SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITAN CITIES

1.INTRODUCTION

1.1 PROJECT OVERVIEW

Waste is any substantial that is undesirable or unusable. It is any substance which is discarded after primary use, or is worthless, flawed and of no use. The rapid growth and accumulation of waste in our society is a major problem, especially when monitoring and management tools are not properly maintained. In a smart city that continuously reduces pollution, hygiene is essential and cleaning begins with the setting up of waste treatment facilities in strategic locations. Real-time monitoring and management of strategically placed containers and final destination dumping is essential. As we know that, house to house garbage collection is critical issue for the respective garbage management authority so, to overcome this kind of problem, we came up with the new and refreshing idea. Therefore, this study presents an innovative system that helps keep cities clean by applying a system to monitor and control the level of garbage can. Environmental hygiene is very important for a healthy life. In our daily lives, waste containers should be stored without proper supervision until they overflow and fill up to leak and produce environmental pollutants that cause serious problems for human and environmental health. Is often. In smart cities, garbage containers need to be monitored and managed to ensure a healthy and smooth environment. In the field of technological progress, real-time monitoring and manipulation of waste treatment is a difficult topic that arouses urgent interest in the research community. Traditional methods of monitoring waste in strategically located waste bins are time-consuming, labor-intensive, costly, highly tedious and inefficient methods that do not meet the needs of smart cities. This study paper continuously detects the layout and implementation of IoT, as well as the percentage and location of waste in the bin, displays a \"full\" message when the bin is 85% full, and has a 15-time margin. Provides an ultrasonic sensor to give. % Will be supplied. Visual display if the emptying process is delayed.

1.2 PURPOSE

As such, the proposed SWM systems can be roughly divided into a system that improve internal processes and systems that disseminate the information by providing a holistic real-time view. A small number of studies propose economic and ecological features for the SWM system. Economic features can be either incentive (or punishment based. The monitoring of citizens' waste sorting and the calculation of payments in many SWM systems can be based on blockchain technology. Blockchain technology ensures the decentralization and security of transactions owing to its use of cryptographic hash functions and public key cryptographic systems. The pay-asyou-throw usage-pricing model, by which users are charged a rate based on amount of waste, is quite common in SWM systems that calculate the personal cost of waste disposal. Some systems use rewards for citizens who correctly sort and separate garbage. The ecological aspects are linked to waste segregation and the measurement of environmental impact. This study identified the following goals of city-level SWM systems implementation: timely garbage disposal, optimization of the movement of garbage trucks, minimization of costs fuel and working hours of drivers improvement of the environmental situation in the city, citizens' increased awareness regarding the separate collection of waste, citizens' increased motivation to donate waste separately, and the provision of information to the city administration and various city services regarding the process of waste collection.

2. LITERATURE REVIEW

2.1 EXISTING PROBLEM

Solid waste are generated in India out of which only 87000 TDP are collected by the municipal corporation and rest of solid waste are spread on the roads. According to solid waste review of India 90% of municipal solid waste are disposed of in open dumps and landfills which create problems to public health and environment. Nowadays the main problem we people face is how we can tackle garbage which is spreading on the roads which affects our environment and also harms the people's health so to overcome these problems we have implemented the smart garbage collector system. The traditional way to tackle with Garbage was too difficult and also utilizes human effort, time and cost which has no use even in the presence of modern technology. Solid waste management is the biggest challenge in urban areas. Lots of systems have been developed and various methods have been used for waste management systems. This project also implemented using RFID (radio frequency identification) to improve waste management by providing early automatic identification of waste at bin level

Title: Inventory routing for dynamic waste collection

Author's Name: Martijn Mes, Marco Schutten, and Arturo Perez Rivera

Year: 2014

Description: Martijn Mes et al address the problem of collecting waste from sensor-equipped underground containers. These sensors enable the use of a dynamic collection policy. The problem, which is known as a reverse inventory routing problem, involves decisions regarding routing and container selection. In more dense networks, the latter becomes more important. To ensure uncertainty in deposit volumes and fluctuations due to daily and seasonal effects, we need the balances over time. We tune the parameters of this policy using optimal learning techniques combined with simulation

Title: Capacitated location of collection sites in an urban waste management system

Author's Name: Giapaolo Ghiani, Demetri Lagana, Emanuele Manni and Chefi Trik

Year: 2012

Description: Giapaolo Ghiani et al propose an integer programming model that helps decision-makers in choosing the sites where to locate the unsorted waste collection bins in a residential town, as well as the capacities of the bins to be located at each collection site. This model helps in assessing tactical decisions through constraints that force each collection area to be capacitated enough to fit the expected waste to be directed to that area. It resulted in a lower number of activated collection sites and fewer bins to be used.

Title: IOT-based waste management for smart city

Author's Name: Parkash and Prabus V

Year: 2015

Description: Parkash et al present the day scenario or the problems, many times we see that the garbage bins or Dust bins placed in public places in the cities are overflowing due to the increase in waste every day. It creates unhygienic conditions for the people and creates a bad smell around the surroundings which leads to the spreading of some deadly diseases & human illnesses, to avoid such a situation we are planning to design "IoT Based Waste Management for Smart Cities". In this system there are multiple dustbins located throughout the city or the Campus, these dustbins are provided with a low-cost embedded device that helps in tracking the level of the garbage bins and a unique ID will be provided for every dustbin in the city so that it is easy to identify which garbage bin is full. When the level reaches the threshold limit, the device will transmit the level along with the unique ID provided. These details can be accessed by the concerned authorities or workers from their place with the help of the Internet and immediate action can be made to clean the dustbins

Title: IOT-based smart waste management system using Wireless Sensor Network and Embedded Linux Board

