requirement (Epic)** | **User Story Number** | **User Story**  **/ Task** | **Priority** | **Release** |
| Admin | IBM Watson | USN-1 | Used to generate the  data of the bin. | High | Sprint-1 |
| Admin | Node-red | USN-2 | Used  to connect the Watson platform and create a dash board | High | Sprint-2 |
| Customer | Dashboard | USN-3 | Used to receive the bin’s data | High | Sprint-3 |
| Customer | Web application | USN-4 | Used to receive the location and  data of the bin | High | Sprint-4 |

## Table 5.3.1. User Stories

**14**

# CHAPTER - 6

**PROJECT PLANNING AND SCHEDULING**

## SPRINT PLANNING AND ESTIMATION SPRINT 1

The first sprint involves the setting up of IBM IoT Watson Platform to generate the bin’s data (Internet of Things-mj). After that a device must be created and registered in the Watson IoT Platform. Then the device is switched on and then the coding part is given.

Organization ID: nmp0h6 Device Type: IoT

Device ID: 12345

Authentication Token: 123456789

## Code for generating Random bin data:

{

“BIN 1”: random (0,100),

“BIN 2”: random (0,100),

“BIN 3”: random (0,100),

“BIN 4”: random (0,100),

“BIN 5”: random (0,100)

}

The device simulator is switched on and the random bin values are generated and can be viewed in the recent events tab.

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**SPRINT 2**

In this step, an organization called smart bin is created and registered. Then an API key is generated for the registered device. In node-red, the IBM Watson IoT Platform is connected using the API key, Device Type and Device ID.Then a msg.payload node is connected to receive the bin’s data. Then the function node (Bin 1 value node, Bin 2 value node, Bin 3 value node, Bin 4 value node, Bin 5 value node) is connected with the IBM Watson in node and it is connected to the gauge dashboard node.

Code for each gauge: msg.payload=msg.payload[“BIN 1”]; global.get(“b1”);

return msg; msg.payload=msg.payload[“BIN 2”]; global.get(“b2”);

return msg; msg.payload=msg.payload[“BIN 3”]; global.get(“b3”);

return msg; msg.payload=msg.payload[“BIN 4”]; global.get(“b4”);

return msg;

## 16

msg.payload=msg.payload[“BIN 5”]; global.get(“b5”)

return msg;

## SPRINT 3

In Sprint 3, once the connection of gauge dashboard node is done with the function node,all the bin values are made to be appear in the dashboard page using the code below:

## Code:

msg.payload={“BIN 1”:global.get(“b1”), “BIN 2”:global.get(“b2”),“BIN 3 ”: global .

get(“b3”), “BIN 4”: global.get(“b4”), “BIN 5”: global.get(“b5”)}; return msg;

Then the http:in, function and http response nodes are connected with each other to create the dashboard we page.Then a url is created for the dashboard ( https://node- red-yqmlm-2022-11-13.eu-gb.mybluemix.net/binvalues.ui).Then the output is seen in the dashboard web page in gauge form when the device simulator is switched on.

## SPRINT 4

In this Sprint a mobile application is created using the MITAPP Inventor. In the frontend designer block, the mobile screen in which we wanted to view the data is created. Lables are created as BIN 1, BIN 2, BIN 3, BIN 4 and BIN 5. Two text boxes are created near each bin for receiving the location and bin value (in %). Web 1 and a clock is created for the backend process. In the backend process: web 1 is connected with the clock 1and a url is attached (https://n ode-red-yqmlm-2022-11-13.eu- gb.mybluemix.net/binvalues.ui). Then web1.GotText block is created .

## 17

Decode is connected. And a get responseContent is attached. Likewise for all bins connections are established.Then a QR code is generated,by scanning the code we can view the output in mobile.

