SMART WASTE MANAGEMENT SYSTEM FOR

METROPOLITIANCITIES

✓ TEAMID:

PNT2022TMID05

331PROJECT

✓ REPORT

1. INTRODUCTION

1.1 Project Overview

IoT is bringing revolution to almost every aspect of our lives by changing how we do things. The

use of Smart IoT devices is on the rise with all the industries heavily investing in IoT.
The main aimsof

investing in IoT are to improve operations efficiency, improve product quality, and
reduce the costsof

production.

1.2 Purpose

Smart waste management is about using technology and data to create a more

efficient waste industry. Based on IoT (Internet of Things) technology, smart waste

management aims to optimizeresource allocation, reduce running costs, and increase

the sustainability of waste services

Abstract

✓ In today's world, one of the major environmental problems is the collection, management and disposal of the garbage. The main theme of the work is to develop a Smart intelligent garbage alert system for a proper waste management. This paper proposes a Garbage level detection in bins. Getting the weight of the garbage in the bin. Alerts the authorized person to empty the bin whenever the bins are full. Garbage level of the bins can be monitored through a web App. We can view the location of every bin in the web application by sending GPS location from the device.

Introduction

✓ Smart waste management is an idea where we can control many problems, which disturbs the society in pollution and Diseases. The Smart waste management is compatible mainly with concept of smart cities. Waste management is one of the primary Problem that the world faces irrespective of the case of developed or developing country. The key issue in the waste management is that the garbage bin at Public places gets overflowed well in advance before the commencement of the next cleaning process. It In turn leads to various hazards such as bad odor & Ugliness to that place which may be the root cause for spread of various diseases. To avoid all such Hazardous scenario and maintain public cleanliness and health this work is mounted on a smart garbage System. The main theme of the work is to develop a Smart intelligent garbage alert system for a proper Garbage management .This paper proposes a smart Alert system for garbage clearance by giving an alert Signal to the municipal web server for instant Cleaning of dustbin with proper verification based On level of garbage filling.

This process is aided by The ultrasonic sensor which is interfaced with Arduino UNO to check the level of garbage filled in The dustbin and sends the alert to the municipal web Server once if garbage is filled . After cleaning the Dustbin, the driver confirms the task of emptying the garbage with the aid of RFID Tag. RFID is a Computing technology that is used for verification Process and in addition, it also enhances the smart Garbage alert system by providing automatic Identification of garbage filled in the dustbin and Sends the status of clean-up to the server affirming that the work is done. The whole process is upheld by an embedded module integrated with RF ID and IOT Facilitation. The real time status of how waste Collection is being done could be monitored and Followed up by the municipality authority with the Aid of this system. In addition to this the necessary Remedial / alternate measures could be adapted. An Android application is developed and linked to a Web server to intimate the alerts from the Microcontroller to the urban office and to perform the remote monitoring of the cleaning process, done by the workers, thereby reducing the manual Process of monitoring and verification. The Notifications are sent to the Android application Using Wi-Fi module.

Literature Survey

[1] Authors have considered two garbage bins, for waste Segregation, and sensors are attached to bins for garbage Data collection to avoid Overfilling. Overfilling of the bins is prevented using Sensors, but no Mechanism for waste Collection is proposed

[2] The proposed system uses Ultrasonic sensors to collect Real-time garbage level which takes the garbage Readings every time the lid of the bin is opened and Closed. Ease of the users is taken into Consideration. But there is no mechanism to assign routes to trucks for the collection Process.

[3] This paper focuses on the Real time garbage level and the level of toxicity present in it and uses the air quality Sensor CCS811 for measuring the toxicity level. The routes are generated Using Dijkstras algorithm. The system rewards the Points in virtual wallets Based on waste Disposed to encourage People to keep the city Clean, but the algorithm Used for routing is not explained in detail.

[4] The system uses real-time Garbage data and calculates the shortest path using Google API.The capacity of the Truck is not considered while generating shortest routes.

[5]Waste collection problem is a set-covering and vehicle routing problem (VRP) involving inter-arrival time constraints, bi-level optimization formula to model the split delivery VRP with several trips to decide the shortest path. Developed an ACO algorithm for route improvisation. It lacked service for vehicles of a particular category to traverse small streets or bridges that have weight constraint.

[6]Waste collection routing Problem is included in a Mixed-integer nonlinear Programming model after which garbage is unloaded to find out the optimal route for all the garbage trucks. Aimed to avoid the combined collection of Waste which differed in Quality. Instead, it focused on the Collection of Homogeneous trash cans Owing to the same Quality of waste for higher rate of recovery and lower rate of Disposal.

[7]The primary components of IoT are accompanied with Intelligent Transportation Systems and surveillance Systems which enhance Quality of Service in waste Collection. It has proposed an advanced Decision Support System model. Covered an important Aspect of waste Collection which is Access to areas which are not feasible to visit.

[8]The paper discussed Different variations of Vehicle Routing Problem (VRP) and mainly focuses on the variation of VRP which is used for reduction of fuel the generation of Routes focuses on the Distance and fuel Consumption. The Vehicle capacities are not considered.

Reference

- **[1]** P. Chowdhury, R. Sen, D. Ray, P. Roy and S. Sarkar, Garbage Monitoring and Disposal System for Smart City Using Iot, 2018 Second International Conference on Green Computing and Internet of Things (ICGCIoT), Bangalore, India, 2018, pp. 455-460, doi:10.1109/ICGCIoT.2018.8753060.