Author's Name: Lata Kusum and Shri S K Singh

Year: 2016

Description: Lata Kusum et al present the Smart waste management system that identifies the fullness of the bin using a wireless sensor network and embedded Linux board and informs the authorized person about the cleaning of the bin. The system provides a web interface to the cleaning authority so that they can monitor and clean the garbage bin. In this project, Raspberry Pi is used as an embedded Linux board which is designed based on the arm 11 microcontroller architecture. The Embedded Linux board makes the communication with all distributed sensor nodes placed in the tested area through ZigBee protocol and itself acts as a coordinating node in the wireless sensor network. The goal of the coordinator node is to collect parameters like the bin level and odor wirelessly. Each sensor node consists of a level sensor and gas sensors and one ZigBee RF antenna device for communication with the coordinator node. Raspberry Pi stores collected data in the database and analyze the stored data. The board has an Ethernet interface and runs a simple data web server. Hence coordinator collects the data over ZigBee wireless communication protocol and allows the user to monitor the data from a web browser. The cleaning authority can collect the garbage on time.

Title: Overview of solid waste bin monitoring and collection system

Author's Name: Md. Shafiqul Islam, Maher Arebey, M.A. Hannan and Hasan Basri

Year: 2012

Description: Md. Shafiqul Islam et al introduced an integrated system combined with an integrated system of Radio Frequency Identification, Global Position System, General Packet Radio Service, Geographic Information System, and web camera. The built-in RFID reader in collection trucks would automatically retrieve all sorts of customer information and bin information from the RFID tag, mounted with each bin. GPS would give the location information of the collection truck. All The information on the central server would be updated automatically through the GPRS communication system. betterer than the existing system in terms of high-speed data transmission, precise real-time, and reliability.

2.2 REFERENCES

1.Lata Kusum and Shri S K Singh (2016) - IOT-based smart waste management system using Wireless Sensor Network and Embedded Linux Board

2.Parkash and Prabus V(2015) - IOT-based waste management for smart city

3. Martijn Mes, Marco Schutten, and Arturo Perez Rivera(2014) - Inventory routing for dynamic waste collection

4. Md. Shafiqul Islam, Maher Arebey, M.A. Hannan and Hasan Basri

(2012) - Overview of solid waste bin monitoring and collection system

5. Giapaolo Ghiani, Demetri Lagana, Emanuele Manni and Chefi Trik

(2012) - Capacitated location of collection sites in an urban waste management system

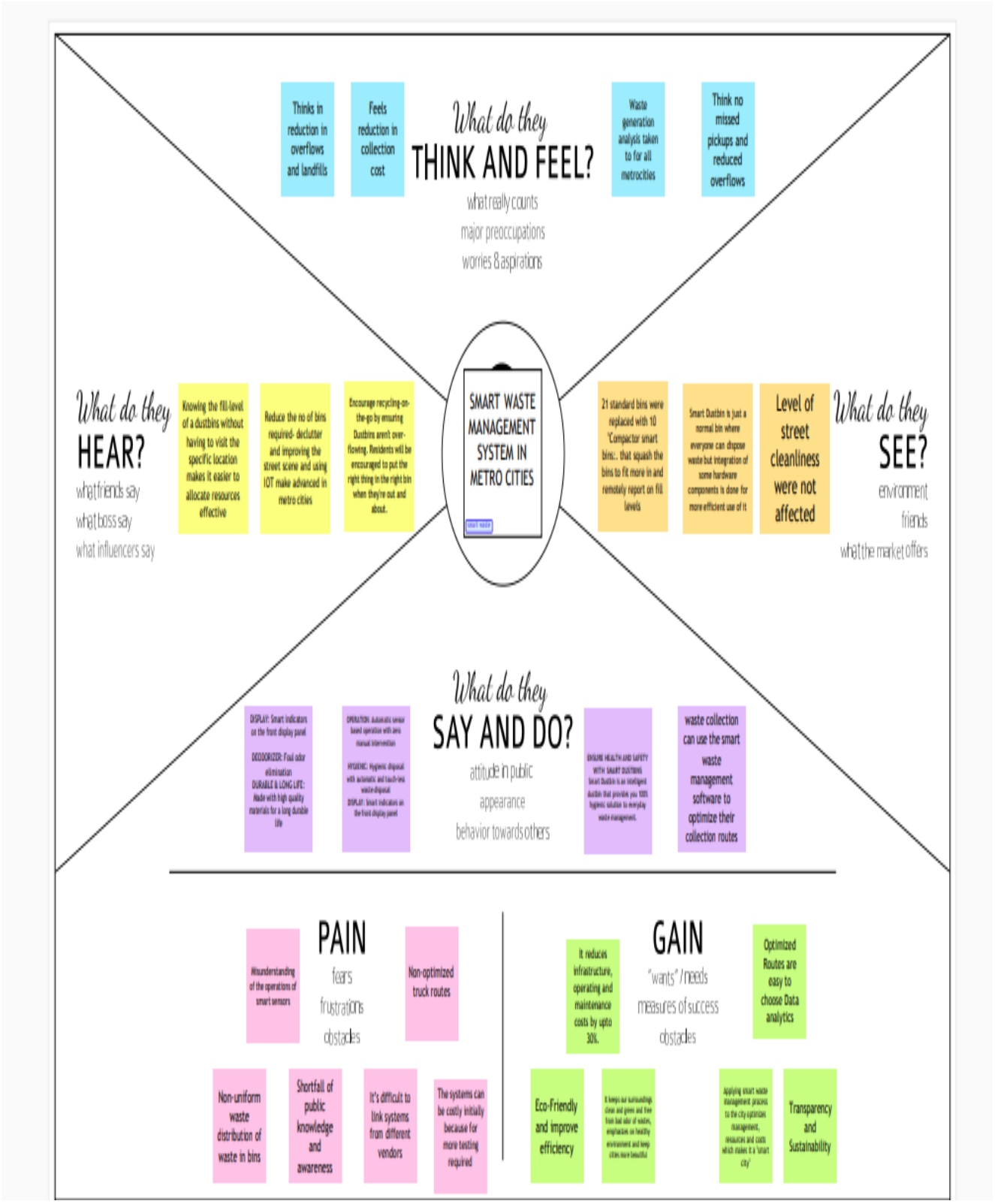
6.Chowdhury Belal and U Chowdhury Morshed (2007) RFID-based real-time smart waste management system

2.3 PROBLEM STATEMENT DEFINITION

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.