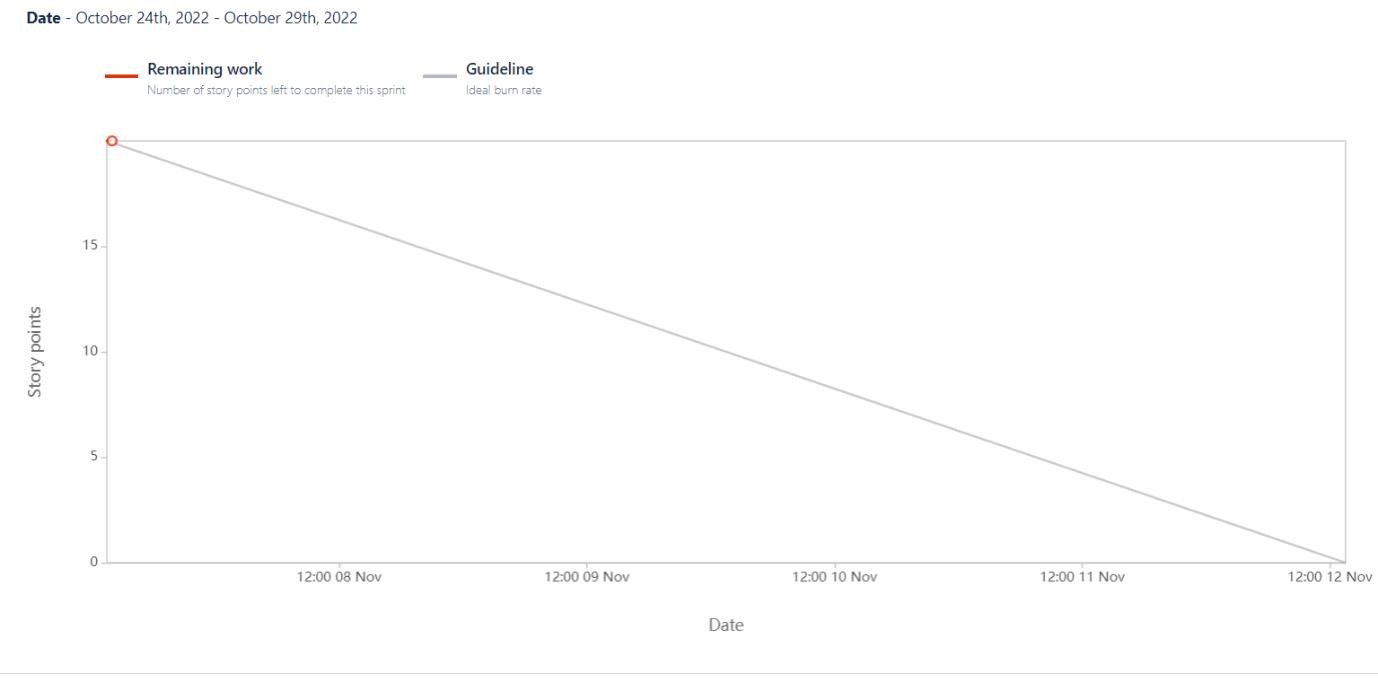
## SPRINT DELIVERY SCHEDULE

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sprint** | **Functional Requirement (Epic)** | **User Story Number** | **User Story / Task** | **Story Points** | **Priority** | **Team Members** |
| Sprint-1 | IoT Platform | USN-1 | Creating random data for bin values in IoT Watson platform | 20 | High | ASHOK E |
| Sprint-2 | Node-red | USN-2 | Connecting IoT Watson to node-red and giving connections to create a dashboard | 20 | High | KARTHI G |
| Sprint-3 | Web application | USN-3 | Creating a web Application using MITapp inventor | 20 | High | VINOTH KANNA V |
| Sprint-4 | Final output | USN-4 | Connecting all connections and getting final result | 20 | Medium | MANOJ KUMAR S |