- **[2]** S. Lokuliyana, A. Jayakody, G. S. B. Dabarera, R. K. R. Ranaweera, P. G. D. M. Perera and P. A. D. V. R. Panangala, Location Based Garbage Management System with IoT for Smart City, 2018 13th International Conference on Computer Science & Education (ICCSE), Colombo, 2018, pp. 1-5, doi:10.1109/ICCSE.2018.8468682.

- **[3]** Mirchandani, S., Wadhwa, S., Wadhwa, P., & Joseph, R. (2017). IoT enabled dustbins. 2017 International Conference on Big Data, IoT and Data Science (BID). doi:10.1109/bid.2017.8336576.

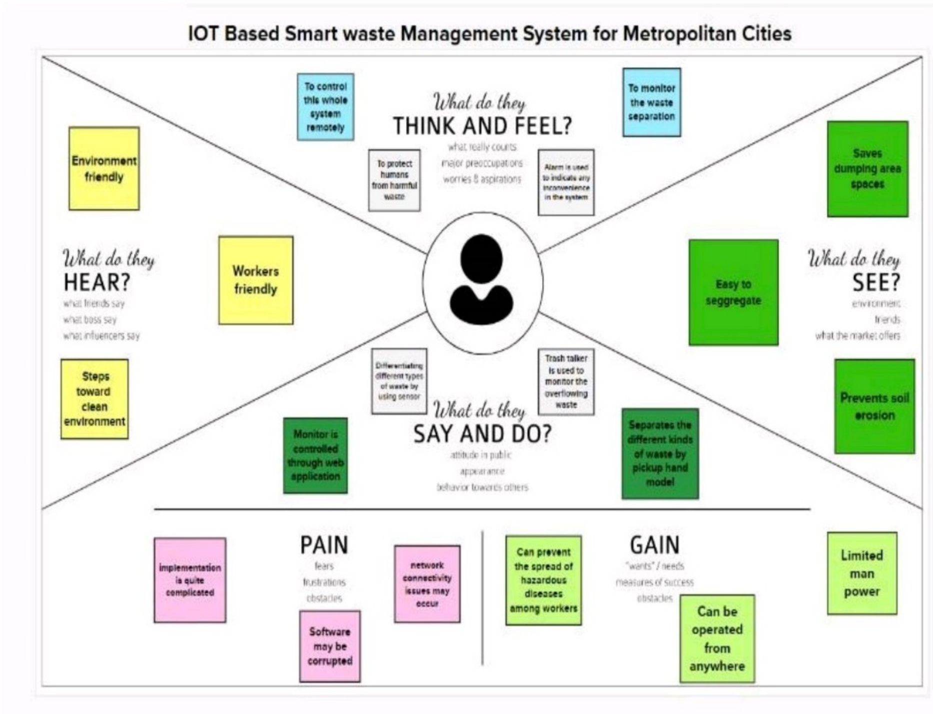
- **[4]** Chaudhari, S. S., & Bhole, V. Y. (2018). Solid Waste Collection as a Service using IoT -Solution for Smart Cities. 2018 International Conference on Smart City and Emerging Technology (ICSCET). Doi:10.1109/icscet.2018.8537326.

- **[5]** Huang, Shan-Huen & Lin, Pei-Chun. (2015). Vehicle routing—Scheduling for municipal waste collection system under the Keep Trash Off the Ground policy. Omega. 55. 10.1016/j.omega.2015.02.004.

- **[6]** Fooladi, Somayeh, Hamed Fazlollahtabar, and Iraj Mahdavi. Waste Collection vehicle routing problem considering similarity pattern of Trashcan and garbage unloading. (2015).

- **[7]** Medvedev, Alexey & Fedchenkov, Petr & Zaslavsky, Arkady & Anagnostopoulos, Theodoros & Khoruzhnikov, Sergey. (2015). Waste Management as an IoT-Enabled Service in Smart Cities. 10.1007/978-3-319-23126-6_10.

- **[8]** Y. Peng and X. Wang, Research on a Vehicle Routing Schedule to Reduce Fuel Consumption, 2009 International Conference on Me


IOT Based Smart waste Management System for Metropolitan Cities
To control this whole system remotely
What do they THINK AND FEEL?
what really counts
major preoccupations
worries & aspirations
To monitor the waste separation
To protect humans from harmful waste
Alarm is used to indicate any inconvenience in the system
Environment friendly
What do they HEAR?
what friends say
what boss say
what influencers say
Workers friendly
Steps toward clean environment
Saves dumping area spaces
Easy to seggregate
What do they SEE?
environment
friends
what the market offers
Prevents soil erosion
Differentiating different types of waste by using sensor
Trash talker is used to monitor the overflowing waste
What do they SAY AND DO?
attitude in public
appearance
behavior towards others
Monitor is controlled through web application
Separates the different kinds of waste by pickup hand model
PAIN
fears
frustrations
obstacles
implementation is quite complicated
network connectivity issues may occur
Software may be corrupted
GAIN
"wants" / needs
measures of success
obstacles
Can prevent the spread of hazardous diseases among workers
Can be operated from anywhere
Limited man power