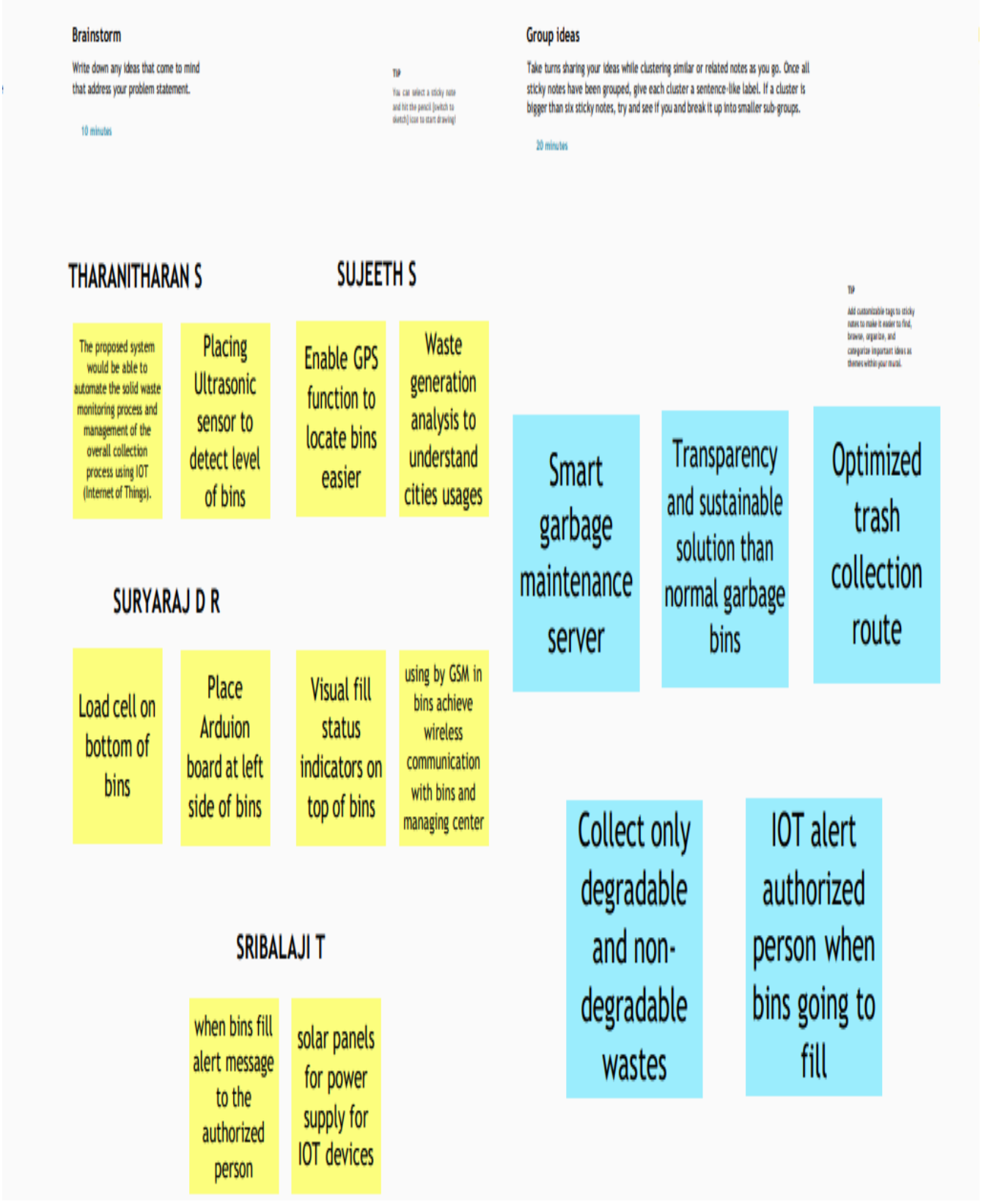
3. IDEATION & PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS



3.2 IDEATION & BRAINSTORMING

Brainstorm & Idea Prioritization Template:



Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes

Waste generation analysis to understand cities usages

Raspberry-pi with ultrasonic, GPS, Load cell, are configured

Importance

If each of these tasks could get done without any difficulty or cost, which would have the most positive impact?

TIP

Participants can use their cursors to point at where sticky notes should go on the grid. The facilitator can confirm the spot by selecting the laser pointer holding the H key on the keyboard.

3.3 Proposed Solution

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

5.	Business Model (Revenue Model)	Waste Management organises its operations into two reportable business segments: Solid Waste, comprising the Company's waste collection, transfer, recycling and resource recovery, and disposal services, which are operated and managed locally by the Company's various subsidiaries, which focus on distinct geographic areas; and Corporate and Other, comprising the Company's other activities, including its development and operation of landfill gas-to-energy 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 IoT-based 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

STEP 1

Problem Solving Cards

-Basic question

#Problem Statement

1. *What's most valuable to the customer?*
2. *What are we the best at?*
3. *Where are we looking to improve?*

STEP 2

Framing Statements

Smart waste management system framing

How can we use our Optimization skills to increase the customer's value of Saving Time, in order to improve the waste management?