**Table 6.2.1 Sprint Delivery Schedule**

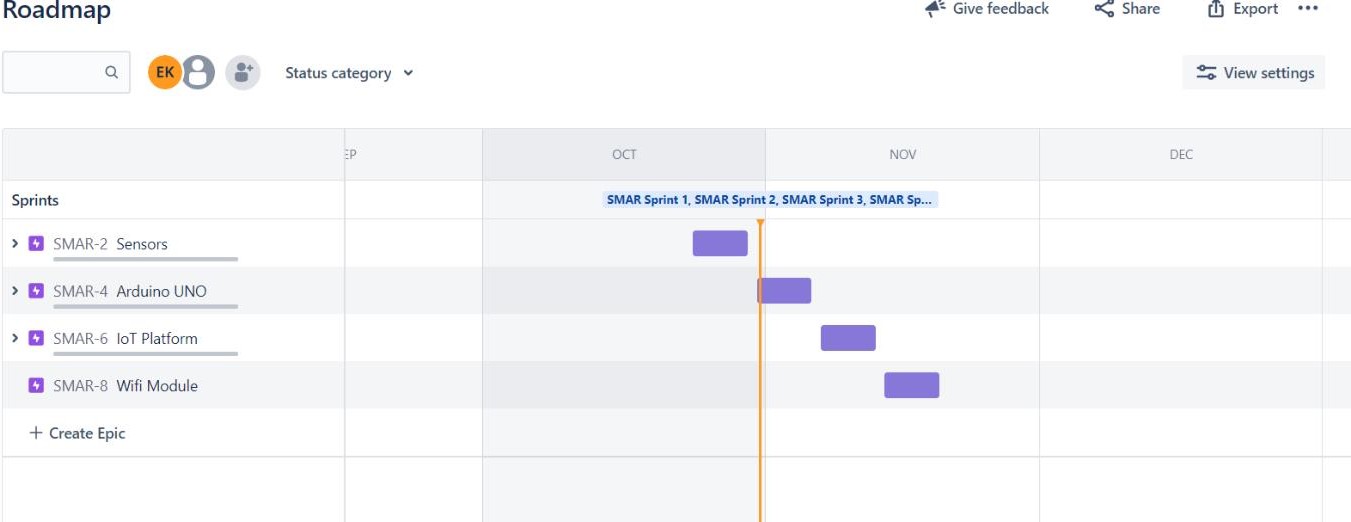
## 18

* 1. **REPORTS FROM JIRA Burndown Chart**



## Fig 6.3.1 Burndown chart

**Road Map**



## Fig 6.3.2 Road Map

* 1. **FEATURE 1**

# CHAPTER -7 CODING AND SOLUTIONS

Code for generating Random bin data:

{

“BIN 1”: random (0,100),

“BIN 2”: random (0,100),

“BIN 3”: random (0,100),

“BIN 4”: random (0,100),

“BIN 5”: random (0,100)

}

## FEATURE 2

Code for each gauge: msg.payload=msg.payload[“BIN 1”]; global.get(“b1”);

return msg; msg.payload=msg.payload[“BIN 2”]; global.get(“b2”);

return msg; msg.payload=msg.payload[“BIN 3”]; global.get(“b3”);

return msg;

msg.payload=msg.payload[“BIN 4”]; global.get(“b4”);

return msg; msg.payload=msg.payload[“BIN 5”]; global.get(“b5”);

return msg;

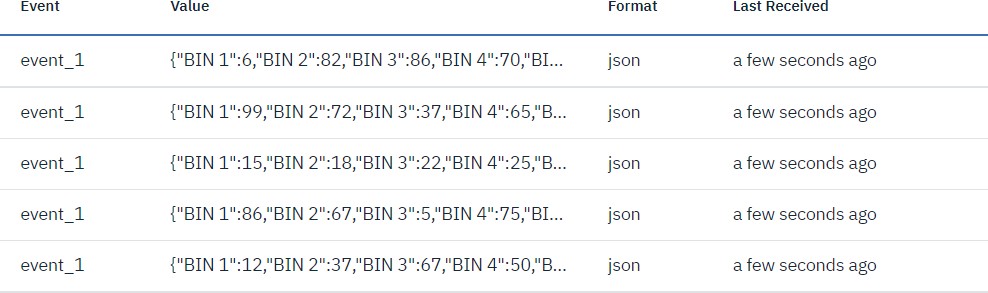
Code for dashboard:

msg.payload={“BIN 1”:global.get(“b1”), “BIN 2”:global.get(“b2”),“BIN 3 ”: global .

get(“b3”), “BIN 4”: global.get(“b4”), “BIN 5”: global.get(“b5”)}; return msg;

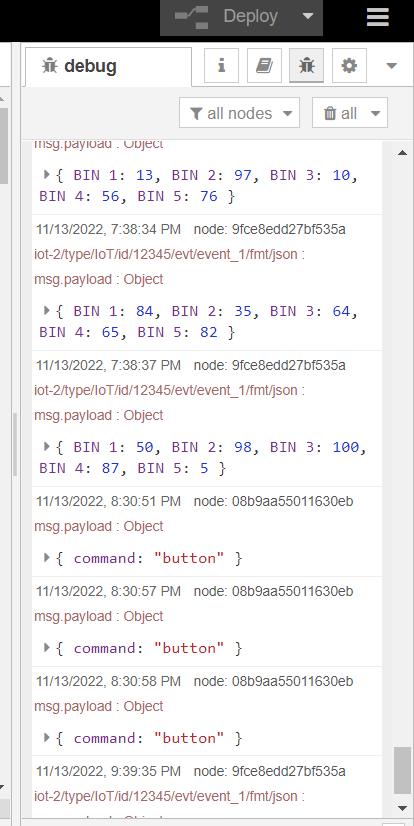
# CHAPTER-8 TESTING

## TEST CASE 1



**Fig 8.1.1 Test Case 1(Runtime)**

## TEST CASE 2



**Fig 8.1.2 Test Case 2**

## USER ACCEPTANCE TESTING

The purpose of this document is to briefly explain the test coverage and open issues of the Smart waste management system for metropolitan cities project at the time of the release to the User Acceptance Testing (UAT).