IDEATION PHASE
DEFINE THE PROBLEM STATEMENTS

Project Design Phase-I
Proposed Solution Template

Proposed Solution Template:

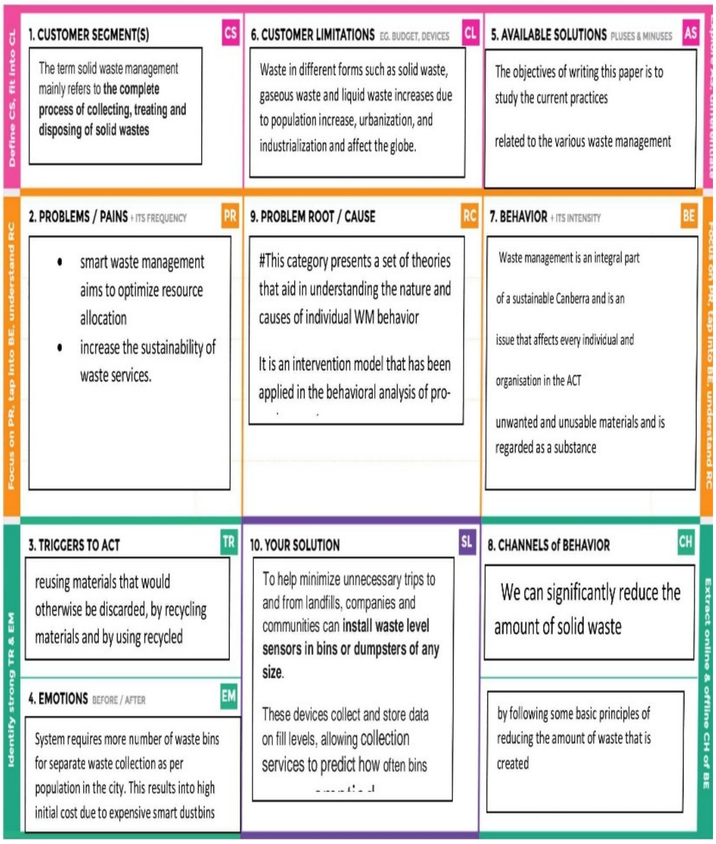
Project team shall fill the following information in proposed solution template.

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 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.

Project Design Phase-I

Problem Solution Fit


Define CS, fit into CL

1. CUSTOMER SEGMENT(S) CS

The term solid waste management mainly refers to **the complete process of collecting, treating and disposing of solid wastes**

6. CUSTOMER LIMITATIONS EG. BUDGET, DEVICES CL

Waste in different forms such as solid waste, gaseous waste and liquid waste increases due to population increase, urbanization, and industrialization and affect the globe.

5. AVAILABLE SOLUTIONS PLUSES & MINUSES AS

The objectives of writing this paper is to study the current practices

related to the various waste management

Focus on PR, tap into BE, understand RC

2. PROBLEMS / PAINS + ITS FREQUENCY PR

- smart waste management aims to optimize resource allocation
- increase the sustainability of waste services.

9. PROBLEM ROOT / CAUSE RC

#This category presents a set of theories that aid in understanding the nature and causes of individual WM behavior

It is an intervention model that has been applied in the behavioral analysis of pro-

7. BEHAVIOR + ITS INTENSITY BE

Waste management is an integral part

of a sustainable Canberra and is an

issue that affects every individual and

organisation in the ACT

unwanted and unusable materials and is regarded as a substance

Identify strong TR & EM

3. TRIGGERS TO ACT TR

reusing materials that would otherwise be discarded, by recycling materials and by using recycled

4. EMOTIONS BEFORE / AFTER EM

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

10. YOUR SOLUTION SL

To help minimize unnecessary trips to and from landfills, companies and communities can **install waste level sensors in bins or dumpsters of any size.**

These devices collect and store data on fill levels, allowing collection services to predict how often bins

8. CHANNELS of BEHAVIOR CH

We can significantly reduce the amount of solid waste

by following some basic principles of reducing the amount of waste that is created

Extract online & offline CH of BE

PROJECT DESIGN PHASE-II
SOLUTION REQUIREMENTS
(FUNCTIONAL & NON-FUNCTIONAL)

Functional Requirements:

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Fitting IoT device in the trashcans.	The IoT device need to be fixed in the dustbin with water proof safety. The IoT device consists Ultrasonic sensor, IR sensor, Weight sensor. To send data to the cloud GSM/GPRS is used.
FR-2	Connecting to the cloud.	The device should configure to connect to the cloud. The data of sensors need to be received and processed.
FR-3	Predictions for bin fulness.	In this system, a 24×7 monitoring system is designed for monitoring dumpsters, A smart and organized system is designed for selective clearing the ultrasonic sensor is used for measuring the level of waste in the dustbin, DC motor powered platform is used for segregating wet and dry waste, IR sensor and moisture sensor is used for separating wet and dry waste. If either of the containers is full then an alert message is sent from the dustbin to employees and the cloud. In turn, employees can clear the corresponding dumpster.
FR-4	Real-time waste monitoring	Trash and recycling containers can be outfitted or produced with low-cost sensors that monitor everything from the amount and types of material in a container to temperature, odour and location of the bin.
FR-5	Do not miss a pick	For periodically picked bins, we provide Pick evaluation. The tool records picks (sensor) and compares them to the schedule. Authorized person can immediately identify any missed, or off-schedule picks.
FR-6	Routes to the dumpsters	Based on current bin fill-levels and predictions of reaching full capacity, you are ready to respond and schedule waste collection. driver can compare planned vs. executed routes to identify any inconsistencies.