The greatest problem regarding waste management in developing countries begins at the very starting point of the process. Due to lack of proper systems for disposal and collections, wastes and garbage's end up in the roads and surrounding. According to a report from Google research, the amount of waste generation in 2010 was around 20,000 tons per day, and it is estimated that by 2025 the amount will be no less than around 47000 tons per day. With the existing methods of collecting and disposal it is near impossible to manage such amount of waste in the future as around 30% of waste end up on the roads and public places due to ineffective disposing and collecting methods. Not only that, there is even no systematic methodology for the collected garbage for treating and recycling thus most of them end up in land filling and river water, making the environment unhealthier.
The prime impediment of implementing smart waste management system based on IoT in a developing country is the social and economic infrastructure of the country itself. The initial stage of this system comprises of proper disposal and collection, which is the biggest challenge. In addition, to motivate and influence people to follow proper waste disposal methods is also important.

STEP 3

Ideas

Problem Solution

Example ideas:

Ai-based smart waste bin, designed for public places, enabling them to Monitor and Manage

Reduce the number of bins required & DE-cluttering and improving the street scene

Previously there were numerous initiatives on waste management and educating people to dispose waste properly, and as they failed to achieve significant results, we have figured out the scopes that could be develop. To solve this problem, we have designed a process that ensures proper disposal and efficient waste collection. The procedures we designed involves creative initiative that will inspire people to dump in designated area or bins, and innovative method by using Decreasing Time algorithm or DTA for monitoring garbage generation and collection of the garbage's.

4.REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENTS

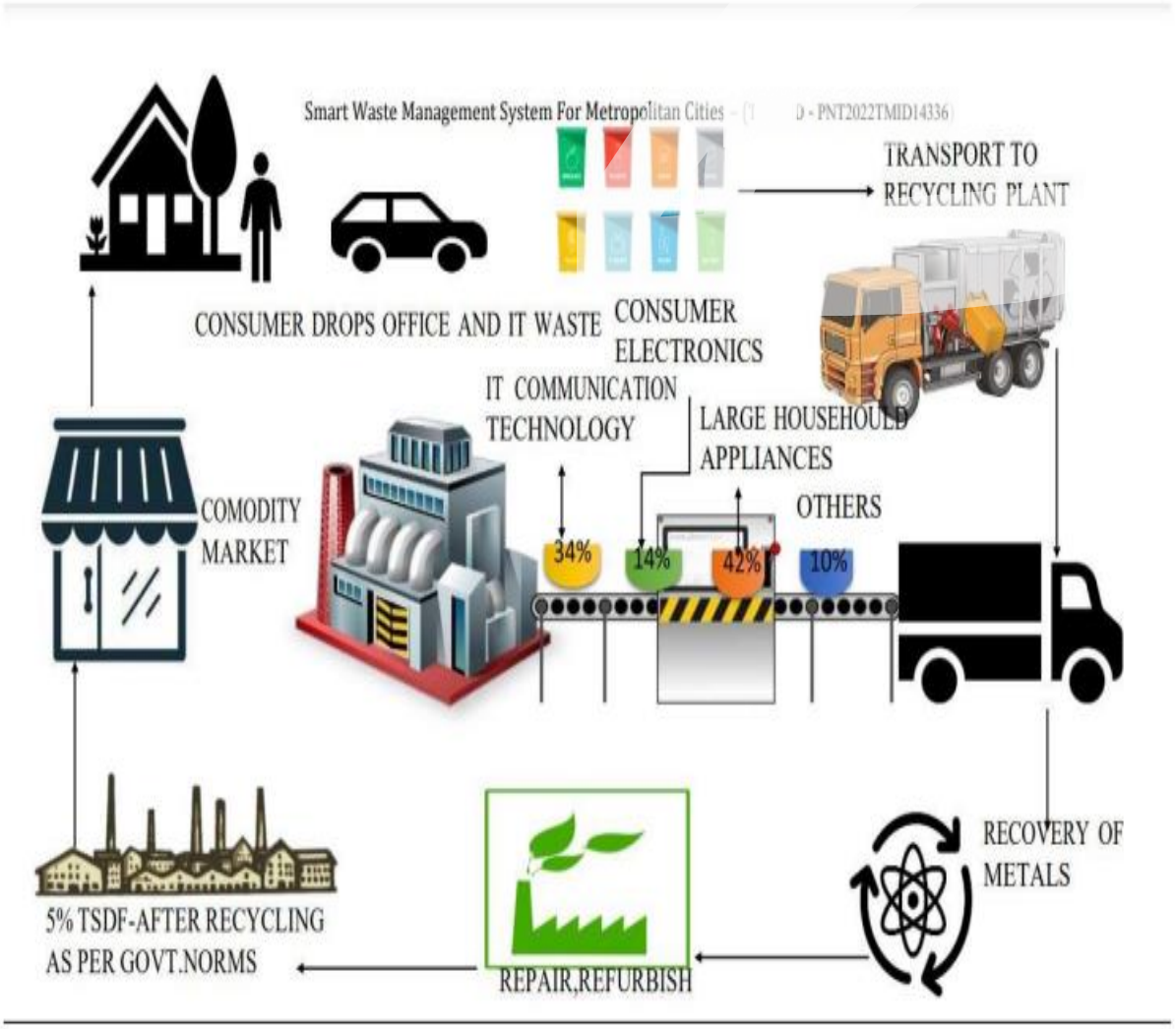
FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Detailed bin inventory.	All monitored bins and stands can be seen on the map, and you can visit them at any time via the Street View feature from Google. Bins or stands are visible on the map as green, orange or red circles. You can see bin details in the Dashboard – capacity, waste type, last measurement, GPS location and collection schedule or pick recognition.
FR-2	Real time bin monitoring.	The Dashboard displays real-time data on fill-levels of bins monitored by smart sensors. In addition to the % of fill-level, based on the historical data, the tool predicts when the bin will become full, one of the functionalities that are not included even in the best waste management software.. Sensors recognize picks as well; so you can check 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 depo-bin-discharge in the area. The tool assigns bin a rating (1-10) and calculates distance from depo-bin discharge.
FR-4	Adjust bin distribution.	Ensure the most optimal distribution of bins. Identify areas with either dense or sparse 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 real-time data on fill-levels and pick recognition, we can show you how full the bins you collect are.