## Defect Analysis

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Resolution** | **Severity 1** | **Severity 2** | **Severity 3** | **Severity 4** | **Subtotal** |
| **By Design** | 8 | 5 | 3 | 1 | 16 |
| **Duplicate** | 0 | 0 | 2 | 3 | 5 |
| **External** | 2 | 3 | 0 | 1 | 6 |
| **Fixed** | 9 | 2 | 4 | 9 | 24 |
| **Not**  **Reproduced** | 0 | 0 | 2 | 0 | 2 |
| **Skipped** | 0 | 0 | 0 | 1 | 1 |
| **Won’t Fix** | 0 | 0 | 0 | 1 | 1 |
| **Totals** | 19 | 10 | 11 | 16 | 55 |

**Table 8.1. Defect Analysis**

## Test case Analysis

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Section** | **Total Cases** | **Not Tested** | **Fail** | **Pass** |
| **User Application** | 5 | 0 | 0 | 5 |
| **Web Application** | 20 | 0 | 0 | 20 |
| **Security** | 3 | 0 | 0 | 3 |
| **Outsource Shipping** | 4 | 0 | 0 | 4 |
| **Exception Reporting** | 8 | 0 | 0 | 8 |
| **Final Report Output** | 3 | 0 | 0 | 3 |
| **Version control** | 1 | 0 | 0 | 1 |

**Table 8.2. Test case Analysis**

# CHAPTER -9 RESULT

## 9.1 PERFORMANCE METRICS NFT-Detailed Test Plan

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S.No** | **Project Overview** | **NFT Test Approach** | **Assumption/Dependencies/Risks** | **Approvals/ Sign Off** |
| 1 | Bin Monitoring Web-UI | Stress | App Crash/Developer team/ Site Down | Approved |
| 2 | Bin  Monitoring Web-UI | Load | Server Crash/Developer team/ Server Down | Approved |

**Table 9.1. NFT-Detailed Test Plan**

## End of Test Report

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Project Overview** | **NFT Test approach** | **NFR-Met** | **GO/NO-GO**  **Decision** | **Identified Defects** | **Approvals/ Sign Off** |
| Bin Monitoring Web-UI | Stress | Performance | GO | Closed | Approved |
| Bin Monitoring  Web-UI | Load | Scalability | NO-GO | Closed | Approved |

**Table 9.2. End of Test Report**

# CHAPTER-10 ADVANTAGES & DISADVANTAGES

## Advantages:

1.The garbage will be collected on time-to-time basis. 2.Less manpower, emission, fuel use and traffic congestion.

3.Analytics data to manage collection routes and placement of bins needed. 4.Improved environment (i.e, no overflowing bins and less unpleasant odours.)

5*.* Reduction in Collection Cost, Reduction in CO2 emission 6.No missed pickups

## Disadvantages:

1.It requires a well-structured hardware. 2.The process is not always cost-efficient.

3.The resultant product may have a short lifespan. 4.Increased cost of the dustbins.

# CHAPTER -11 CONCLUSION

This project work is the implementation of smart waste management system using Watson IoT platform, node-red and MITAPP Inventor. This system assures the cleaning of dustbins soon when the garbage level reaches its maximum. This reduces the total number of trips of garbage collection vehicle and hence reduces the overall expenditure associated with the garbage collection. It ultimately helps to keep cleanliness in the society. Therefore, the smart Waste management system makes the garbage collection more efficient. Smart dustbins help us to reduce pollution. This project ensures waste collection on time which in turn ensures less contamination of environment, no spread of disease and a cleaner surrounding.

# CHAPTER -12 FUTURE SCOPE

By deploying sensors, network infrastructure, and data visualization platforms, waste management will be able to generate actionable insights, to make informed decisions. Automatic garbage fill alerting system helps us to reduce the pollution. Many times, garbage dustbin is overflow and many animals like dog or cow enters inside or near the dustbin. Also, some birds are also trying to take out garbage from dustbin. This project can avoid such situations. And the message can be sent directly to the cleaning vehicle instead of the contractor’s office. Apart from this, differentiation can be made between dry trash bin and wet trash bin collecting plastic dry waste and biodegradable waste respectively. To implement this methane and smell sensors can be used. This helps in distinguishing the waste at the source and hence reducing the requirement of manpower.