Non-functional Requirements:

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	IoT solutions for waste management problems offer municipalities data intelligence and real-time insights. In that regard, the fill patterns of specific containers can be identified by historical data and managed accordingly in the long term. In addition to hardware solutions, mobile applications are used to overcome the challenges in the regular waste management system, such as keeping track of the drivers while they are operating on the field.
NFR-2	**Security**	Building and deploying IoT-based smart waste management in cities can be a complex, time-consuming and resource-intensive process. Many municipal IT departments will not have the resources or in-house skills to support such a project internally.
NFR-3	**Reliability**	One of the difficult operational problems of municipal and local authorities are facing is the collection of municipal solid waste. In recent years, due to environmental concerns and number of costs, most of the municipalities have been forced for assessing their solid waste management and examining their cost- effectiveness and environmental impact, forexample, designing the collection of routes. During the past 15 years
NFR-4	**Performance**	An integrated Arduino program is developed to synchronize the identification system, automated lid system, micro-controller, display system, and communication system. An ultrasonic sensor is attached to the front side of the garbage bin. The transmitter of the ultrasonic sensor emits an ultrasonic sound that is beyond the human ear listening range, and the receiver receives the reflected sound waves by the solid objects.
NFR-5	**Availability**	Another purpose of this project is to make the proposed waste management system as cheap as possible. A cost in BDT is presented in the following Table 3 needs for the construction of the proposed smart bin.

NFR-6	**Scalability**	The city diverts about 80% of its waste from landfills and hopes to go “zero waste” by the end of 2020. Besides strict regulations and high waste management fees for end consumers and businesses.

4.2 Non-functional Requirements:

The project requires a user interface for monitoring and manually intervening (if required) in the efficient and timely collection of garbage from the selected Garbage bins.

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

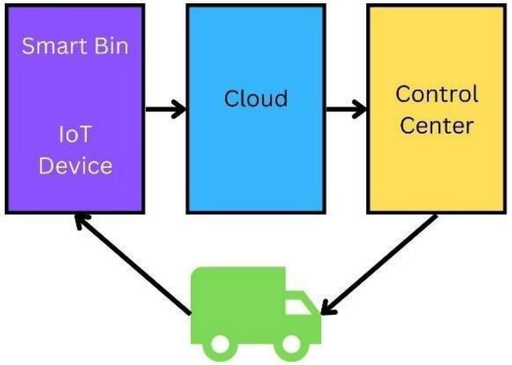
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The current state of technology in the field of smart waste management involves the use of sensors that measure the fill level of the trash bin. Measured data is sent to the Cloud for further processing and analysis. By exploiting this data, trash collection can be planned as well as truck routes can be optimized. IoT device verifies that usability is a special and important perspective to analyse user requirements, which can further improve the design quality.

NFR-2	**Security**	Security ensures the level of assurance in data collection, processing and conveying. As this is totally depend upon cloud service we need to make security more particular without channel crash.
NFR-3	**Reliability**	Smart waste management is also about creating better working conditions for waste collectors. Instead of driving the same collection routes and servicing empty bins, waste collectors can spend their time more efficiently, taking care of bins that need servicing. This system is more reliable at any cost by taking care of garbage bins and monitoring bin activity.
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 Sensor'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 provided with required data-driven and decision making prototypes which would help uses to monitor its performance and encounter their quires.
NFR-5	**Availability**	Availability refers to already available solutions and the new renovative technology that we include in the system which we are building new now. This system have much available solutions for users and this made users to operate easily where we have used sensors, GPS detectors, and so on.
NFR-6	**Scalability**	We have to customize the number of bins in the town/city which we are going to monitor 24/7 a week and collect data. So, we need to measure the total bins and avail services to all bins in an proper rotational shifts.