4.2 NON-FUNCTIONAL REQUIREMENTS

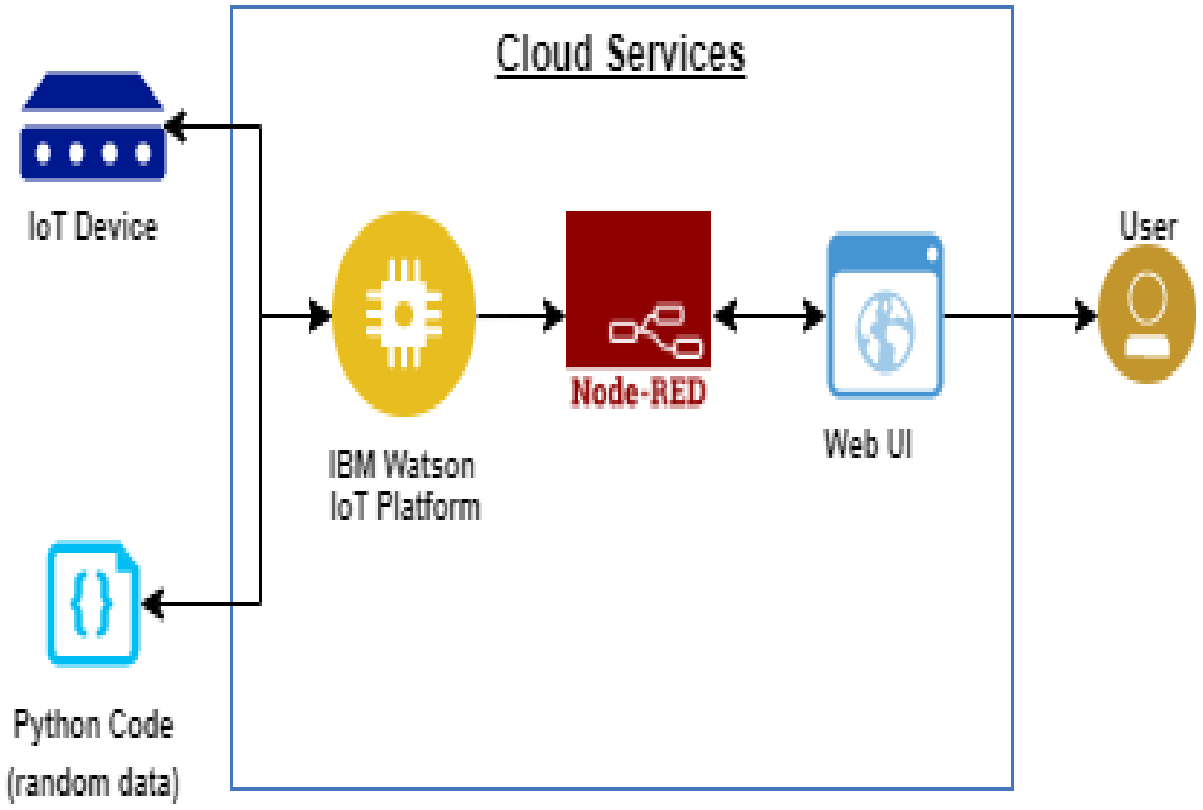
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	IoT device verifies that usability is a special and important perspective to analyze user requirements, which can further improve the design quality. In the design process with user experience as the core, the analysis of users' product usability can indeed help designers better understand users' potential needs in waste management, behavior and experience.
NFR-2	**Security**	Use a reusable bottles Use reusable grocery bags Purchase wisely and recycle Avoid single use food and drink containers.
NFR-3	**Reliability**	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 Sensoneo's Smart Waste Management Software System, a powerful cloud-based platform, for data-driven daily operations, available also as a waste management app. Customers are hence provided data-driven decision making, and optimization of waste collection routes, frequencies, and vehicle loads resulting in route reduction by at least 30%.
NFR-5	**Availability**	By developing & deploying resilient hardware and beautiful software we empower cities, businesses, and countries to manage waste smarter.

5. PROJECT DESIGN

5.1 DATA FLOW DIAGRAM



5.2 Solution & Technical Architecture



5.3 USER STORY

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Admin (who manage web server)	Web server login	USN-1	As a admin, I have my user name and password for every worker and co-workers tomanage them.	I can manage web account and direct workers.	High	Sprint-1
Co-admin	Login	USN-2	As a co-admin, I'll manage other monitoringactivities like garbage level monitoring, location accuracy, garbage separation andremoval of waste within a scheduled time.	I can monitor garbage bins activities.	High	Sprint-2
Customer (Webuser)	User	USN-3	Here comes the customer, he/she will haveaccess to mobile apps or login web pages to view progress of bins and to report if anyquery found.	He/ she has the right tomake a query if any.	High	Sprint-3
Customer Care Executive	Worker	USN-4	The customer care executive, will try to rectifythe queries from customers by contacting co-admin. If case of any critical/ emergency situation query can be conveyed to higher authority.	I can attend calls and respond people by rectifying the problem.	High	Sprint-4
Truck driver	Worker	USN-5	Here, truck driver is a worker who has particular assignments that he has to report when and where the garbage has been pickedaccording to the daily schedule. And should update the happenings in the given website (web page login).	I can update my activitieson site when the given task has been completed.	Moderate	Sprint-5