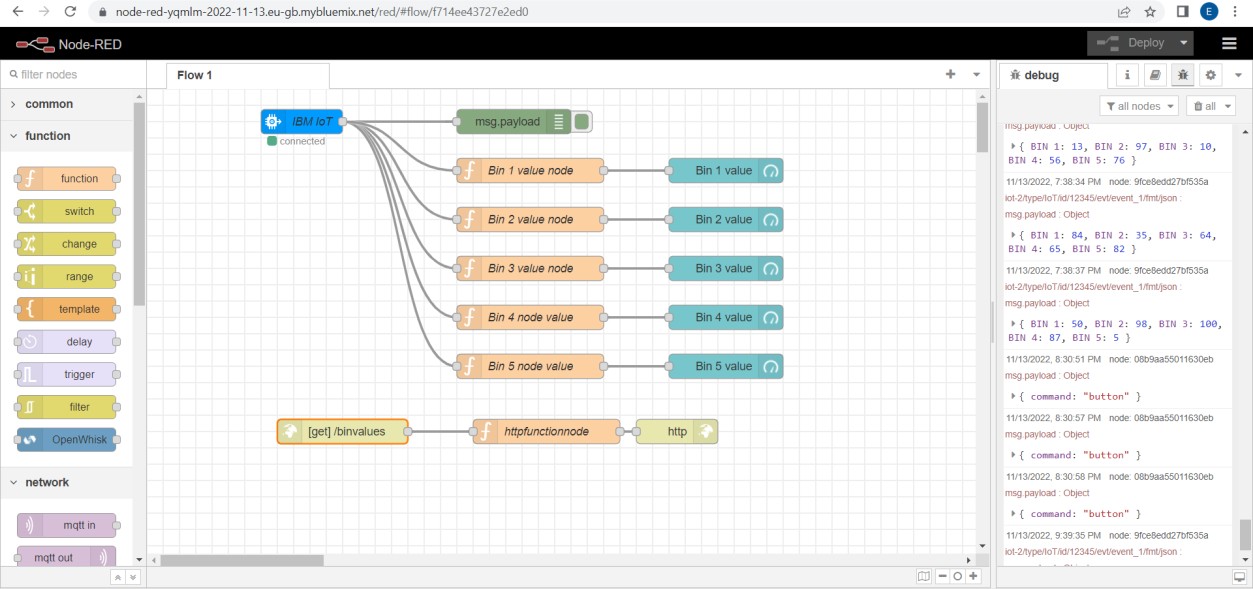
# CHAPTER -13 APPENDIX

## 13.1 SCREENSHOTS SPRINT 1



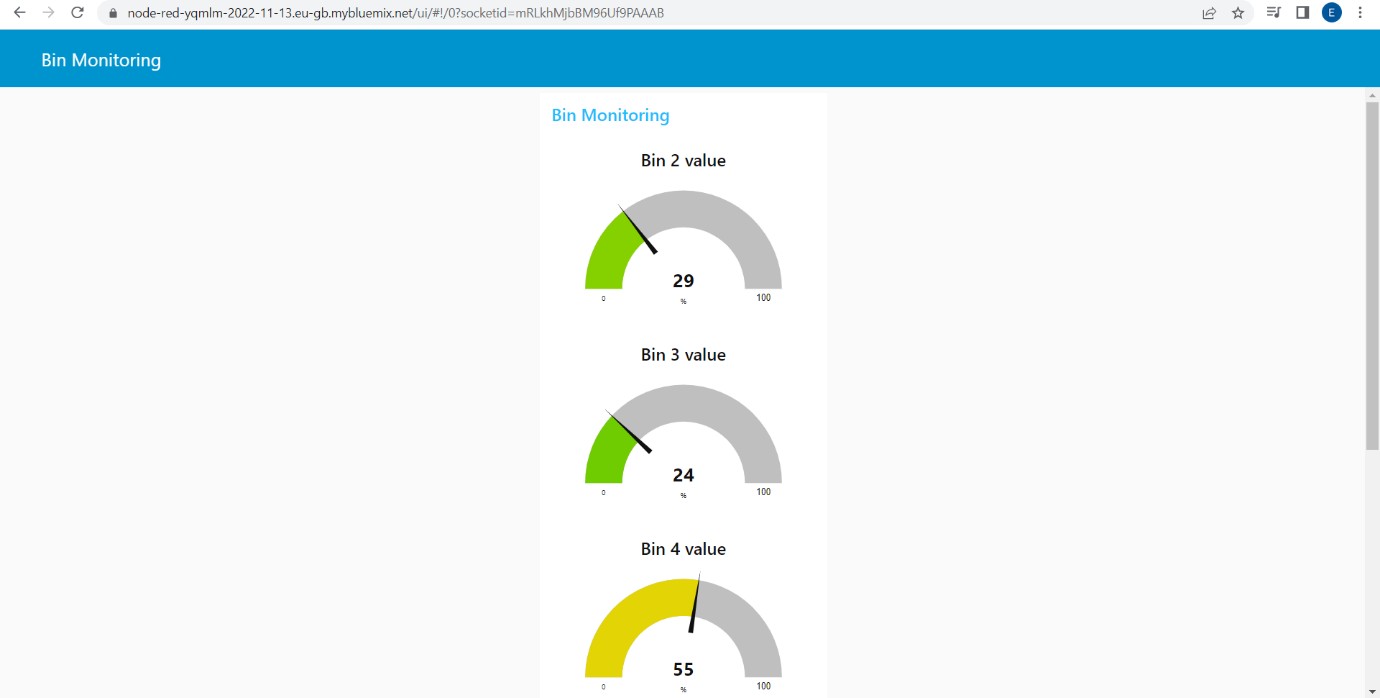
