SMART WASTE MANAGEMENT FOR METROPOLITAN CITIES

PROJECT REPORT

Submitted by

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ABSTRACT

The neat and clean surrounding is the main driving force for any city to be called a “smart city”. Many modern cities are currently encumbered with various challenges such as smart transport system, smart grid, smart environment, and smart living. Now-a-days, proper waste management is the major concern for cities and urban areas. The traditional waste management approaches are not sophisticated enough to achieve a proficient and robust waste management. Smart Waste Management is on top priority in any smart city as it directly affects the lifestyle, healthcare and environment. This article deliberates a comprehensive survey of various proposed approaches for smart bin systems such as Smart Garbage Monitoring System, Wisely Waste Segregation System, and Smart Waste Collection System. In addition to this Survey, we propose a framework for a smart Garbage Management System. One of the challenges most cities and towns are confronting is the decline in the cleanliness of the environment regarding the garbage management. This occurs due to the mismanagement of the garbage collection. This mismanagement creates the spread of garbage in the community which in turn creates unhealthy conditions in the immediate area. It also stimulates several serious diseases amongst the people in close proximity and degrades the beauty of the area. To avoid mismanagement of the garbage and to improve the cleanliness of the society, the Garbage monitoring system is designed.

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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Waste management is all the activities and actions required to manage waste from its inception to its final disposal. This includes, treatment and disposal of waste together with monitoring and regulation. Waste collection methods vary widely among different countries and regions. Domestic waste collection services are often provided by local government authorities. Curbside collection is the most common method of disposal in most countries, in which waste is collected at regular intervals by specialized trucks. Waste collected is then transported to an appropriate disposal area. Nowadays, cities with developing economies experience exhausted waste collection services, inadequately managed and uncontrolled dumpsites and the problems are worsening. Waste collection method in such countries is anon-going challenge and many struggle due to weak institutions and rapid urbanization.

1.2 PURPOSE

With an increase in population at an unprecedented rate, the scenario of cleanliness with respect to garbage management in terms of collection, sorting and finally disposal is facing an increasing number of challenges . The overflow of garbage in public areas creates the unhygienic condition in the nearby surrounding which may cause serious diseases. To avoid this and to automate the cleaning and ensure end to end efficient garbage disposal "IOT BASED GARBAGE MANAGEMENT SYSTEM" is proposed.In most of the city the overflowed garbage bins are creating an unhygienic environment .This will further lead to different types of diseases. To over come these situations an efficient smart waste collection has to developed.

- By 2030, almost two-third of the world's population will be living in cities. This fact requires the development of sustainable solutions for urban life, managing waste is a key issue for the health

❖ Efficient and energy-saving waste management, reducing CO2,air pollution and vehicle exhaust emissions—these are just a few examples for the demands of future cities. In views of that, the efficient use and responsible handling of resources become more important.

❖ Even with great route optimization, the worker must still physically go to the dustbin to check waste levels. Because of this, trucks often visit containers that do not need emptying, which wastes both time and fuel.

❖ Waste management prevents harm to human health and the environment by reducing the volume and hazardous character of residential and industrial waste.

❖ Improving proper waste management will reduce pollution, recycle useful materials and create more green energy.

CHAPTER 2

LITERATURE SURVEY

A Literature Review Surveys scholarly articles, books, and other sources (e.g., dissertations, conference proceedings) relevant to a topic for a thesis or dissertation. Its purpose is to demonstrate that the writer has insight fully and critically surveyed relevant literature on his or her topic in order to convince an intended audience that the topic is worth addressing

2.1 EXISTING PROBLEMS

- Manual systems in which employees clear the dumpsters periodically.
- No systematic approach towards clearing the dumpsters.
- Unclear about the status of a particular location
- Employees are unaware of the need for a particular Location
- Very less effective in cleaning city

2.2 REFERENCE

🗐 **Smart bin: Smart waste management system**

In this paper, we present the Smart bin system that identifies fullness of litter bin. The system is designed to collect data and to deliver the data through wireless mesh network. The system also employs duty cycle technique to reduce power consumption and to maximize operational time. The Smart bin system was tested in an outdoor environment. Through the tested, we collected data and applied sense-making methods to obtain litter bin utilization and litter bin daily seasonality information. With such information, litter bin providers and cleaning contractors are able to make better decision to increase productivity.

🗐 Internet of Things based garbage monitoring system

In today's busy world time is a vital issue which can't be managed by noticing each and every phenomenon with our tight schedule. So now a day's Automatic systems are being preferred over manual system to make life simpler and easier in all aspects. To make it a grand success Internet of Things is the latest internet technology developed. The number of users of internet has grown so rapidly that it has become a necessary part of our daily life. Our matter of concern in this project is development of Internet of Things based Garbage Monitoring System. As the population of world is increasing day by day, the environment should be clean and hygienic for our better life leads. In most of the cities the overflowed garbage bins are creating an obnoxious smell and making an unhygienic environment. And this is leading to the rapid growth of bacteria and viruses which are causing different types of diseases. To overcome these situations efficient garbage collection systems are getting developed based on IoT. Various designs have already been proposed and have advantages as well as disadvantages. This paper is a review of Garbage Monitoring System based on IoT.

🗐 Implementation of an smart waste management system using IoT

Waste collection services, today, are exhausted and unable to bear the burden of rising cities. It is one of the biggest ongoing challenges, being faced by developing economies, where a large variety of goods ranging from cars to metal and hardware end up in inadequately managed and uncontrolled dumpsites, spreading diseases and increasing pollution. However, most of these plans have been able to manage waste once it has already been created. We, therefore, propose a system through a mobile application associated with a Smart Trash Bin. The main aim of this application is to reduce human resources and efforts along with the enhancements of a smart city vision. At regular intervals dustbin will be squashed. Once these smart bins are implemented on a large scale, by replacing our traditional bins present today, waste can be managed efficiently as it avoids unnecessary lumping of wastes on roadside. Breeding of insects and mosquitoes can create nuisance around promoting unclean environment. This may even cause dreadful diseases.

🗐 Garbage management with Smart trash using IoT

The waste produced day to day seems to be unstoppable, from small scale to large scale it is increasing constantly. From different sources we come to know that we don't have proper dumping and disposing mechanism. These are due to lack of technology usages and bad management towards waste disposal. People also do

not take it seriously because either they are not aware or not taking responsibility regards it. To reform the current scenario, we have proposed model of Smart Trash. Here, we made system automatic so that human need not to put extra effort, except dumping garbage in the trash.Also, we proposed management system where if trash is full and it is not made empty on time, message will be delivered to concern authorities. In order to involve more participants, there is reward system i.e., if person use the trash properly such people will be benefited with some reward points that can be redeemed through the shop.

- **Design a smart waste bin for smart waste management**

In this paper, we presented the smart waste-bin that can managed the waste in a smart city project. The system consist of sensors to measure the weight of waste and the level of waste inside the bin. The system also adapt with network environment, to manage all information from waste management. As the result we proposed a prototype of smart waste-bin that suitable for many kind of conventional waste-bin

Smart bin: Smart waste management system 2015 IEEE Tenth International Conference on Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), 1-2, 2015 Fachmin Folianto, Yong Sheng Low, Wai Leong Yeow

Internet of Things based garbage monitoring system 2017 8th Annual Industrial Automation and Electromechanical Engineering Conference (IEMECON), 127-130, 2017 Sagnik Kanta, Srinjoy Jash, Himadri Nath Saha

Implementation of an smart waste management system using IoT 2017 International Conference on Intelligent Sustainable Systems (ICISS), 1155-1156, 2017 P Haribabu, Sankit R Kassa, J Nagaraju, R Karthik, N Shirisha, M Anila

Garbage management with Smart trash using IoT2020 IEEE International Students' Conference on Electrical, Electronics and Computer Science (SCEECS), 1-6, 2020Ankit Mishra, Dilip Kumar Patel, Tamanna Singh, Abhijeet Singh

Design a smart waste bin for smart waste management2017 5th international Conference on Instrumentation, Control, and Automation (ICA), 62-66, 2017 Aksan Surya Wijaya, Zahir Zainuddin, Muhammad Niswar

2.3 PROBLEM STATEMENT

It tells about who,what,where,when &why

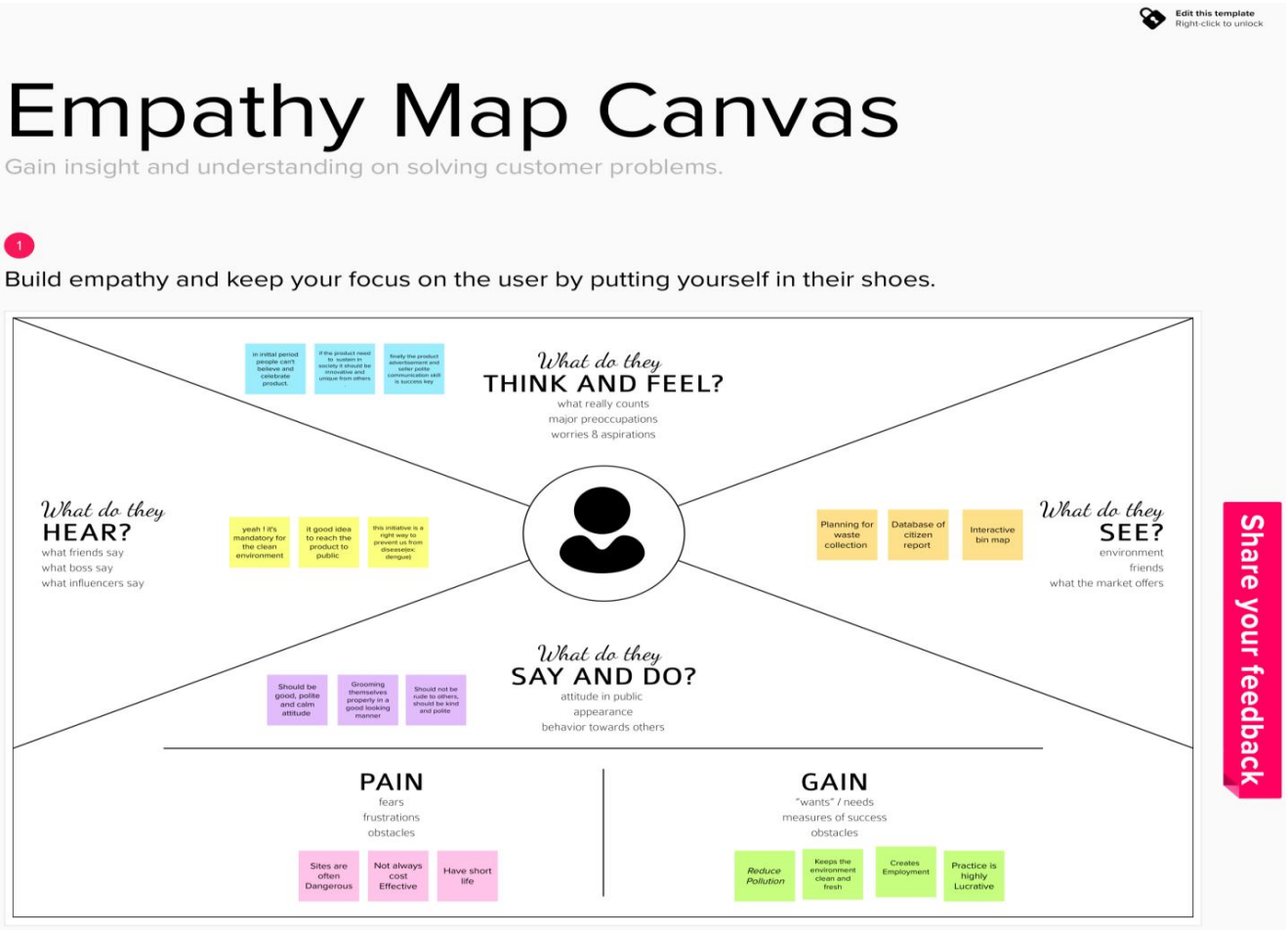
We Create a problem statement to understand our customer's point of view. The Customer Problem Statement template helps us to focus on what matters to create experiences people will love.A well-articulated customer problem statement allows us to find the ideal solution for the challenges our customers face. Throughout the process, we'll also be able to empathize with our customers, which helps us better understand how they perceive our product or service.