6.PROJECT PLANNING AND SCHEDULING

6.1 SPRINT PLANNING AND ESTIMATION

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Team Members
Sprint-1	Login	USN-1	As Administrator, I need to give user id andpasscode for ever workers over there in municipality	10	Suryaraj
Sprint-1	Login	USN-2	As Co-Admin, I'll control the waste level by monitoring them real time web portal. I'll notifytrash truck with location of bin with bin ID	10	Tharanitharan
Sprint-2	Dashboard	USN-3	As Truck Driver, I'll follow Admin's Instructionto reach the filling bin in short roots and save time	20	Sujeeth
Sprint-3	Dashboard	USN-4	As a Local Garbage Collector, I'll gather all the waste from the garbage, load it onto a garbage truck, and deliver it to Landfills	20	Sribalaji
Sprint-4	Dashboard	USN-5	As a Municipality officer, I'll make sure everything is proceeding as planned andwithout any problems	20	Suryaraj

6.2 SPRINT DELIVERY SCHEDULE

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

7.CODING AND SOLUTIONING

7.1 FEATURE 1

- IoT Device
- IBM Watson platform
- Node Red
- Cloudant DB
- Web UI
- Geofence
- MIT App
- Python Code

7.2 FEATURE 2

- Source
- Storage
- Collection
- Transfer
- Transportation
- Final disposal

```
const cap_status =
document.getElementB
yId('cap_status');
```

```
const alert_msg =
document.getElementById('alert_msg');


var ref = firebase.database().ref();

ref.on("value", function(snapshot)
 {
   snapshot.forEach(function (childSnapshot) {

      var value = childSnapshot.val();

            const alert_msg_val = value.alert;

            const cap_status_val =
value.distance_status;



            alert_msg.innerHTML=
`${alert_msg_val}`;
   });
 }, function (error) {
   console.log("Error: " + error.code);
 });
```

8.TESTING

8.1 TEST CASES

Test Scenario	Pre-Requisite	Steps To Execute	Test Data	Expected Result	Actual Result	Status	Comments	TC for Automation(Y/N)	BUG ID	Executed By
Create the IBM Cloud services which are being used in this project.	IBM Cloud Login ID & Password	1.Go to IBM Cloud signup page 2.Enter e-mail id and other credentials 3.Enter a password	https://cloud.ibm.com/login	User should sign up IBM cloud and details should be verified	Working as expected	Pass	Results verified	No		SURYARAJ
Configure the IBM Cloud services which are being used in completing this project.	IBM Cloud Login ID & Password	1.Go to Cloud login 2.Enter user ID & Password 3.Verify login by the popup display	https://cloud.ibm.com/login	User login to IBM Cloud and should be navigated to IBM Cloud dashboard page	Working as expected	Pass	Results verified	No		THARANITHARAN

IBM Watson IoT platform acts as the mediator to connect the web application to IoT devices, so create the IBM Watson IoT platform.	IBM Watson IoT Platform Login ID & Password	1.Login to IBM Cloud 2.Click Catalog 3.Search IoT and click create 4.Go to resource list and search Internet of Things platform 5.Press Launch and click Sign in IBM Watson Platform	https://internetofthings.ibmcloud.com/	User should be navigated to IBM IoT Watson Platform	Working as expected	Pass	Results verified	No		SRIBALAJI
In order to connect the IoT device to the IBM cloud, create a device in the IBM Watson IoT platform	IBM Watson IoT Platform Login ID & Password	1.Login to IBM Watson Platform 2. Click Add Device 3.Enter the details and click Finish. Create Device ID & Device type 4.Turn on Device Simulator and click	Load cell,IR Sensor and GPS/GSM values are generated randomly in simulation	Load cell,IR Sensor and GSM/GPS values should be randomly generated	Working as expected	Pass	Results verified	No		SUJEETH

and get the device credentials.		simulation running. Enter the values of loadcell, IR sensor and GSM/GPS 5.Click Send & Save. Verify the displayed result of the levels								
Configure the connection security and create API keys that are used in the Node-RED service for accessing the IBM IoT Platform.	Node Red Installation	1.Install node red and open node red in command prompt 2.Select IBM input in IoT	https://cloud.ibm.com/developer/appservice/create-app?starterKit=59c9d5bd-4d31-3611-897a-f94eea80dc9f&defaultLanguage=undefined	User should be able to see the Node Red page	Working as expected	Pass	Results verified	No		SURYARAJ

Create a Node-RED service.	Node Red Installation	1.Select IBM IoT input in Node. In IBM IoT Watson Platform, go to apps and click on generate API keys. 2.Copy & paste generated API key and token in the IBM IoT input. After entering all details, click the done button. 3.Add debug to the IBM IoT and rename as Msg.payload and click on done. Click gauge from the dashboard and fill the details & add functions to the gauge. Check the	Values of sensors and button for light ON/OFF is displayed	Values of sensors and button for light ON/ OFF should be displayed	Working as expected	Pass	Results verified	No		THARANITHARAN

		generated values from the debug message. 4.Edit function node, connect them, add another gauge and functions, name them as "loadcell,IR sensor & GSM/GPS" 5.Finally add light ON/OFF buttons to the IBM IoT and debug. Verify the output from NODE RED using Local host link								
Develop a python script to publish random sensor data	Python 3.7.0 (64 bit) installation	1.Download and install Python 3.7.0 2.Develop python code	https://www.python.org/downloads/release/python-370/	User should be able to develop a python code	Working as expected	Pass	Results verified	No		SRIBALAJI