**Fig 13.1.1 Sprint 1**

## SPRINT 2

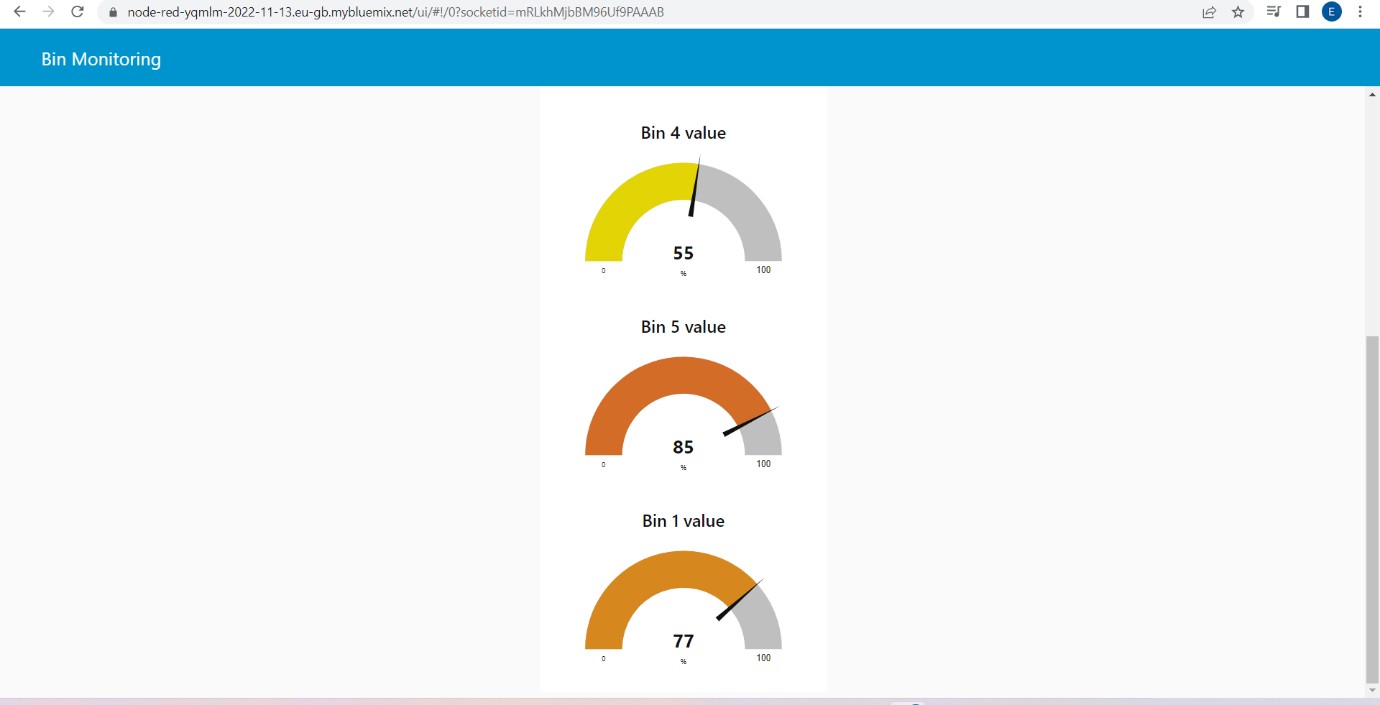


**Fig 13.1.2 Sprint 2**

## SPRINT 3

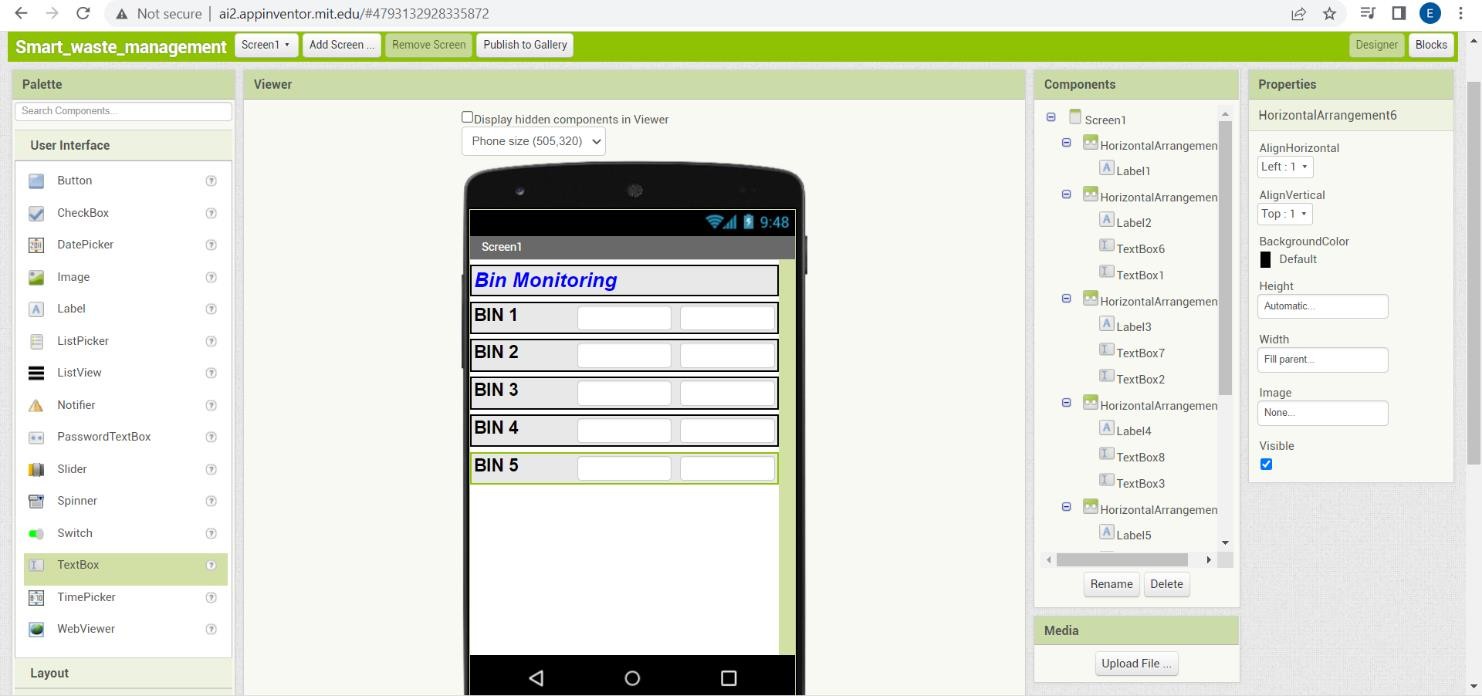