CHAPTER 3

IDEATION & PROPOSED SOLUTION

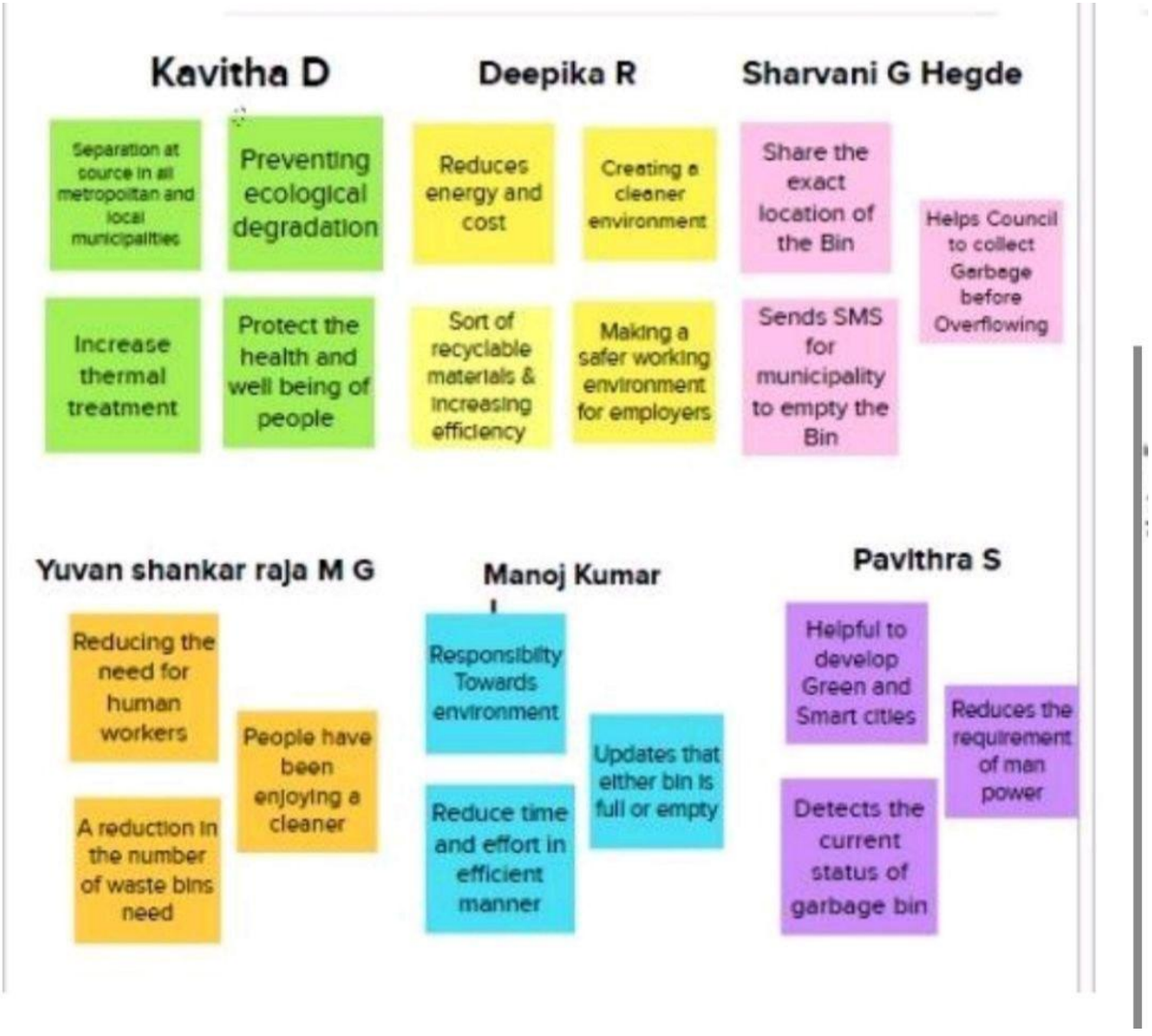
3.1 EMPATHY MAP CANVAS

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 us better understand our 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.



3.2 IDEATION & BRAINSTROMING

Brainstorming provides a free and open environment that encourages everyone within our 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 amount of creative solutions.



3.3 PROPOSED SOLUTION

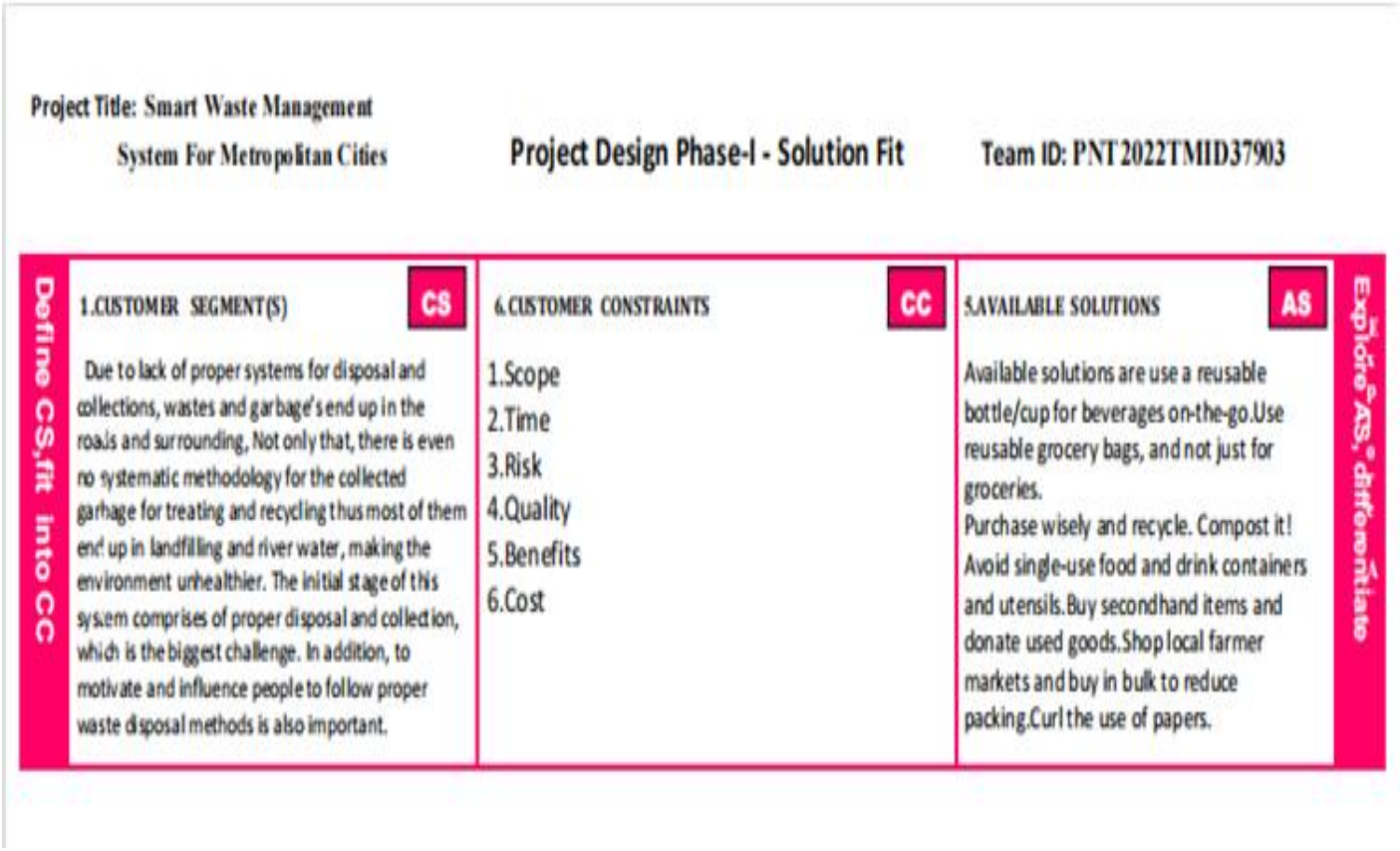
Proposed solution means relate the current situation to a desired result and describe the benefits that will accrue when the desired result is achieved.

SNO.	PARAMETER	DESCRIPTION
1	Problem Statement (Problem to be solved)	People who are living in a metropolitan areas
2	Idea / Solution description	In order to deal with these problems Smart 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
3	Novelty / Uniqueness	After product commissioning is done also we provide continue customer support,both site visit as well as remote support based on customer requirement. comparatively our product is better than current market available product in someway like product design, features, affordable price ,etc .
4	Social Impact / Customer Satisfaction	Social impact : Public awareness and proper knowledge of waste management and end use of different types of waste, health effects, environmental problems and economic issues that are related to waste management is very important for successful execution of any waste management related practices. Customer satisfaction : Reduces the route optimization ,fuel consumption while emptying the dumpsters throughout the city . Save both the time and money

5	Business Model (Revenue Model)	The global smart waste management market size was valued at $1,683.0 million in 2019, and is expected to reach $4,103.6 million by 2027, registering a CAGR of 15.1% from 2020 to 2027. Smart waste management is the concept that uses sensors in waste to track live status of city waste collection services when bins are ready to be emptied, or filled. It also monitors historical data collected by sensors and databases, which can be used to identify and optimize driver routes, fill patterns, reduce operational costs, and schedules. Remote monitoring, and IoT based waste bins are more feasible to collect waste effectively. It also reduces routing and fuel prices.It's market is segmented on the basis of waste type, method, source, and region. By waste type, it is divided into solid waste, special waste, and e-waste. Solid waste segment generated the highest revenue in 2019. On the basis of method, the market is divided into smart collection, smart processing, and smart energy recovery & smart disposal.
6	Scalability of the Solution	Iot for smart waste management's strength lies in the high impacts it created in the daily life and the potential user's behavior.However, for it to be more effective and increase its adoption, it is require to be energy efficient, able to communicate and share information across extended coverage.Existing technology such as Low Power Wide Area Network (LPWAN) with Long Range (LoRa) has been promising. In the perspective of waste management, several different IoT-enable solutions have been proffered with each having its own strengths and weaknesses that requires improvements.

3.4 PROPOSED SOLUTION FIT

The Problem-Solution Fit simply means that we have found a problem with our customer and that the solution we have realized for it actually solves the customer's problem. It helps entrepreneurs, marketers and corporate innovators identify behavioral patterns and recognize what would work.



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

2.JOBS-TO-BE-DONE/PROBLEMS — J&P

As a waste management collector, we'll create and put the plans in place to provide a reliable and efficient service for the collection, transportation and disposal of waste.

9.PROBLEM ROOT CAUSE — RC

- Lack of Public Awareness.
- Refusal to Learn About Compliance.
- Insufficient Investment in Waste Management.
- Lack of Proper Machinery.

7.BEHAVIOUR — BE

- Purchase wisely and recycle
- Shop eco-friendly with reusable bags
- Buy second hand electronics

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

Identify strong TR & EM

3.TRIGGERS — TR

- Landfill –growth.
- Incineration
- best way too trigger the customers to buy the product

4.EMOTIONS — EM

Before: This technology can lead towards the development and adoption of a cleaner production, circular economy and effective waste management, thus improving environmental sustainability.

After: Sustainable cities may seek ways to use the capabilities of disruptive technologies toward making changes in human behaviour to pro-environmental behaviour.

10.YOUR SOLUTION — SL

Our first job is to explain about the product clearly to the customers and main trick his we have too compare our product to the market available products and, then we need too explain our customers about the advantages and positive thing about the product. Mainly when the product is new to the market means we have too give a discount and good advertisement to the product. And the positive news can make a product successfully

8.CHANNELS OF BEHAVIOUR — CH

online:

- Use emails and articles instead of letters and magazines
- Create voluntary awareness in social media

Offline

- Reduce recycle reuse
- Buy second hands and reduce goods
- Use biodegradable covers
- Compost it

Identify strong TR & EM

CHAPTER 4

REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIRMENTS

The Functional Requirements Specification describes what the system must do; how the system does it is described in the Design Specification. If a User Requirement Specification was written, all requirements outlined in the User Requirement Specification should be addressed in the Functional Requirements Specification.

Following are the functional requirements of the proposed solution.

FR No.	FUNCTIONAL REQUIRMENTS(EPIC)	SUB REQUIRMENTS(STORY/SUB-TASK
1	Admin	login by using valid user name and password. add bins,add users, view the bin dashboard. View all the bins on the map, gives optimized routes for bin collection. Set garbage collector on duty and can view bin fill level of bins in real time and their location on google map.
2	Garbage collector	View the location of full bins on the map. Get optimized routes for bin collection.
3	System	validate and authenticate a registered user upon login. Fetch and Display the current levels of bin. Sends a SMS alert to Garbage collector on duty when bin is full.