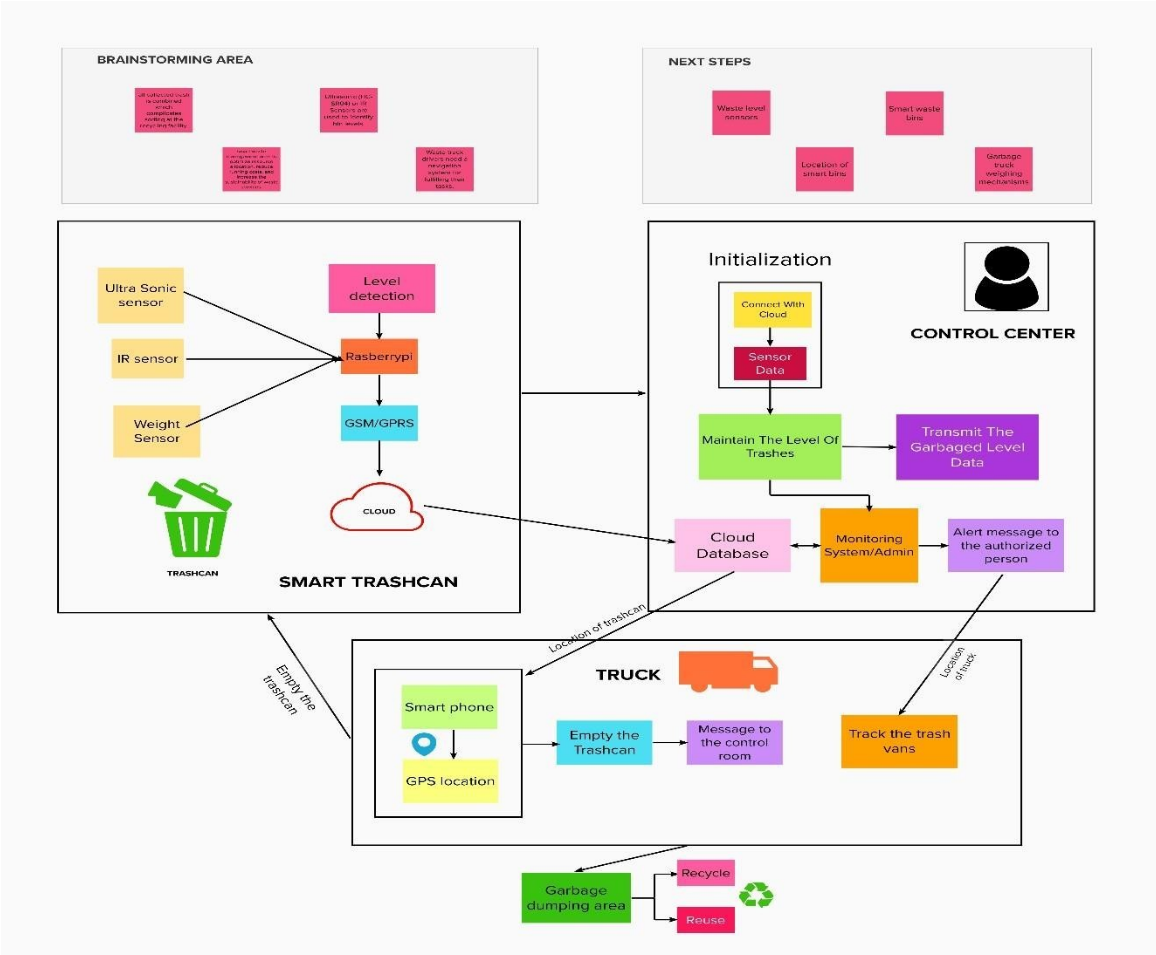
PROJECT DESIGN PHASE-II

DATA FLOW DIAGRAM & USER STORIES

Data Flow Diagram:



Simplified Diagram



The IoT device is fitted in the trashcans.

- The sensors in the device senses the garbage level.
- The GSM/GPRS will send the information about the garbage level to the cloud.
- The admin in the control center notifies the authorized person to collect the garbage.

- The truck driver will be notified the route to the filled dumpsters.
- The trashes are loaded to the truck.
- The more number of bins needed in high populated area.
- The overflowing of trashcans can be avoided.
- No missed pickups of trashcans.
- New smart dustbins can be install by just connecting the IoT device to the cloud.

User Stories:

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Admin	Login	USN-1	As an admin, I can monitor every dustbin and its garbage levels.	I can monitor the system.	High	Sprint-4
		USN-2	As an admin, I will inform the authorized person to empty the trashcan.	I can inform authorized person.	Medium	Sprint-2
		USN-3	As an admin, I can notice the trash level of every dustbin.	I can notice the trash level.	Low	Sprint-2
Admin 2	Login	USN-4	As a Co-Admin, I can send alert message to the truck drivers.	I can alert truck driver.	High	Sprint-1
Trash Van Driver	Login	USN-5	As a trash van driver, I will follow the route to the dustbin.	I can reach the filled trashcans.	High	Sprint-2
Garbage Collector		USN-6	As a waste collector, I will collect all the trash from the dumpsters and load it to the truck.	I can empty the trashcans.	Medium	Sprint-2

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Municipal officer	Login	USN-7	As a municipality officer, I can supervise the process and ensure the cleanliness of city.	I can manage all these process going good.	High	Sprint-1
Trashcan Monitor	Register	USN-8	As a trashcan monitor, I can initialize new trashcans.	I can register new smart trashcans.	Medium	Sprint-3
		USN-9	As a trashcan monitor, I can check the quality of IoT device’s quality.	I can check the IoT device.	Medium	Sprint-3

PROJECT DESIGN PHASE-II

TECHNOLOGY STACK (ARCHITECTURE & STACK)

Technical Architecture:

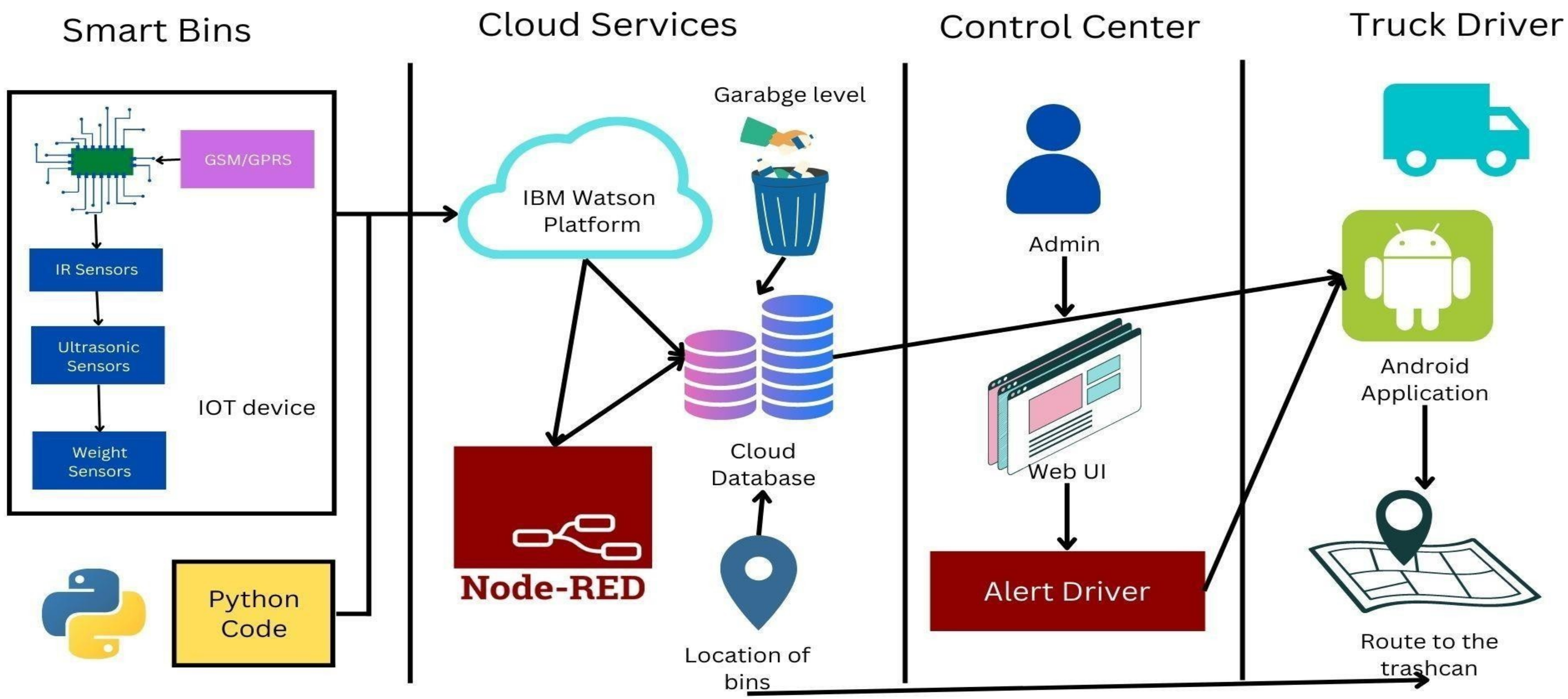


Table-1 : Components & Technologies:

S.No	Component	Description	Technology
1.	Arduino Uno	The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller.	Arduino programming itself is done in **C++.**
2.	Application Logic-1	Logic for IR sensor data.	C++/Python
3.	Application Logic-2	Logic for Ultrasonic sensor data.	C++/Python
4.	Application Logic-3	Logic for a Weight sensor data	C++/Python
5.	GPRS/GSM	The Arduino GSM shield allows an Arduino board to connect to the internet, send and receive SMS, and make voice calls using the GSM library.	C++/Python
6.	Cloud Sever	Application deployment on Local System / Cloud	IBM Watson IoT Platform, Node Red
7.	Cloud Database	Database Service on Cloud	IBM Watson IoT platform, Cloudant DB
8.	User Interface	How user interacts with application to alert the truck driver.	HTML, CSS, JavaScript , Python etc.
9.	External API-1	Purpose of External API used in the application to locate the trashcans.	Google Maps Geolocation API

Table-2: Application Characteristics:

S.No	Characteristics	Description	Technology
1.	Open-Source Microcontroller	Arduino Uno is used to make the IoT device	C++/Python
2.	Security	Encryption/Decryption used for security purpose	GSM/GPRS,Python
3.	Scalable Architecture	New features can be added.	Node Red
4.	Availability	Web application can be accessed from anywhere	IBM Watson IoT Platform, HTML, CSS, JavaScript
5.	Performance	All truck drivers can access the application at same time.	Cloudant DB, IBM Watson IoT Platform

PROJECT PLANNING PHASE
PROJECT PLANNING TEMPLATE (PRODUCT BACKLOG, SPRINT PLANNING, STORIES, STORY POINTS)

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

Use the below template to create product backlog and sprint schedule

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Login	USN-1	As a Administrator, I need to give user id and passcode for ever workers over there in municipality	10	High	Shivani
Sprint-1	Login	USN-2	As a Co-Admin, I'll control the waste level by monitoring them vai real time web portal. Once the filling happens, I'll notify trash truck with location of bin with bin ID	10	High	Shivani
Sprint-2	Dashboard	USN-3	As a Truck Driver, I'll follow Co-Admin's Instruction to reach the filling bin in short roots and save time	20	Low	Sowndarya sw tha
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	Medium	Sally jannet
Sprint-4	Dashboard	USN-5	As a Municipality officer, I'll make sure everything is proceeding as planned and without any problems	20	High	Sam santhosh