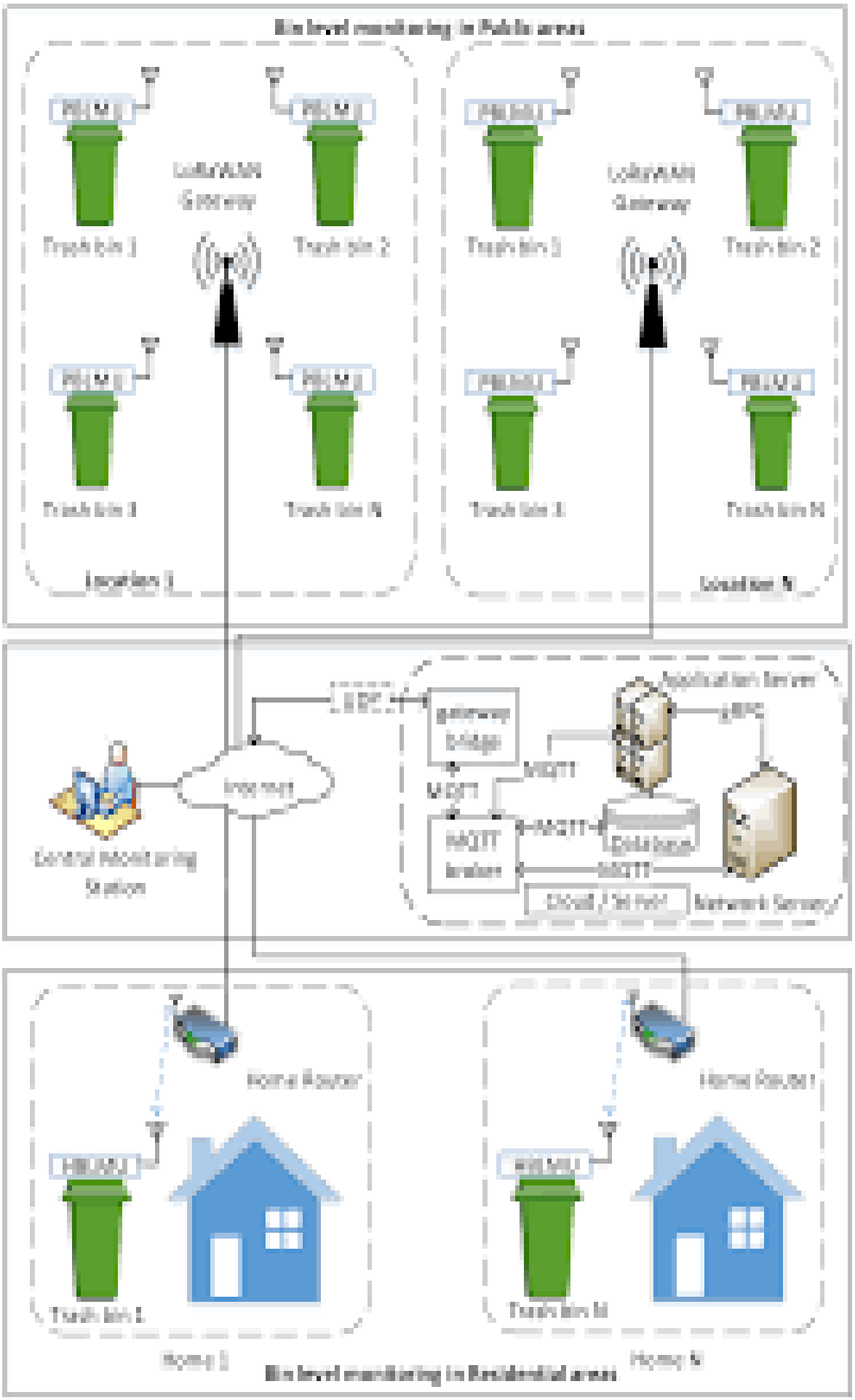
such as load cell ,IR sensor and GSM/ GPS to the IBM IoT platform										
After developing python code, commands are received just print the statements which represent the control of the devices.	Python 3.7.0 (64 bit) installation	1.Download and install Python 3.7.0 2.After python code	Get the output from the code	User should be able to get the results from the developed code	Working as expected	Pass	Results verified	No		SUJEETH
Publish Data to The IBM Cloud	IBM Cloud Login ID & Password	1.Run the python code 2.Verify the displayed output	Publishment of python code	User should be able to publish the code	Working as expected	Pass	Results verified	No		SURYARAJ

Create Web UI in Node - Red	MIT Inventor Login ID & password	1.Go to Node Red. Select http in & http response. Add functions and select another http in and http response. Connect them to IBM IoT output and function .Print the command statements such as light ON/OFF and sensor 2.Go to MIT app inventor and create frontend using buttons, horizontal arrangement, text bar, etc. Add blocks and so on to create back end. Verify the output	Sensors values and command values can be seen in the mobile application	Sensors values and command values should be seen in the mobile application	Working as expected	Pass	Results verified	No		THARANITHARAN

Configure the Node-RED flow to receive data from the IBM IoT platform and also use Cloudant DB nodes to store the received sensor data in the cloudant DB	IBM Cloud Login ID & Password	1.Go to IBM cloud, search Cloudant in Catalog, Add new dashboard, go to Node Red 2.Connect to cloudant and verify the results	Cloudant is connected by NODE RED	User should be able to connect the Cloudant and Node Red	Working as expected	Pass	Results verified	No		SRIBALAJ

9.RESULTS

9.1 PERFORMANCE METRICES


Bin level monitoring in Public areas
LoRaWAN Gateway
Trash bin 1
Trash bin 2
Trash bin N
Location 1
Location N
Internet
General Monitoring Station
gateway bridge
MQTT
MQTT broker
Application Server
gRPC
Database
Network Server
Home Router
Home 1
Home N
Bin level monitoring in Residential areas

10.ADVANTAGES AND DISADVANTAGES

10.1 ADVANTAGES

- It saves time and money by using smart waste collection bins and systems equipped with fill level sensors. As smart transport vehicles go only to the filled containers or bins. It reduces infrastructure, operating and maintenance costs by upto30%.
- It decreases traffic flow and consecutively noise due to less air pollution as result of less waste collection vehicles on the roads. This has become possible due to two way communication between smart dustbins and service operators.
- It keeps our surroundings clean and green and free from bad odour of wastes, emphasizes on healthy environment and keep cities more beautiful.
- It further reduces manpower requirements to handle the garbage collection process.
- Applying smart waste management process to the city optimizes management, resources and costs which makes it a "smart city".
- It helps administration to generate extra revenue by advertisements on smart devices.