		Allow the Admin to add bins,add users. Get the geolocation of garbage collector and give optimized routes for bin collection

4.2 NON-FUNCTIONAL REQUIRMENTS

Nonfunctional Requirements define system attributes such as security, reliability, performance, maintainability, scalability, and usability. They serve as constraints or restrictions on the design of the system across the different backlogs.

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

NFR NO.	NON-FUNCTIONAL REQUIRMENT	DESCRIPTION
1	Usability	User research centered smart application design for users to sorting and deal with the waste accurately with improved user experience and usability living in smart city
2	Security	The System should allow a secured communication between server,admin and users
3	Reliability	The System should be reliable and must not degrade the performance of the existing system and should not lead to the hanging of the system
4	Performance	The system must be designed such that it has a quick response time; the system must execute commands fast enough, including page load and refresh time
5	Availability	User research helps to get the user needs

		and collect the data for the main function optimization design for waste sorting in smart city, and pass the user test about its availability.
6	Scalability	Storage should be efficiently used. The system should be portable. The size of the application should not be too big to allow easy download and faster app loading time. The system and database must recover from failure quickly while devoid of frequent failure

CHAPTER 5

PROJECT DESIGN

5.1 DATAFLOW DIAGRAM:

A Data Flow Diagram is a traditional visual representation of the information flows within a system. Smart waste management solutions use sensors placed in waste receptacles to measure fill levels and to notify city collection services when bins are ready to be emptied. Over time, historical data collected by sensors can be used to identify fill patterns, optimize driver routes and schedules,
and reduce operational costs.

Data Flow Diagram For Smart Waste Management

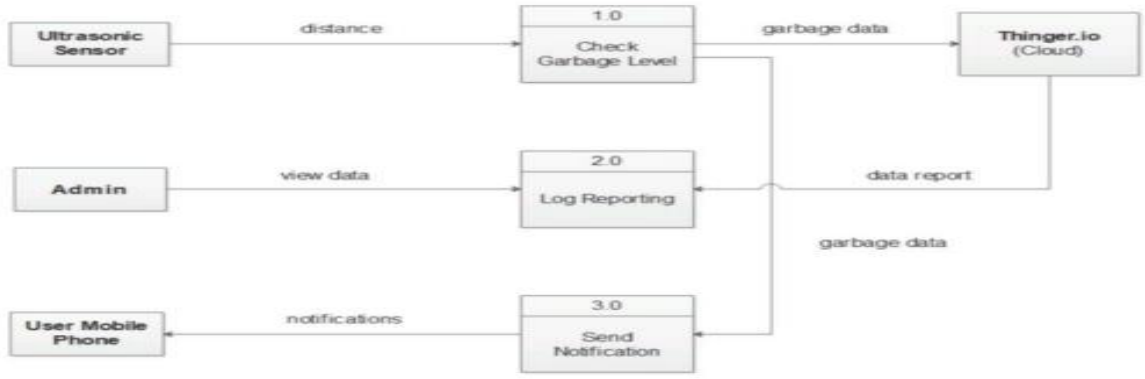


Fig.5.1 Data Flow Diagram

5.2 SOLUTION & TECHNICAL ARCHITECTURE

TECHNICAL ARCHITECTURE

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to:Find the best tech solution to solve existing business problems.Describe the structure, characteristics, behavior, and other aspects of the software to project stakeholders.Define features, development phases, and solution requirements.
Provide specifications according to which the solution is defined, managed, and delivered. The Deliverable shall include the architectural diagram consists of

required components and their descriptions in table 1 and their applications in table 2.

1. Include all the processes (As an application logic / Technology Block)
2. Provide infrastructural demarcation (Local / Cloud)
3. Indicate external interfaces (third party API's etc.)
4. Indicate Data Storage components /Services.

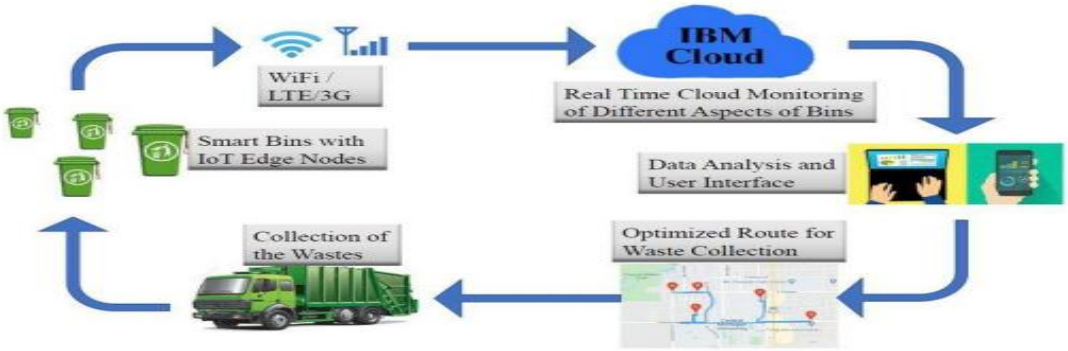


Fig.5.2 Flow diagram

Table 1 : Components & Technologies:

SNO	COMPONENTS	DESCRIPTION	TECHNOLOGY
1	User Interface	How user interacts with application	e.g. Web UI, Mobile App, Chat bot etc. HTML, CSS, JavaScript / Angular Js / React Js etc
2	Application Logic-1	Logic for a process in the application	Java / Python/C
3	File storage	File storage requirements	IBM Block Storage or Other Storage Service or Local File system

4	GPS	(GPS) is a network of satellites and receiving devices used to determine the location of something on Earth.	GPS Trackers
5	sensors	An ultrasonic Sensors is an instrument that measures the distance to an object using ultrasonic sound waves.	Ultrasonic Sensors
6	Power supply	Arduino is an open source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs of ultrasonic sensor	Arduino

Table-2: Application Characteristics:

S.NO	CHARACTERISTICS	DESCRIPTION	TECHNOLOGY
1	Open-Source Frameworks	List the open-source frameworks used	Technology of Open source framework
2	Security Implementations	List all the security / access controls implemented, use of firewalls etc.	e.g. SHA-256, Encryptions, IAM Controls, OWASP etc.
3	Scalable Architecture	Justify the scalability of architecture (3 – tier, Micro-services)	Technology used
4	Availability	Justify the availability of application (e.g. use of load balancers, distributed servers etc.)	Technology used
5	Performance	Design consideration for the performance of the application (number of requests per sec, use of Cache, use of CDN's) etc	Technology used

5.3 USER STORIES

A user story is an informal, general explanation of a software feature written from the perspective of the end user. Its purpose is to articulate how a software feature will provide value to the customer.It's tempting to think that user stories are, simply put, software system requirements. But they're not.A key component of agile software development is putting people first, and a user story puts end users at the center of the conversation. These stories use non-technical language to provide context for the development team and their efforts. After reading a user story, the team knows why they are building, what they're building, and what value

it creates. User stories are one of the core components of an agile program. They help provide a user-focused framework for daily work which drives collaboration, creativity, and a better product overall.

TYPE	FUNCTIONAL REQUIREMENT (EPIC)	USER STORY NUMBER	USER STORY / TASK	ACCEPTANCE CRITERIA	PRIORITY	RELEASE
Customer (Mobile user)	Update the Mobile Number	USN-1	Based on User register number,Sms Send to municipality person With Bin Details and Geo location .	I can receive confirmation Sms	Medium	Sprint-1
		USN-2	As a user, when send Sms there is no response , make a call to authorized person	I can receive Call and Confirm	High	Sprint-1

CHAPTER 6

PROJECT PLANNING & SCHEDULING

6.1 SPRINT PLANNING & ESTIMATION

Sprint planning is an event in scrum that kicks off the sprint. The purpose of sprint planning is to define what can be delivered in the sprint and how that work will be achieved. Sprint planning is done in collaboration with the whole scrum team.

SPRINT	FUNCTIONAL REQUIREMENT(EPIC)	USER STORY NUMBER	USER STORY/TASK	STORY POINTS	PRIORITY	TEAM MEMBERS
Sprint-1	Installation	USN-1	As a Admin, I can install the kit	5	High	Deepika.R, Kavitha.D
		USN-2	As a Admin, I will be placing the bin in correct location	8	High	Yuvan Shankar Raja.M.G, Sharvani G Hegde
Sprint-2	Monitor	USN-3	As a Admin, I can login into the webpage	4	Medium	Manoj kumar.J, Pavithra.S

		USN-4	As a Admin, I can check the waste level inside the bin	5	High	Deepika.R, Yuvan Shankar Raja.M.G
		USN-5	As a Admin, As admin I will be monitoring the location of the bin regularly	9	Medium	Kavitha.D, Sharvani G Hegde
Sprint-3	Notification	USN-6	As an Admin I will get a notification or SMS once the bin get filled	5	High	Manoj kumar.J, Pavithra.S
		USN-7	As a Admin I will get the notification of the location through GPS	10	High	Deepika.R, Sharvani G Hegde
		USN-8	As a Admin I will get the	5	Low	Kavitha.D, Pavithra.S

			notification of the garbage level			
Sprint-4	Collection	USN-9	As a admin ,I will find the exact location of the garbage filled bin	10	Medium	Manoj kumar.J, Yuvan Shankar Raja.M.G
		USN-10	As a admin, I have to empty the bin regularly	10	High	Sharvani G Hegde, Manoj kumar.J

6.2 SPRINT DELIVERY SCHEDULING

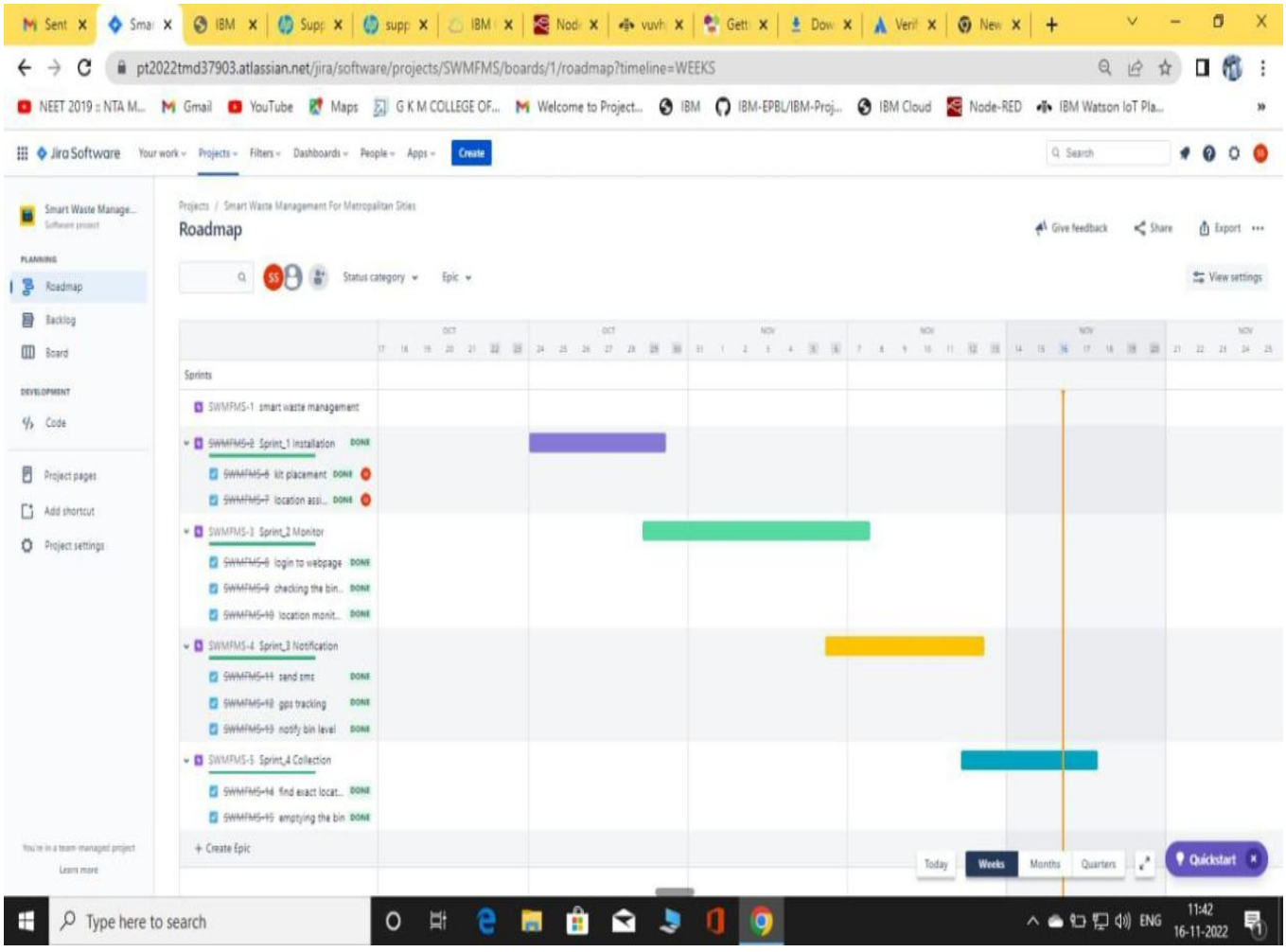
Sprint is one time boxed iteration of a continuous development cycle. Within a Sprint, planned amount of work has to be completed by the team and made ready for review. The term is mainly used in Scrum Agile methodology but somewhat basic idea of Kanban continuous delivery is also essence of Sprint Scrum

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	13	5 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	18	8 Days	29 Oct 2022	06 Nov 2022		06 Nov 2022
Sprint-3	20	6 Days	06 Nov 2022	12 Nov 2022		12 Nov 2022

Sprint-4	20	5 Days	12 Nov 2022	17 Nov 2022		18 Nov 2022

6.3 REPORTS FROM JIRA

Jira is a software application used for issue tracking and project management. The tool, developed by the Australian software company Atlassian, has become widely used by agile development teams to track bugs, stories, epics, and other tasks.