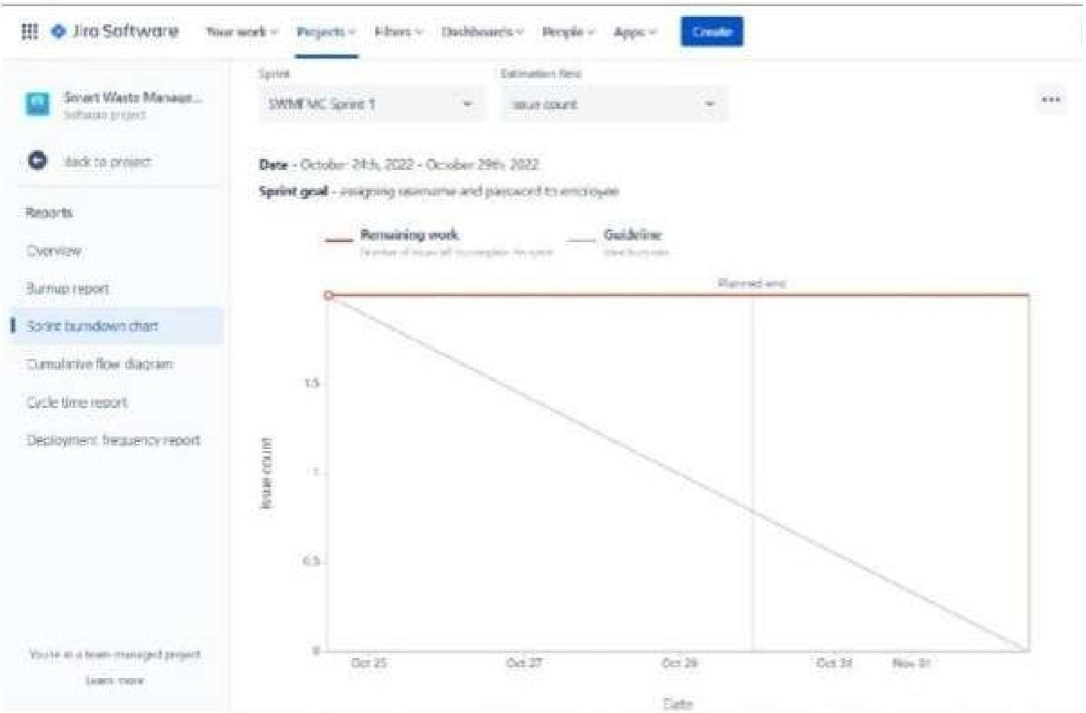
Project Tracker, Velocity & Burndown Chart: (4 Marks)

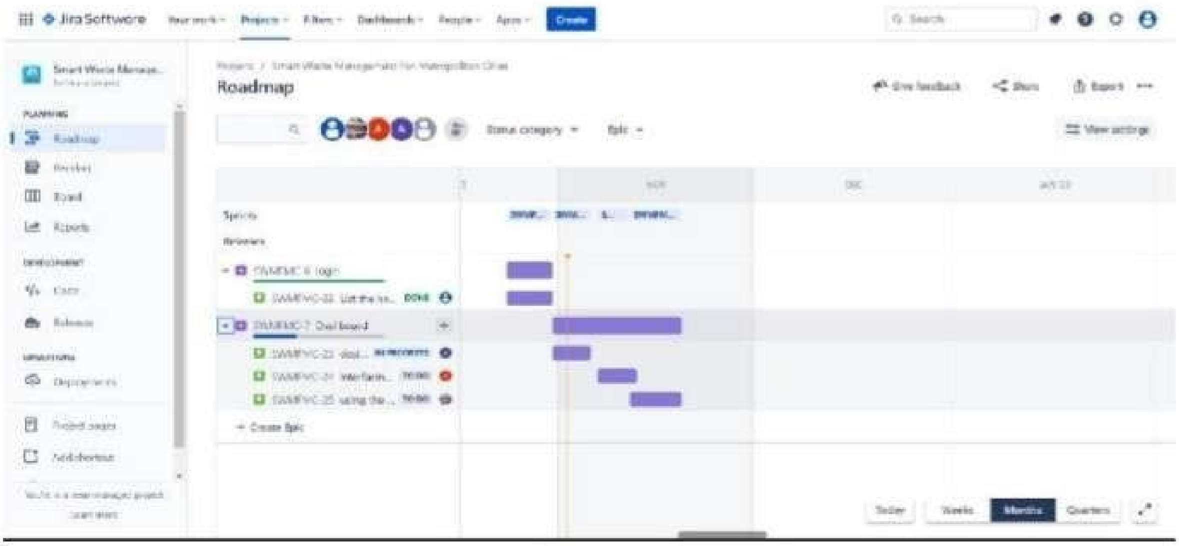
Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022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