10.2 DISADVANTAGES

- System requires a greater number of waste bins for separate waste collection as per population in the city. This results into high initial cost due to expensive smart dustbins compare to other methods.
- Sensor nodes used in the dustbins have limited memory size.
- Wireless technologies used in the system such as ZigBee and Wi-Fi have shorter range and lower data speed. In RFID based systems, RFID tags are affected by surrounding metal objects (if any).
- It reduces manpower requirements which results into increase in unemployment's for unskilled people.
- The training must be provided to the people involved in the smart waste management system.

11.CONCLUSION

Smart waste management is faced with a number of issues which include lack of throughput, inadequate solid waste data, efficiency problem, delays in collection and resistance to new technologies. Presently, waste management is a major problem for authorities who are responsible for such task because it's a costly service and it hugely impacts the environment as a whole. This study introduced a smart waste monitoring system that uses several sensors and communication technologies to achieve the set task. The proposed system was achieved through the development of theoretical models, layout, and decision-making algorithms during the project. There is an enormous amount of room for the development of this project for it to meet commercial standards. One of my many recommendations would be that of the addition of other sensors e.g., accelerometer. The accelerometer will make the system save more energy by turning on the system to measure the bin level only when the lid is opened to dispose waste. The system would then update its current state on Thing Speak and turn off, preventing unnecessary measurement when the bin's level has not been altered due to dormancy. Another recommendation is the use of solar panel for power generation making its power supply autonomous.

12.FUTURE SCOPES

Public can also view the collection rates, and which is the nearest empty bin to their house. Growing Smart Cities could be a huge potential market for such systems. Cost of this system is about 847(esp., uno and hc-sr04). + Compactor system (according to bin). This is an initiative to take the Swachh Bharat campaign to the next level

13.APPENDIX

13.1 SOURCE PROGRAM

```
. <!DOCTYPE html>
<html>

<head>
  <link rel="stylesheet"
href="https://cdn.jsdelivr.net/npm/bootstrap@4.3.1/dist/css/bootstrap.min.css"
integrity="sha384-
ggOyR0iXCbMQv3Xipma34MD+dH/1fQ784/j6cY/iJTQUOhcWr7x9JvoRxT2MZ
w1T" crossorigin="anonymous">
        <meta charset="utf-8">
        <meta name="viewport" content="width=device-width">
        <title>Garbage Management System</title>
        <link rel="icon" type="image/x-icon" href="/Images/DUMPSTER.png">
        <link href="style.css" rel="stylesheet" type="text/css" />
        <script src="https://www.gstatic.com/firebasejs/8.10.1/firebase-
app.js"></script>
        <script src="https://www.gstatic.com/firebasejs/8.10.1/firebase-
database.js"></script>

        <script>
                var firebaseConfig =
                {
                        apiKey: "AIzaSyB9ysbnaWc3IyeCioh-aJQT_UCMd5CBFeU",
                        authDomain: "fir-test-923b4.firebaseapp.com",
                        databaseURL: "https://fir-test-923b4-default-
rtdb.firebaseio.com",
                        projectId: "fir-test-923b4",
                        storageBucket: "fir-test-923b4.appspot.com",
                        messagingSenderId: "943542145393",
                        appId: "1:943542145393:web:9b5ec7593e6a3cbd7966d0",
                        measurementId: "G-BN7JNX1Q7B"
                };
                firebase.initializeApp(firebaseConfig)
        </script>
        <script defer src="database.js"></script>
</head>

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

```
            <div id="map_container">
                <h1 id="live_location_heading" >LIVE LOCATION</h1>
                <div id="map"></div>
                <div id="alert_msg">ALERT MESSAGE!</div>
   </div>
        </div>
<center><a href="https://goo.gl/maps/G9XET5mzSw1ynHQ18"
  type="button" class="btn btn-dark">DUMPSTER</a></center>

        <script
            src="https://maps.googleapis.com/maps/api/js?key=AIzaSyBBLyWj-
3FWtCbCXGW3ysEiI2fDfrv2v0Q&callback=myMap"></script></div>
</body>

</html>


html, body
        {
        height: 100%;
            margin: 0px;
            padding:0px;
        }
#container
{
        display: flex;
        flex-direction: row;
        height: 100%;
        width: 100%;
        position: relative;
}
#logo_container
{
        height: 100%;
        width: 12%;
        background-color: #C5C6D0;
        display: flex;
        flex-direction: column;
        vertical-align: text-bottom;
}
.logo
{
        width:70%;
```

```
        margin: 5% 15%;

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

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

```
        height: 40%;
        margin:5% 10%;
        background-color:#185adc;
        border-radius:20px;
        display: flex;
        justify-content: center;
        align-items: center;
        color: white;
        font-size: 60px;


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

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

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

```
}
#alert_msg
{
        width:92%;
        height:20%;
        margin:4%;
        background-color:grey;
        border-radius: 20px;
        display: flex;
        justify-content: center;
        align-items: center;
        color: #41af7f;
        font-size: 25px;
        font-weight: bold;
}
.lat
{
        margin: 0px;
        font-size:0px;
}



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

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

_____
}
```