CHAPTER 7

CODING & SOLUTIONING

7.1 FEATURE 1

7.1.1 ARDUINO

Arduino is a software company, project, and user community that designs and manufactures computer open-source hardware,open-source software, and microcontroller-based kits for building digital devices and interactive objects that can sense and control physical devices .The project is based on microcontroller board designs, produced by several vendors, using various microcontrollers. These systems provide sets of digital and analog I/O pins that can interface to various expansion boards (termed *shields*) and other circuits. The boards feature serial communication interfaces, including Universal Serial Bus (USB) on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino project provides an integrated development environment(IDE) based on a programming language named *Processing*, which also supports the languages C and C++. The first Arduino was introduced in 2005, aiming to provide a low cost, easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include
simple robots, thermostats, and motion detectors.

Fig 7.1. ARDUINO UNO BOARD

7.1.2. GSM 900 MODULE

GSM (Global System for Mobile Communications, originally Group Special *Mobile*), is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe the protocols for second-generation (2G) digital cellular networks used by mobile phones, first deployed in Finland in July 1991 .As of 2014 it has become the default global standard for mobile communications - with over 90% market share, operating in over 219 countries and territories .

Fig 7.2. GSM 900 MODULE

GSM networks operate in a number of different carrier frequency ranges (separated into GSM frequency ranges for 2G and UMTS frequency bands for 3G), with most 2G GSM networks operating in the 900 MHz or 1800 MHz bands. Where these bands were already allocated, the 850 MHz and 1900 MHz bands were used instead (for example in Canada and the United States). In rare cases the 400 and 450 MHz frequency bands are assigned in some countries because they were previously used for first generation systems.

7.1.3. ULTRASONIC SENSOR

A special sonic transducer is used for the ultrasonic proximity sensors, which allows for alternate transmission and reception of sound waves. The sonic waves emitted by the transducer are reflected by an object and received back in the transducer. After having emitted the sound waves, the ultrasonic sensor will switch to receive mode. The time elapsed between emitting and receiving is proportional to the distance of the object from the sensor. Ultrasonic sensors generate high-

frequency sound waves and evaluate the echo which is received back by the sensor, measuring the time interval between sending the signal and receiving the echo to determine the distance to an object.

Fig.7.3. ULTRASONIC SENSOR

7.1.4. SIM

SIM Card (full form Subscriber Identification Module) is an integrated circuit (IC) intended to securely store the international mobile subscriber identity (IMSI) number and its related key, which are used to identify and authenticate subscribers on mobile telephony devices (such as mobile phones and computers). Technically the actual physical card is known as a universal integrated circuit card (UICC); this smart card is usually made of PVC with embedded contacts and semiconductors, with the SIM as its primary component. In practise the term "SIM card" refers to the entire unit and not simply the IC.

7.1.5. PC OR LAPTOP

A laptop computer is a small personal computer. They are designed to be more portable than traditional desktop computers, with many of the same abilities. Laptops are able to be folded flat for transportation and have a built-in keyboard and touchpad. Most laptops are powerful enough for everyday business administrative, home, or school use. However, if a user does graphical work such as 3D rendering or movie encoding, a more advanced and powerful laptop is needed. As advanced as laptops are, the top-end ones still cannot compete with high powered desktops and workstations when processing power is needed.Your line of work will dictate the laptop type you need. Since there are so many options, it's important to know what laptops with different specifications can do so that you can choose the right one for your business and budget.

7.1.6. COMMUNICTION CABLE

A communication cable is an electrical cable used to send information signals and is most commonly found as coaxial, fiber optic, data & ethernet, and twisted wire pairs.Our tenured, knowledgeable staff is available to work with you to select the best wire and cable for your customers' applications. They are technically trained and experts in communications wire and cable and have in-depth knowledge of our product line, to help you meet your customers' requirements.

7.1.7. 12V POWER ADAPTER

A DC power supply 12v is an electronic circuit that converts an ac voltage to dc voltage. Power Adapter is basically consisting of the following elements: transformer, rectifier, filter and regulator circuits.A power supply is an electrical device that supplies electric power to an electrical load. DC power supply 12v primary function of a power supply is to convert electric current from a source to the correct voltage, current, and frequency to power the load. As a result, power supplies are sometimes referred to as electric power converters. Some power supplies are separate standalone pieces of equipment, while others are built into the load appliances that they power.

Fig 7.4. 12 V POWER ADAPTER

Power supplies are categorized in various ways, including by functional features. For example, a regulated power supply is one that maintains constant output voltage or current despite variations in load current or input voltage. Conversely, the output of an unregulated power supply can change significantly when its input voltage or load current changes.

7.1.8. DUSTBIN

A waste container is a container for temporarily storing waste, and is usually made out of metal or plastic. The curbside dustbins usually consist of three types: trash cans , dumpsters and wheelie bins .All of these are emptied by collectors, who will load the contents into a garbage truck and drive it to a landfill, incinerator or consuming crush facility to be disposed of.

Fig7.5. DUSTBIN

7.1.9. JUMPER WIRE

Jump wires (also called jumper wires) for solderless breadboarding can be obtained in ready-to-use jump wire sets or can be manually manufactured. The latter can become tedious work for larger circuits. Ready to-use jump wires come in different qualities, some even with tiny plugs attached to the wire ends. Jump wire material for ready-made or homemade wires should usually be 22 AWG (0.33 mm) solid copper, tin-plated wire - assuming no tiny plugs are to be attached to the wire ends. The wire ends should be stripped 3⁄16 to 5⁄16 in (4.8 to 7.9 mm). Shorter stripped wires might result in bad contact with the board's spring clips (insulation being caught in the springs). Longer stripped wires increase the likelihood of short-circuits on the board. Needle-nose pliers and tweezers are helpful when inserting or removing wires, particularly on crowded boards.

Fig7.6. JUMPER WIRE

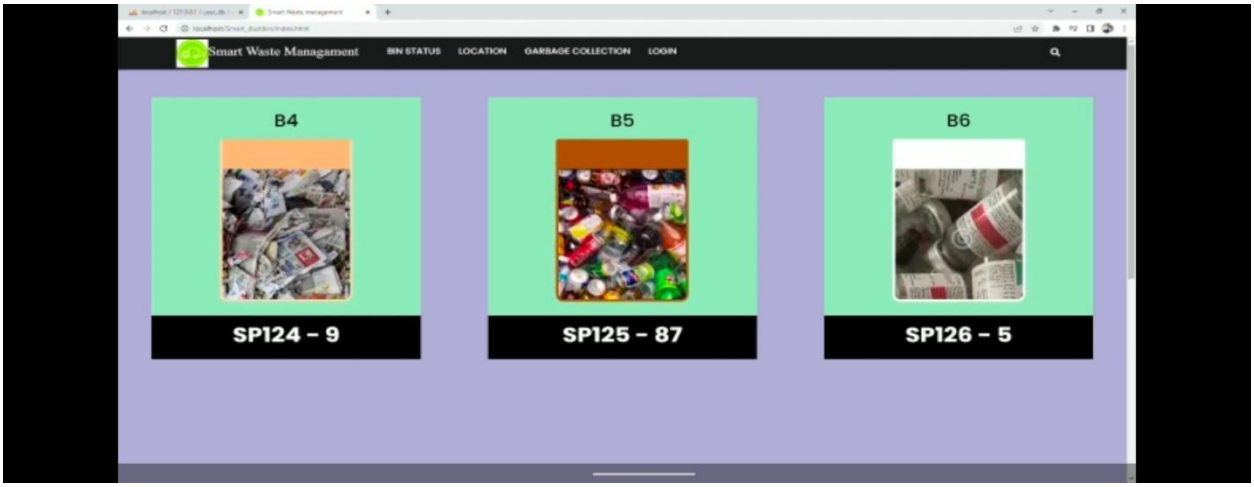
7.2 FEATURE 2

CODING

```
#include <SoftwareSerial.h>
#include <DHT.h>
#define DHTPIN 2
#define DHTTYPE DHT11
constint buzzer = 6; //buzzer to arduino pin 6
DHT dht(DHTPIN, DHTTYPE);
SoftwareSerialmySerial(9, 10);
Int trigPin = 12;
constintechoPin = 11;
int clk;
float hum; //Stores humidity value
float temp;
// defines variables
long duration;
int distance;
void setup()
{
pinMode(buzzer, OUTPUT);
mySerial.begin(9600); // Setting the baud rate of GSM Module
pinMode(trigPin, OUTPUT); // Sets the trigPin as an Output
pinMode(echoPin, INPUT); // Sets the echoPin as an Input
Serial.begin(9600); // Starts the serial communication
dht.begin();
delay(100)
 }

void loop()
{
// Clears the trigPin
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
// Sets the trigPin on HIGH state for 10 micro seconds
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
// Reads the echoPin, returns the sound wave travel time in microseconds
```

```
duration = pulseIn(echoPin, HIGH);
// Calculating the distance
distance= duration*0.034/2;
// Prints the distance on the Serial Monitor
if (distance==5)
{
tone(buzzer, 1000); // Send 1KHz sound signal...
delay(1000); // ...for 1 sec
noTone(buzzer); // Stop sound...
delay(1000);
Serial.print("Distance: ");
Serial.println(distance);
Serial.print(" cm");
hum = dht.readHumidity();
temp= dht.readTemperature();
//Print temp and humidity values to serial monitor
Serial.print("Humidity: ");
Serial.print(hum);
Serial.print(" %, Temp: ");
Serial.print(temp);
Serial.println(" Celsius");
mySerial.println("AT+CMGF=1"); //Sets the GSM Module in Text Mode
delay(1000); // Delay of 1000 milli seconds or 1 second
mySerial.println("AT+CMGS=\"+917059759945\"\r"); // Replace x with mobile
number
delay(1000);
mySerial.println("Distance: ");// The SMS text you want to send
mySerial.print(distance);
mySerial.print(" cm ");// The SMS text you want to send
mySerial.println("Humidity: ");// The SMS text you want to send
mySerial.print(hum);
mySerial.print(" %, Temp: ");// The SMS text you want to send
mySerial.print(temp);
delay(100);
mySerial.println((char)26);// ASCII code of CTRL+Z
delay(5000);
delay(2000);
  }
}
```



7.3 DATABASE SCHEMA

The database schema is the structure of a database described in a formal language supported by the database management system (DBMS). The term "schema" refers to the organization of data as a blueprint of how the database is constructed (divided into database tables in the case of relational databases). The formal definition of a database schema is a set of formulas (sentences) called integrity constraints imposed on a database

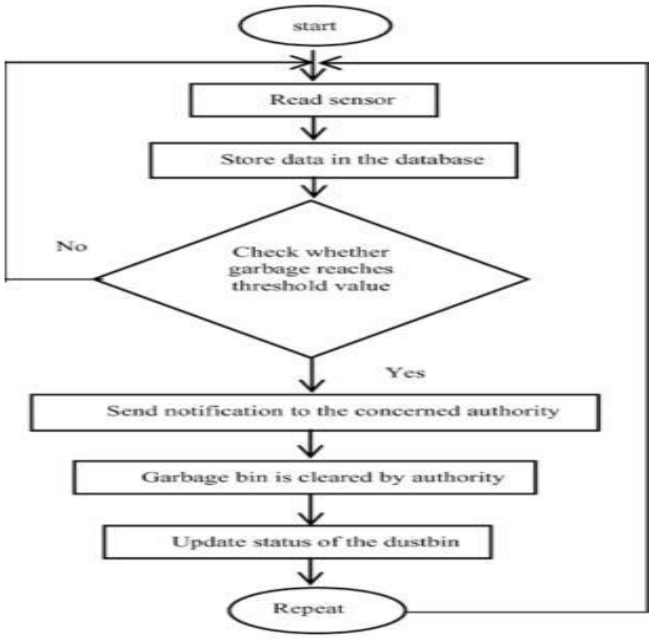


Fig.7.7 Database Schema

CHAPTER 8

TESTING

8.1 TEST CASES

Application testing was performed by our supervisor, client and us regularly during the development phase of the application. Supervisor tested our application on weekly basis and provided his valuable suggestions. Our application was tested using following procedures:

UNIT TESTING

We did unit testing in our project i.e whenever a module was developed, we did testing very carefully. In unit testing of our modules, we tested whether the module is functioning properly according to our requirements or not.