**Fig 13.1.3 Sprint 3(1)**

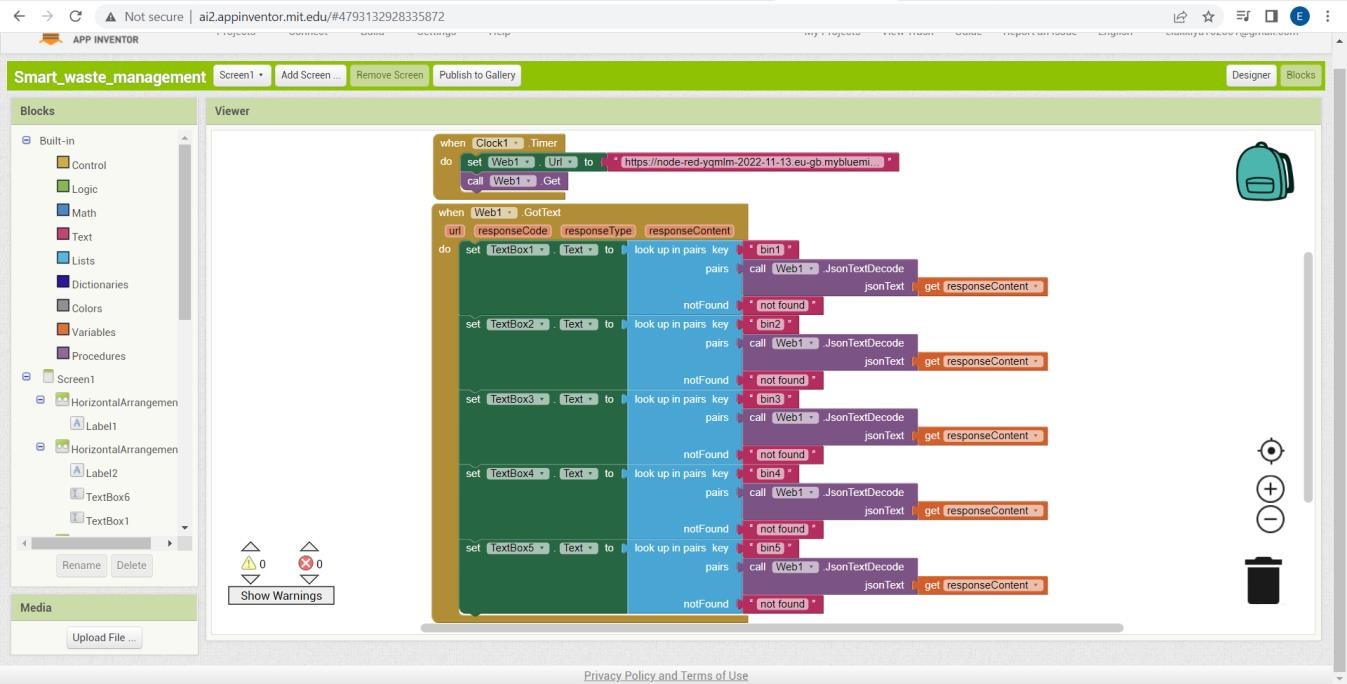


## Fig 13.1.4 Sprint 3(2)

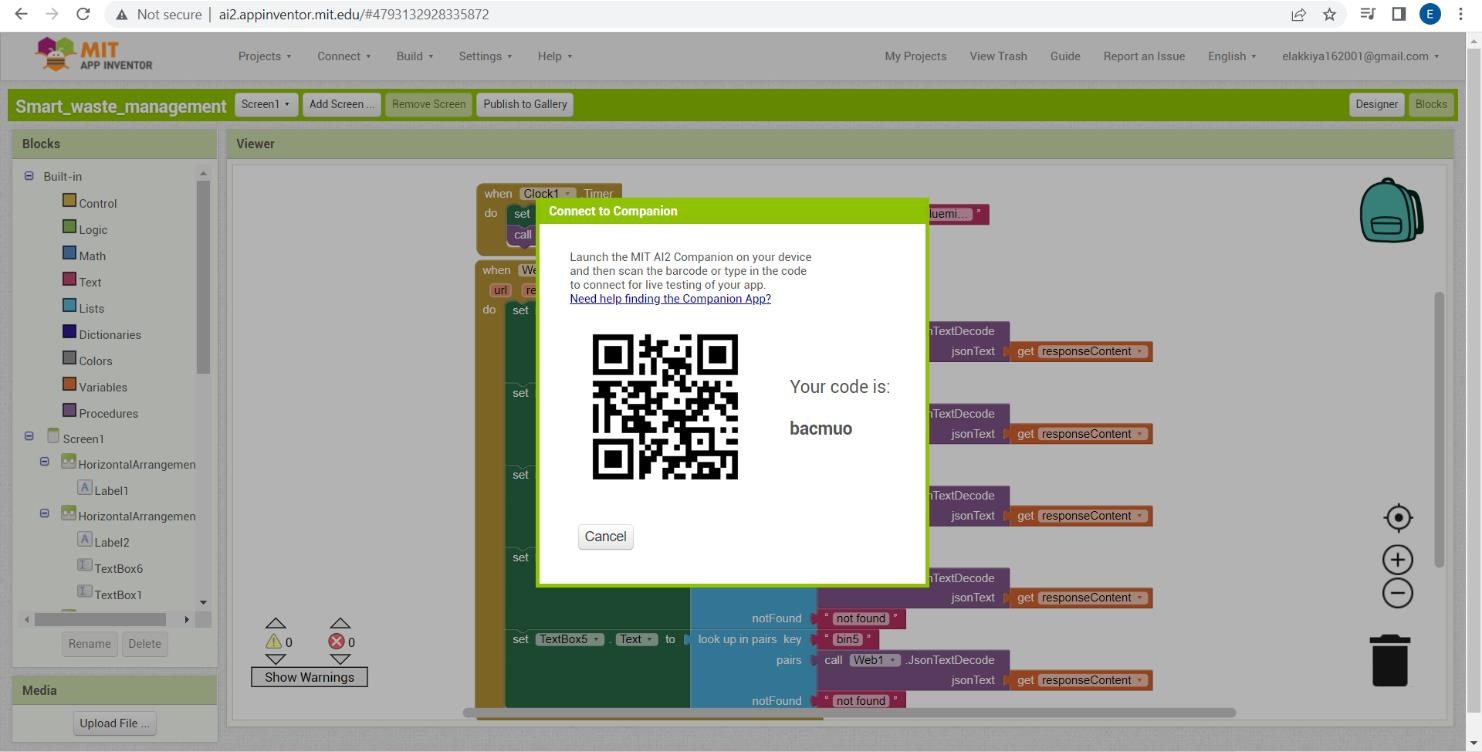
**SPRINT 4**



## Fig 13.1.5 Sprint 4(1)



**Fig 13.1.6 Sprint 4(2)**



## Fig 13.1.7 Sprint 4(3)



**Fig 13.1.8 Sprint 4(4)**

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