INTEGRATION TESTING

We did integration testing of our application by testing the functionality of the module when they were combined.

FUNCTIONAL TESTING

In functional testing, output of the applications were considered, which was done mostly by our supervisor.

USABILITY TESTING

In usability testing, user friendliness of the project was tested i.e can new user understand the application. *Testing* SMART WASTE COLLECTION SYSTEM

SYSTEM TESTING

System testing included entire testing of the application when completed, this was first performed by us and then by our supervisor.

INCREMENTAL INTEGRATION TESTING

Bottom up approach for testing i.e continuous testing of an application as new functionality is added; Application functionality and modules should be independent enough to test separately. This was done by us and our supervisor

8.2 USER ACCEPTANCE TESTING

Acceptance testing was done by our client to verify whether our application meets his requirements or not. User Acceptance Testing (UAT) is a type of testing performed by the end user or the client to verify/accept the software system before moving the software application to the production environment. UAT is done in the final phase of testing after functional, integration and system testing is done.The main Purpose of UAT is to validate end to end business flow. It does not focus on cosmetic errors, spelling mistakes or system testing. User Acceptance Testing is carried out in a separate testing environment with production-like data setup. It is kind of black box testing where two or more end-users will be involved.

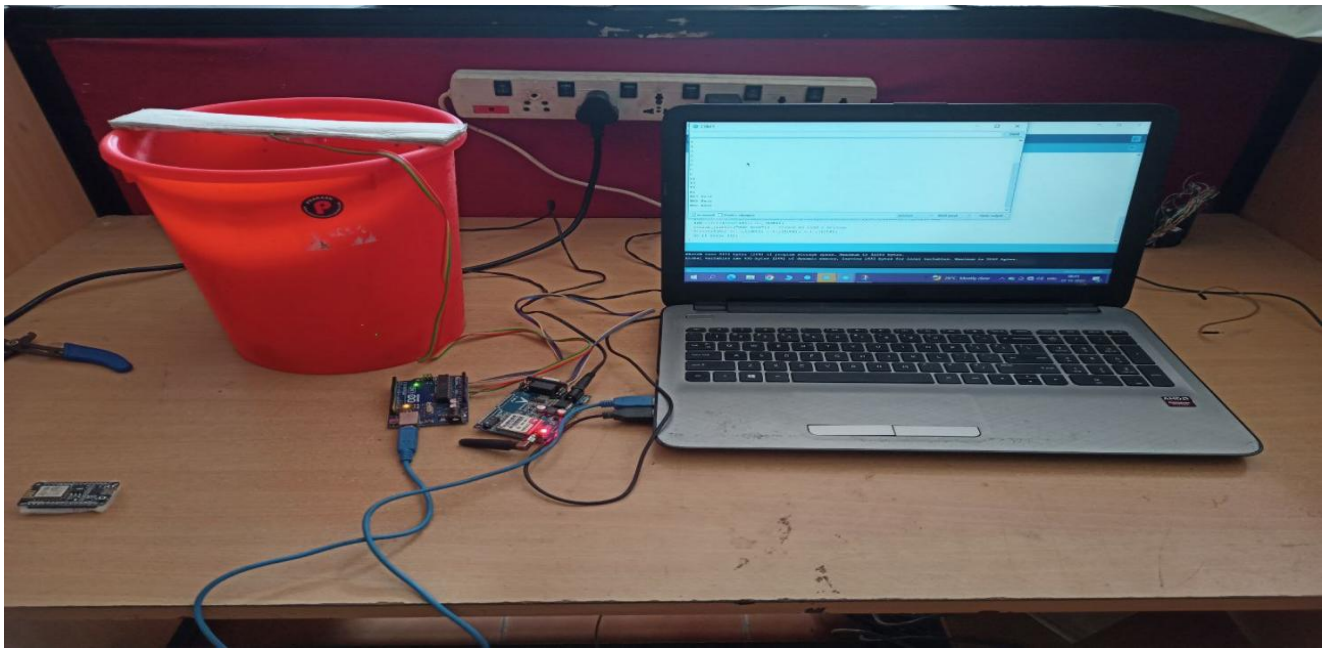


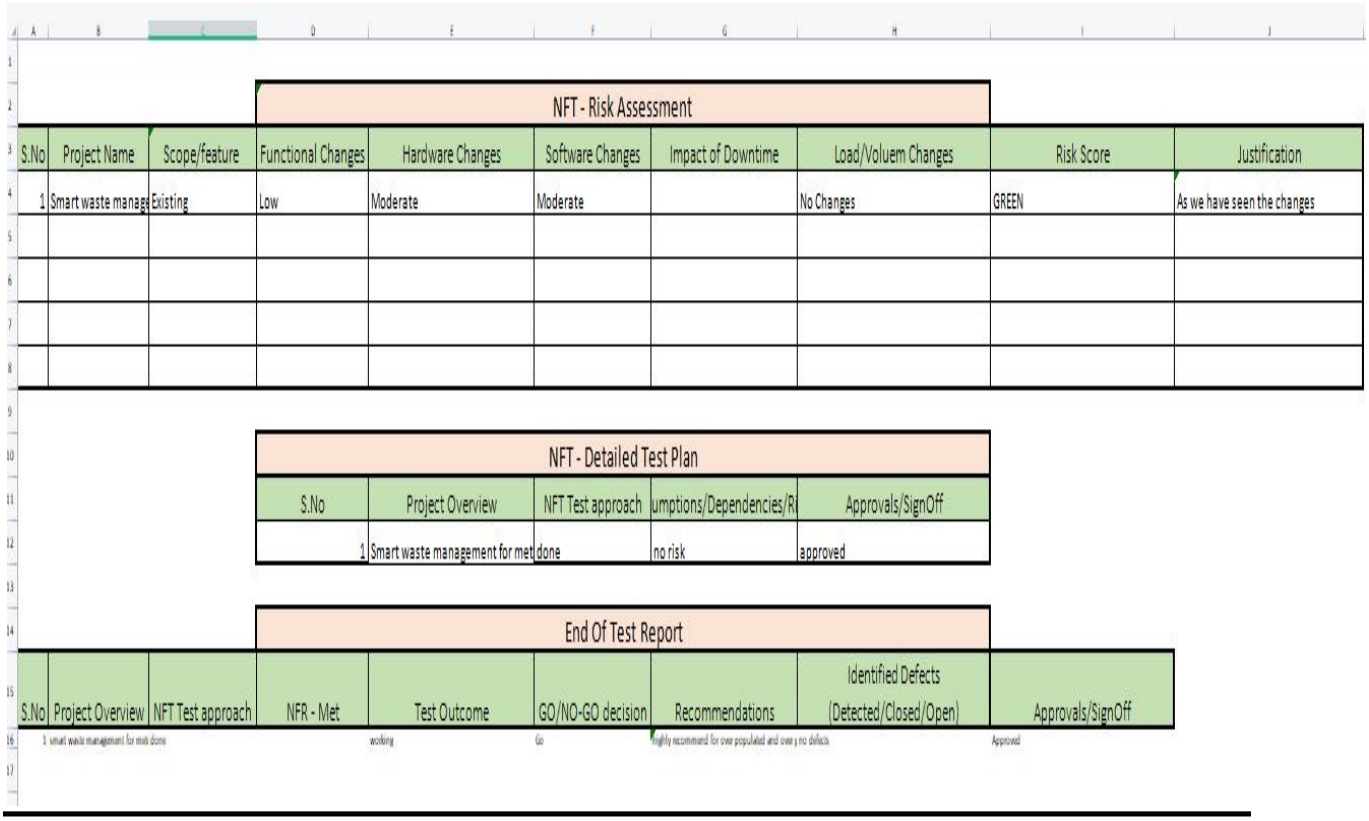
Fig .8.1.Demonstration

CHAPTER 9

RESULTS

9.1 PERFORMANCE METRICS

Performance Testing is a software testing process used for testing the speed, response time, stability, reliability, scalability, and resource usage of a software application under a particular workload. The main purpose of performance testing is to identify and eliminate the performance bottlenecks in the software application.



NFT - Risk Assessment

S.No	Project Name	Scope/feature	Functional Changes	Hardware Changes	Software Changes	Impact of Downtime	Load/Voluem Changes	Risk Score	Justification
1	Smart waste manage	Existing	Low	Moderate	Moderate		No Changes	GREEN	As we have seen the changes

NFT - Detailed Test Plan

S.No	Project Overview	NFT Test approach	umptions/Dependencies/Ri	Approvals/SignOff
1	Smart waste management for met	done	no risk	approved

End Of Test Report

S.No	Project Overview	NFT Test approach	NFR - Met	Test Outcome	GO/NO-GO decision	Recommendations	Identified Defects (Detected/Closed/Open)	Approvals/SignOff
1	smart waste management for moti done			working	Go	highly recommend for over populated and over y no defects		Approved

OBSERVATION AND SYSTEM RESULTS

The sensor that Intellia IoT Waste Management solution use measures the fill level based on the ultrasonic distance measurement technology. These sensors send location, temperature, and fill rate information to the users. Using the real-time data collected from the sensors, the managers can select an optimum pickup route for garbage trucks.Also, the drivers can access the application on their mobile phone/tablets using the internet. Real-time GPS assistance directs them to the pre-decided route. As they go collecting the garbage from the containers, the management is also aware of the progress as the vehicle, as well as the garbage containers, are traced in real-time.The management staff gets their own personalized administration panel over a computer/tablet which gives them a bird eye view over the entire operations

GOOGLE MAP:https://goo.gl/maps/4foFp1rEEk2jHqz16

CHAPTER 10

ADVANTAGES & DISADVANTAGES

ADVANTAGES

- ✓ Less time and fuel consumption as the trucks go only to the filled containers.

- ✓ Decreased noise, traffic flow and air pollution as a result of less trucks on the roads.

- ✓ Our smart operating system enable two way communication between the dustbin deployed in the city and service operator. Therefore the focus is only on collection of route based fill level of the containers.

- ✓ The sensors installed in the containers provide real time information on the fill level.

- ✓ This information helps determine when and where to prioritise collection.
- ✓ In this way both service providers and citizens benefit from an optimized system which results in major cost savings and less urban pollution.
- ✓ Reduces the infrastructure (trucks, containers), operating (fuel) and maintenance costs of the service by upto 30%.

- ✓ Applying this technology to the city optimises management, resources and costs, and makes it a “SMART CITY”.

- ✓ Historical information on collections helps adapt the deployment of containers to the actual needs of the city, therefore reducing the number of containers that clutter up the road and increasing public parking spaces.

- ✓ It keeps the surroundings clean and green, free from bad odour of Wastes emphasizes on healthy environment and keep cities more

beautiful.

- ✓ Reducing manpower required to handle the garbage collection.

DISADVANTAGES

➨System requires more 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 wifi have shorter In range and lower data speed.

➨ In RFID based systems, range and lower data speed. RFID tags are affected by surrounding metal objects (if any).

➨It reduces man power requirements which results into increase in unemployments for unskilled people.

➨The training has to be provided to the people involved in the smart waste management system

CHAPTER 11

CONCLUSION

Solid 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 huge-ly 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 in the course of the project. There is an enormous amount of room for the development of this project in order 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. By using this method the collection of waste in the city becomes more easier. It helps in reducing air pollution, traffic flow, man power, time and money. With the help of proper technology (GPS & SOFTWARE APPLICATIONS) we can guide the trucks in selecting the shortest path for garbage collection. This project can add an edge to the cities aiming to get smart and people-friendly.

CHAPTER 12

FUTURE SCOPE

Every project is always has scope for improvement, perhaps the most pressing issue of separation of waste is when their dispose simultaneously. The waste segregator can be improvised to include the separation of paper and plastic, safe segregation of biomedical waste generated at home, compact and aesthetic Mechanical design.The Global Smart Waste Management System Market is expected to grow at an impressive Compound Annual Growth Rate (CAGR) from 2018 to 2025. The major forces driving the Smart Waste Management System Market include a rise in smart city initiatives across different regions and stringent regulations and compliance requirements for environment protection & waste management. Recently, integration of Internet of Things (IoT) across different verticals is providing good opportunities for the growth of the Smart Waste Management System Market by providing real-time intelligence, thus, leading the organizations to shift towards deployment of smart solutions.As future work, other type of measurements such as toxic gas levels, radiation level inside the waste bins and weight of collected solid waste can be also detected or measured by integrating relevant sensors to the proposed model accordingly.More numbers of separations can be done like metals, plastics, glass etc., with appropriate technology. GSM contraption to intimate to the nearest industry to use the metals collected. Further, plastic can be segregated from the collected dry waste and can be processed based on their types, grades and colors. Solar panels can be fixed to the body of the dustbin for power requirement.By using this proposed scheme will be helpful to easily achieve our mission clean India.Provisions can be made for on spot decomposition of wet wastes

CHAPTER 13

APPENDIX

HARDWARE

The following hardware resources will be vital since they will be the operation environment;
Laptop with the following specifications; 8GB RAM , 1TB Hard drive

Arduino Board

Ultrasonic Sensor

GSM 900 Module

SOFTWARE

The software resources below will be used to program the system;

Local server: Xampp server

Arduino IDE

Front-end: HTML, CSS,Bootstrap and JavaScript

Backend: PHP, MySQL

CHAPTER 14

WEBPAGE CREATION

Web design is the creation of websites and pages to reflect a company's brand and information and ensure a user-friendly experience. Appearance and design are incorporated as vital elements whether you're designing a website, mobile app or maintaining content on a web page.

14.1 PROCESS:

REGISTRATION:

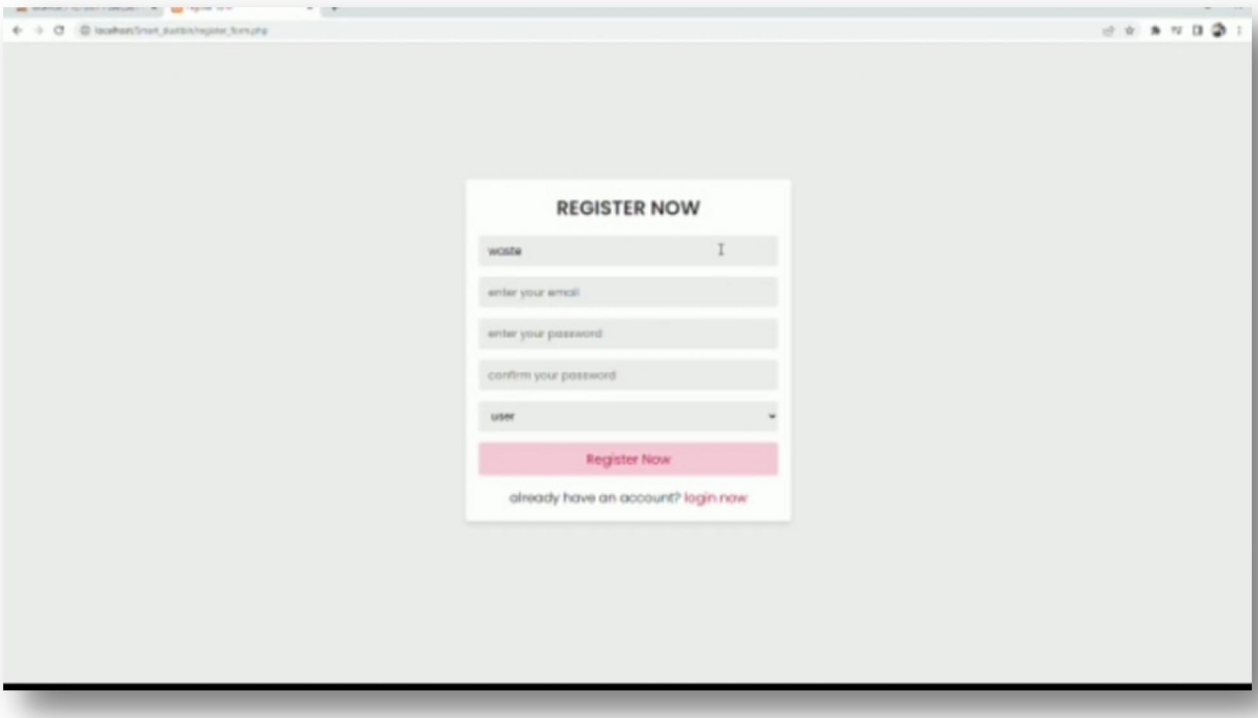


Fig 14.1

LOGIN PAGE:

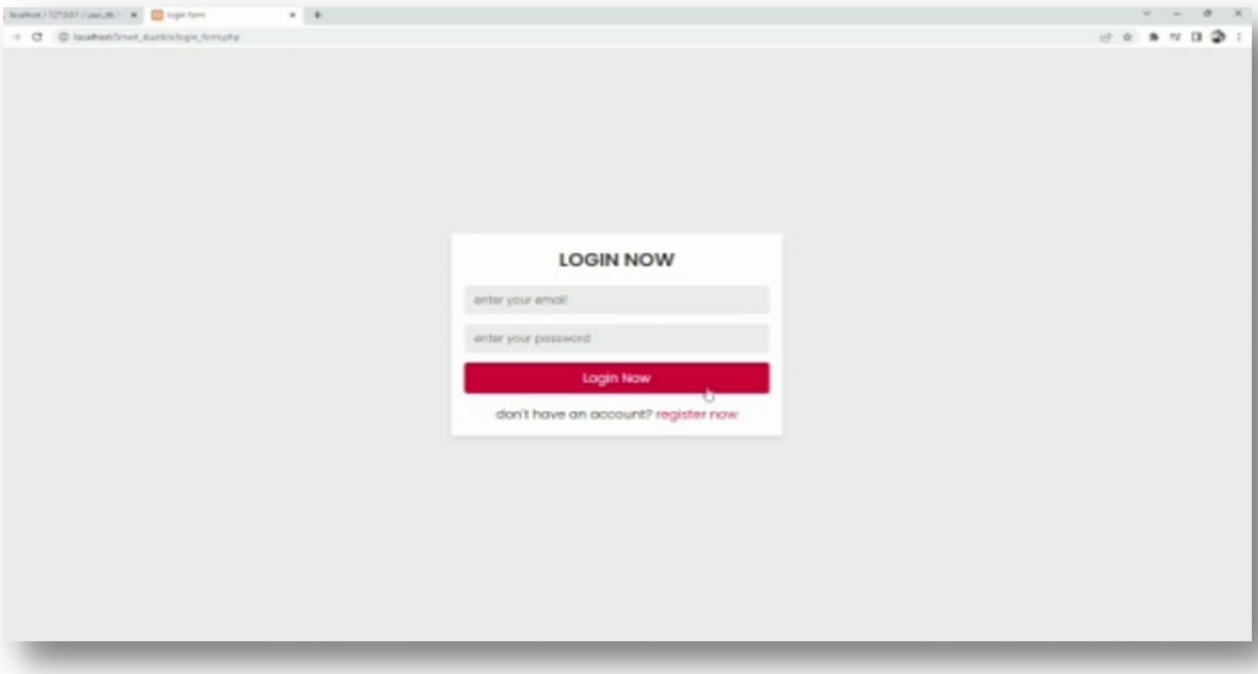


Fig 14.2

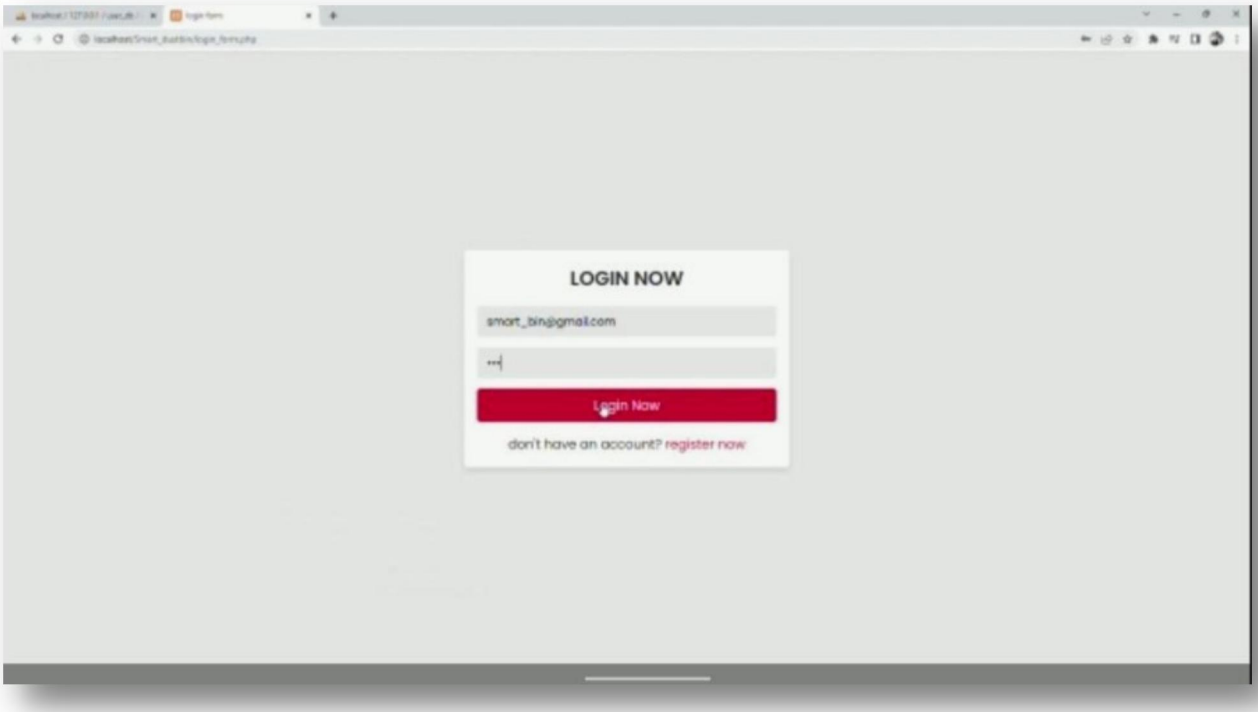


Fig 14.3

WEB PORTAL:

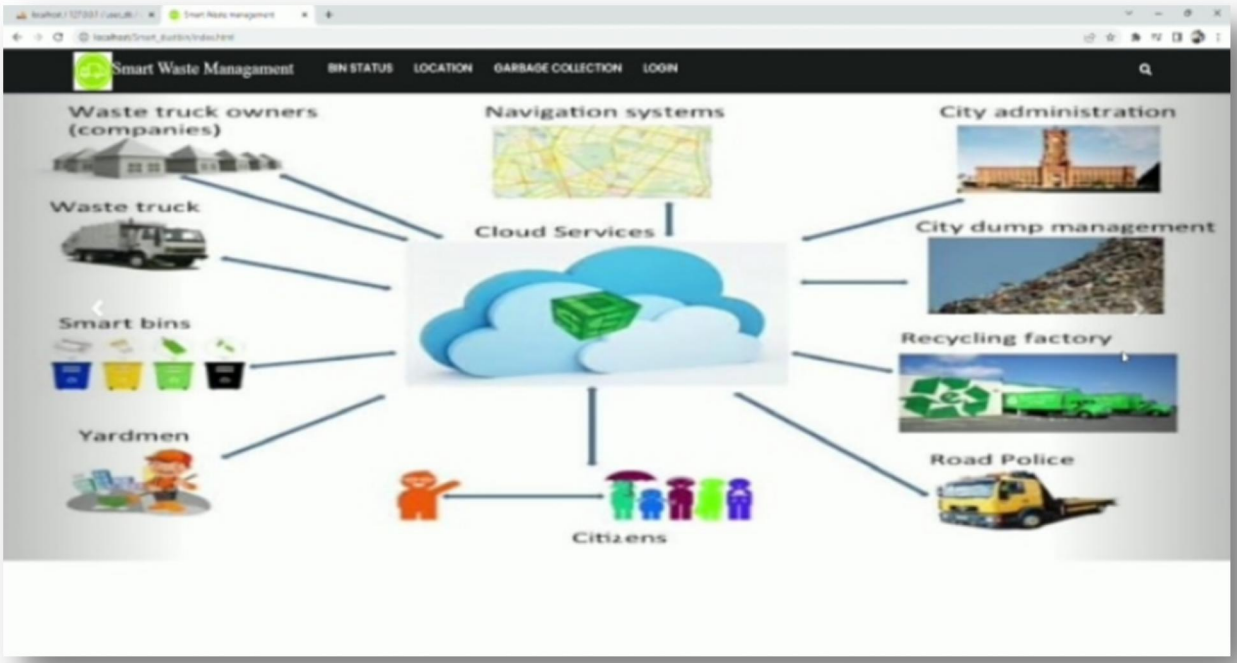


Fig 14.4

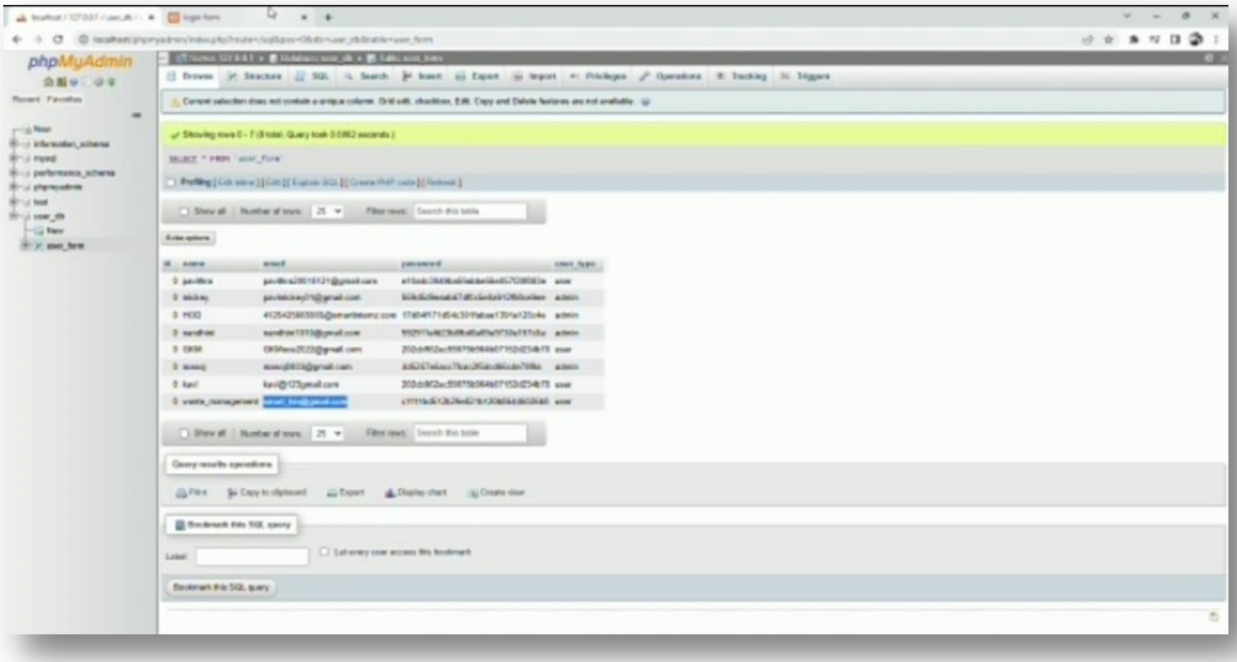


Fig 14.5

DATA COLLECTION:

Fig 14.6

LOCATION

Fig 14.7 GKMCET

CLOUD STORAGE:

Fig 14.8

DEMO:

Fig 14.9

GARBAGE FOUND:

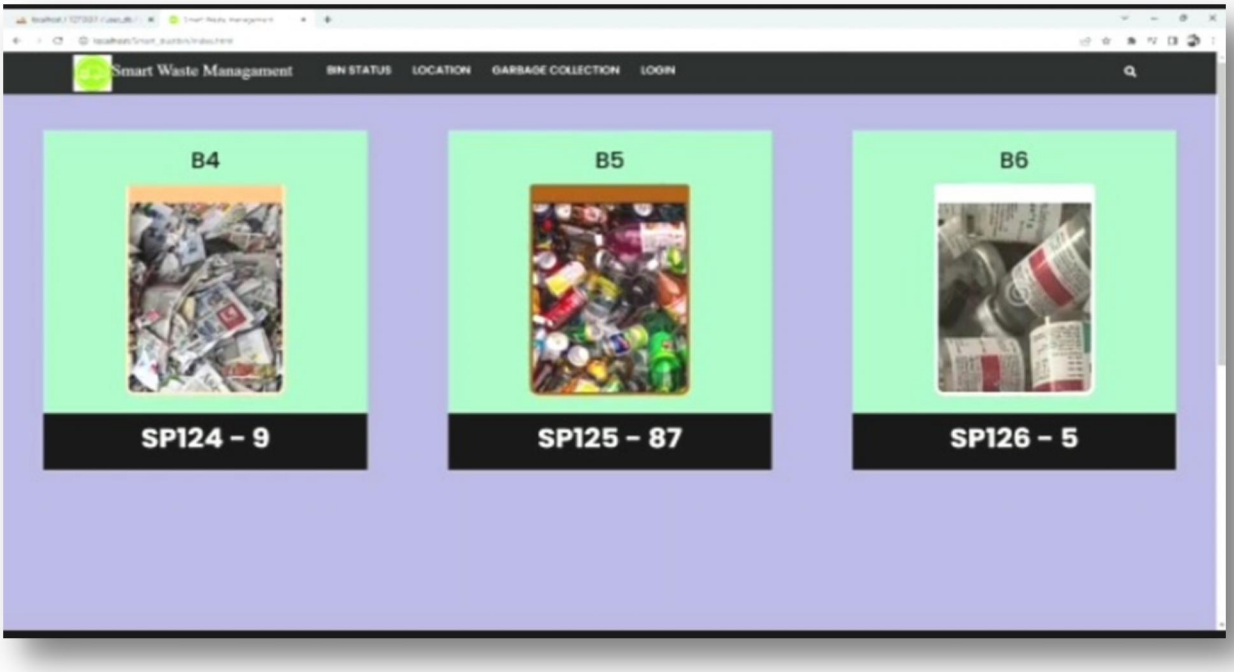


Fig 14.10

GPS LOCATION

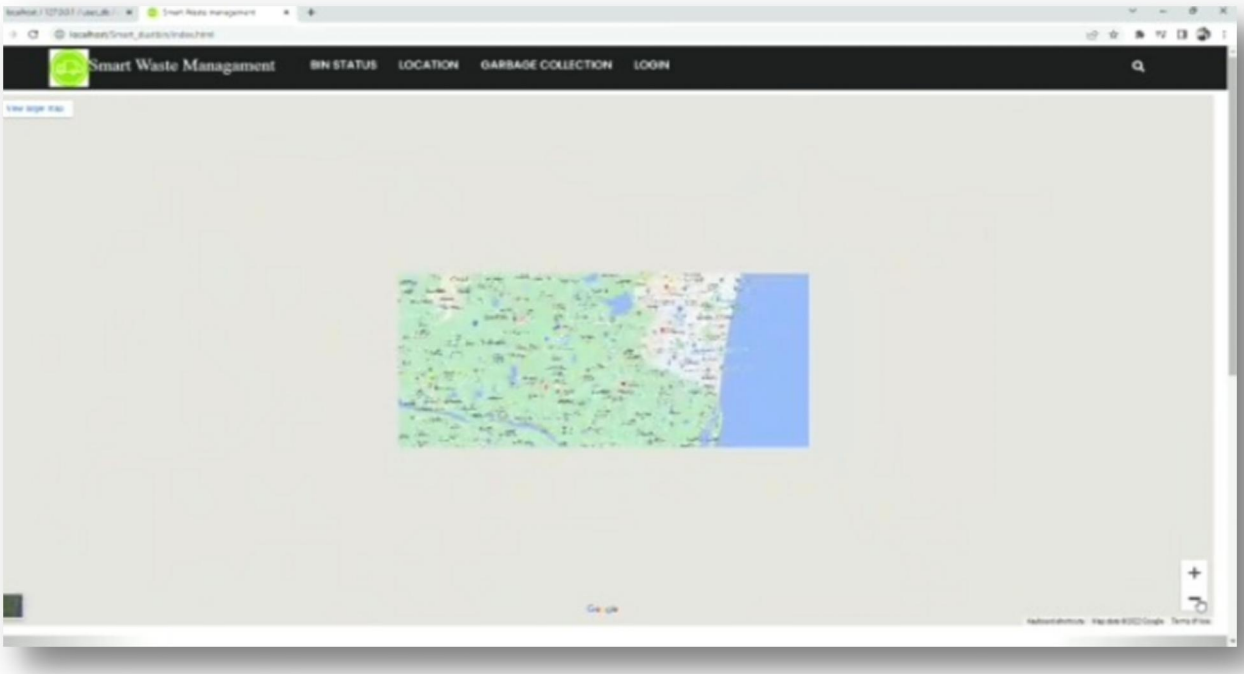


Fig 14.11

TRACKING:

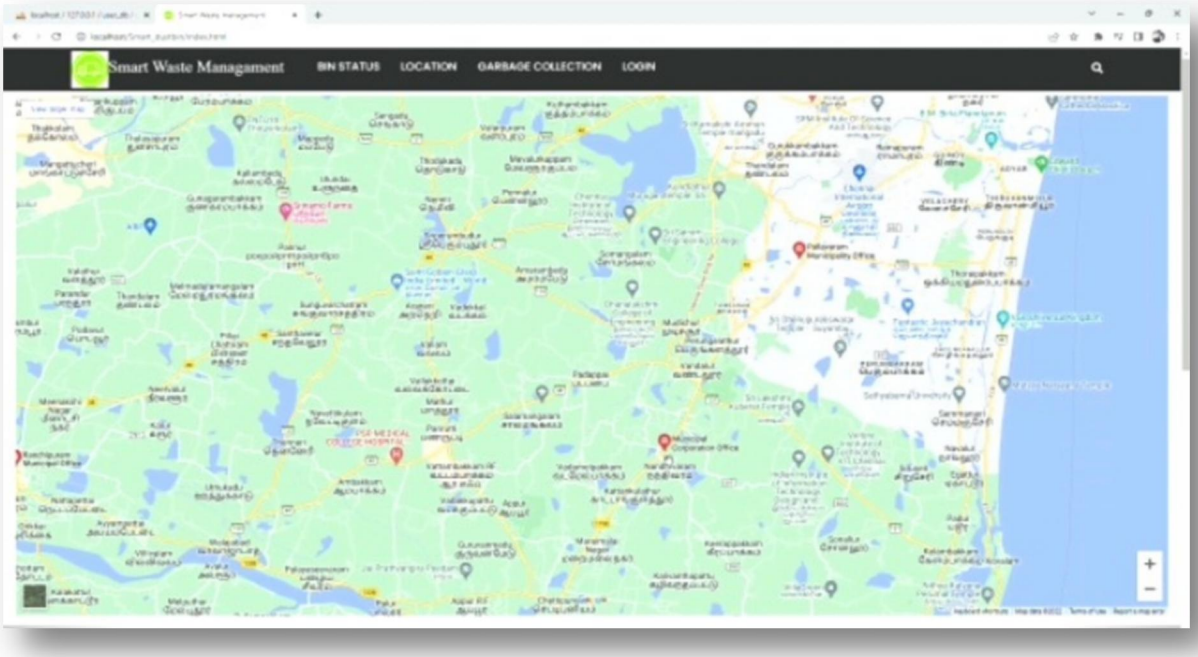


Fig 14.12

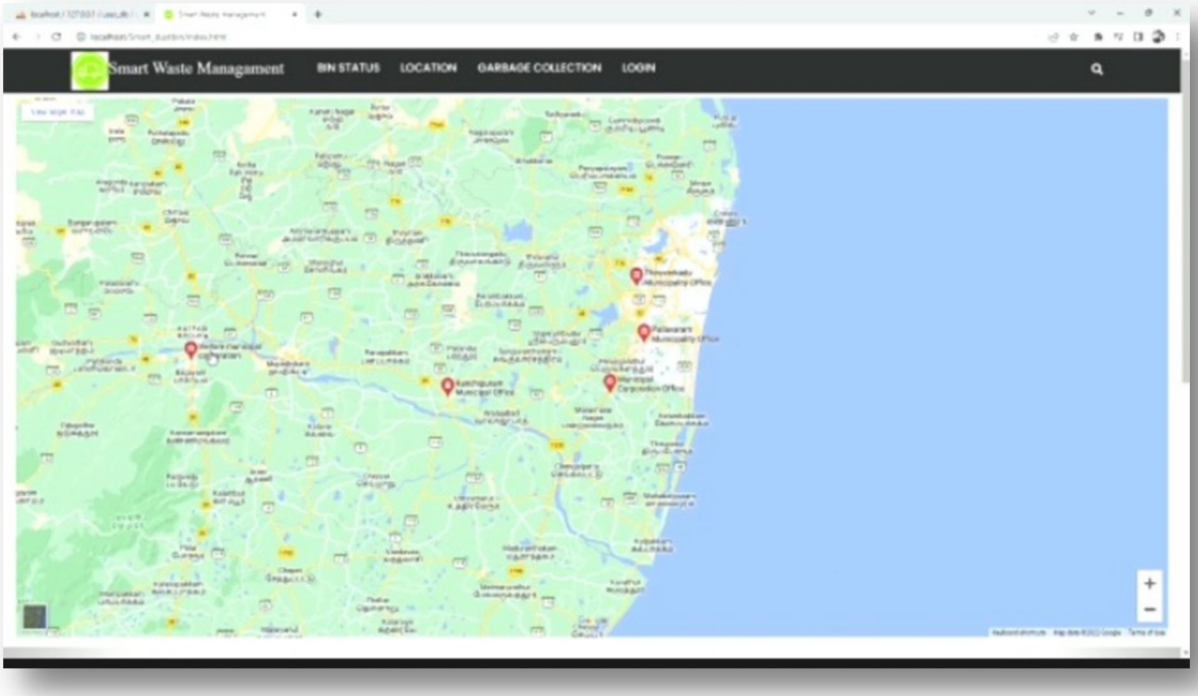


Fig 14.13

REAL TIME GARBAGE UPDATING:

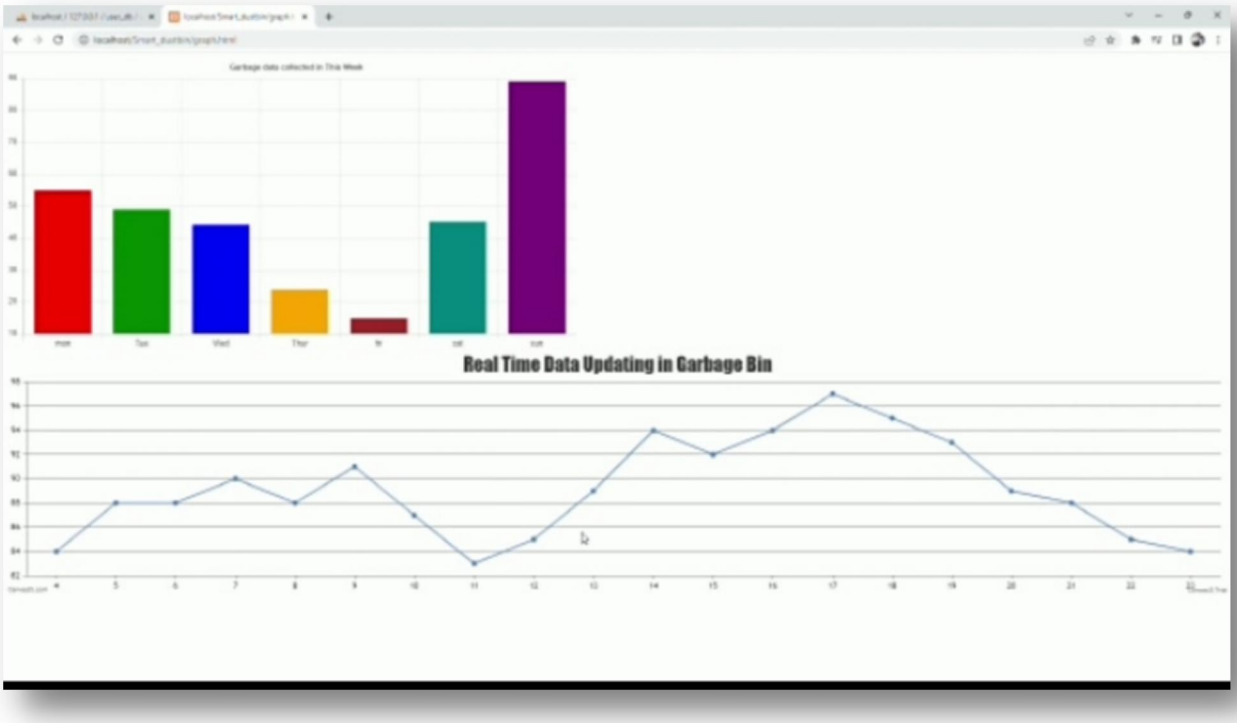


Fig 14.14

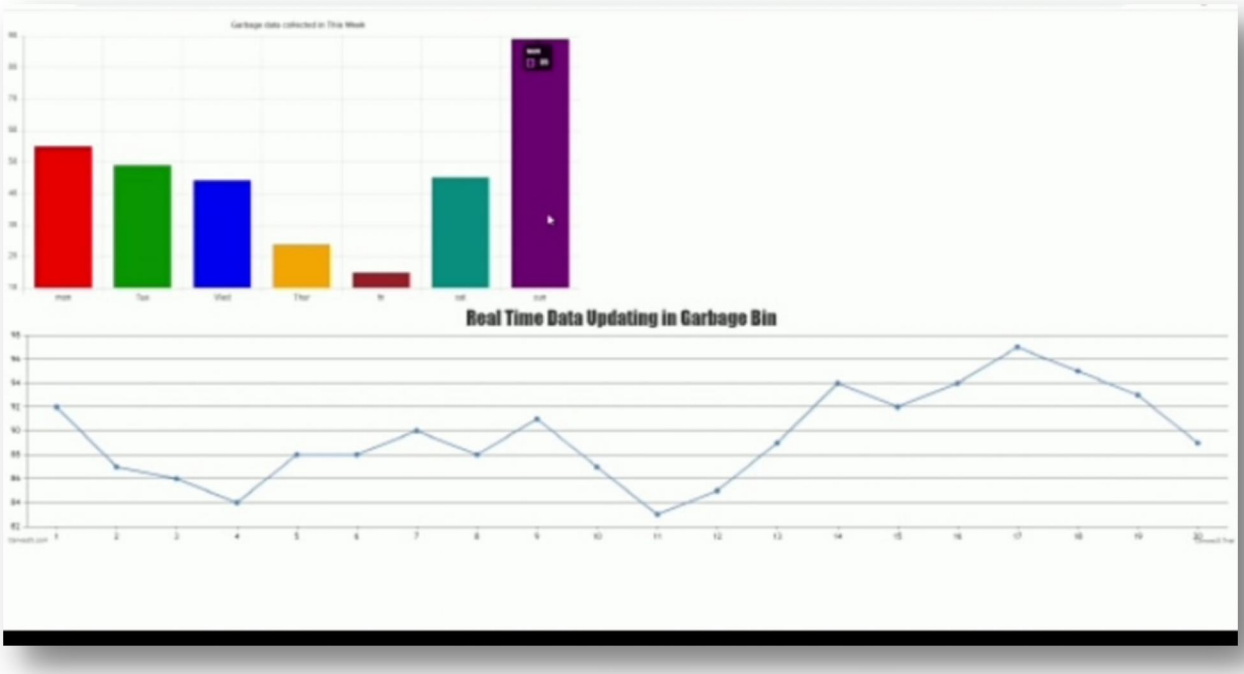
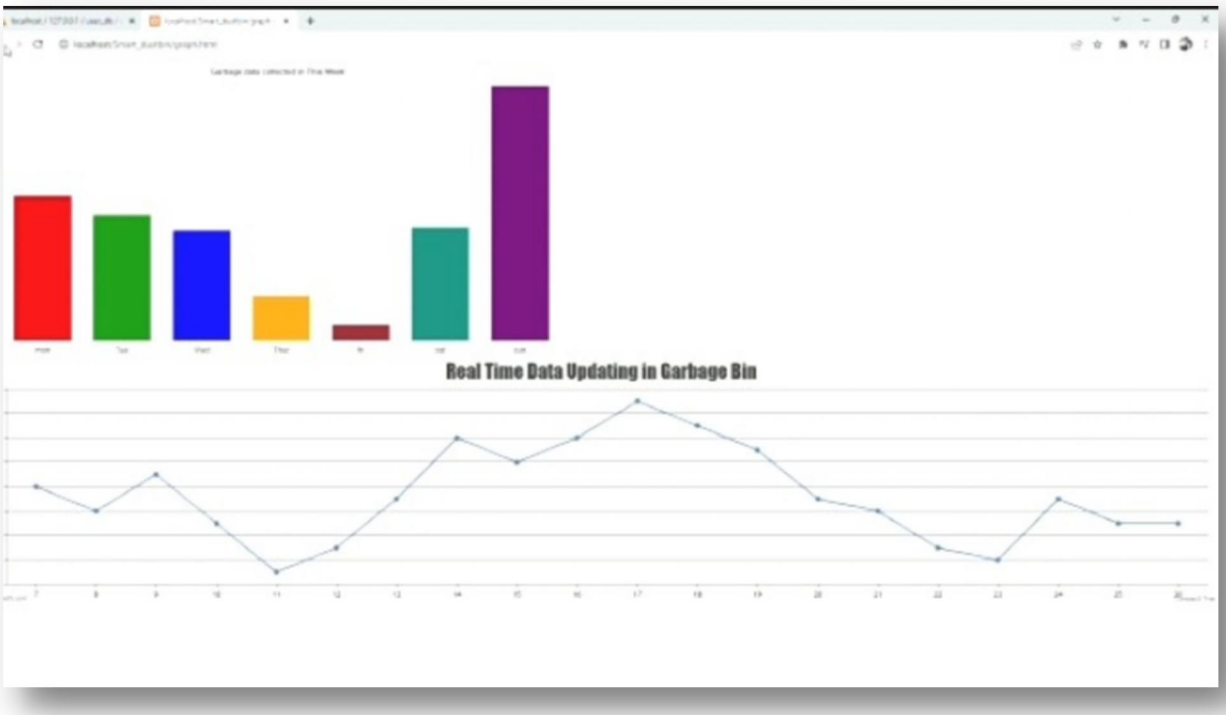


Fig 14.15



14.2 LINK:

FRONTEND WEBPAGE LINK:http://localhost/Smart dustbin/index.html

GITHUB FINAL PROJECT LINK:https://github.com/IBM EPBL/IBM-Project-46860-1660794004/tree/main/Final Deliveribles

SOURCE CODE:https://github.com/IBM EPBL/IBM-Project-46860-1660794004/tree/main/Final Deliveribles/Codings

PROJECT DEMO VIDEO:https://github.com/IBM-EPBL/IBM-Project-46860- 1660794004/blob/main/Final Deliveribles/Final project demo vedio.mp4

ALL FILES: https://github.com/IBM-EPBL/IBM-Project-46860-1660794004/tree/main/Final%20Deliveribles/Codings

CHAPTER 15

REFERENCES

- Mohamed Kaleemuddin S, Dinesh Bose, K I Ramachandran Adarsh S, "Performance comparison of Infrared and Ultrasonic sensors for obstacles of different materials in vehicle/ robot navigation a6ications," IOP Conf. Series: Materials Science and Engineering 149 (2016) 012141
- N. K. Gattim, M. G. Krishna, B. R. Nadh, N. Madhu, and C. L. Reddy,"IoT-based green environment for smart cities," in Microelectronics, Electromagnetics and Telecommunications.Singapore: Springer, 2018,doi: 10.1007/978-981-10-7329-8 27.
- International Journal of Engineering Research & Technology (LIERT)-ISSN: 2278-0181 Vol. 7 Issue 04, April-2018
- IEEE Access Received 18 May 2022, accepted 17 June 2022, date of publication 4 July 2022, date of current version 18 July 2022 Digital Object Mentifier 10 IP/ACCESS 2022 3188.308 loT-Enabled Smart Waste Management Systems for Smart Cities: A Systematic Review.

https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9815071

- Electronics ATRIM. (2014) ATRIM Electronics.in http://extremeelectronics.co.in/datasheets/gsm_shield_sim900

- Performance Impact Of Garbage Collection and Basic GC Tuning https://www.linkedin.com/pulse/performance-impact-garbage-collection-basic-gc-tuning-prasad