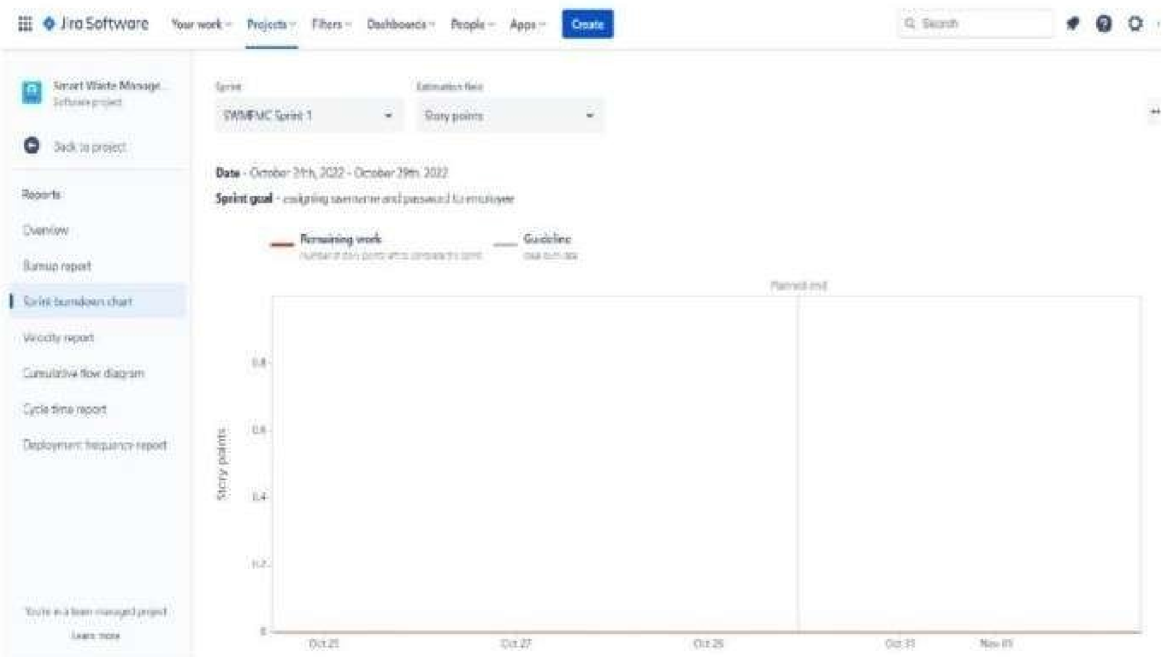
Velocity:
Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day)

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

6.3 Reports from JIRA

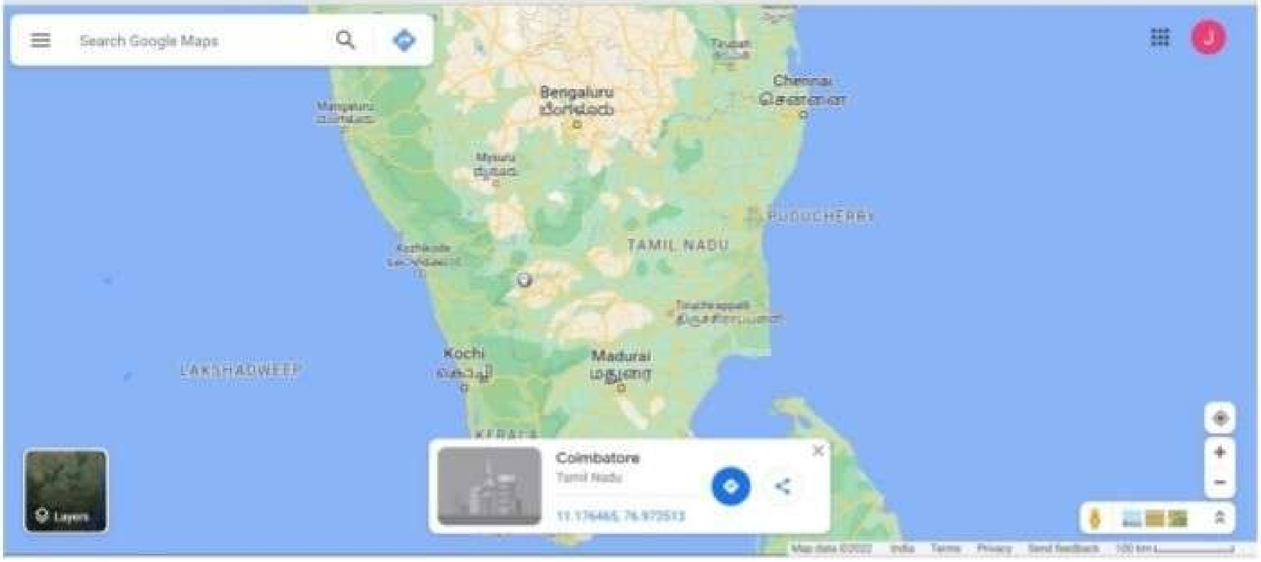



Jira Software
Projects
Filters
Dashboards
People
Apps
Create
Roadmap
Status category
Epic
Sprints
Releases
Create Epic
Today
Weeks
Months
Quarters


Jira Software
Your work
Projects
Filters
Dashboards
People
Apps
Create
Search
Smart Waste Manage...
Software project
Back to project
Reports
Overview
Burnup report
Sprint burndown chart
Velocity report
Cumulative flow diagram
Cycle time report
Deployment frequency report
You're in a team-managed project
Learn more
Sprint
SWMFMC Sprint 1
Estimation field
Story points
Date - October 24th, 2022 - October 29th, 2022
Sprint goal - assigning username and password to employee
Remaining work
Guideline
Planned end
Story points
0.8
0.6
0.4
0.2
0
Oct 25
Oct 27
Oct 29
Oct 31
Nov 01

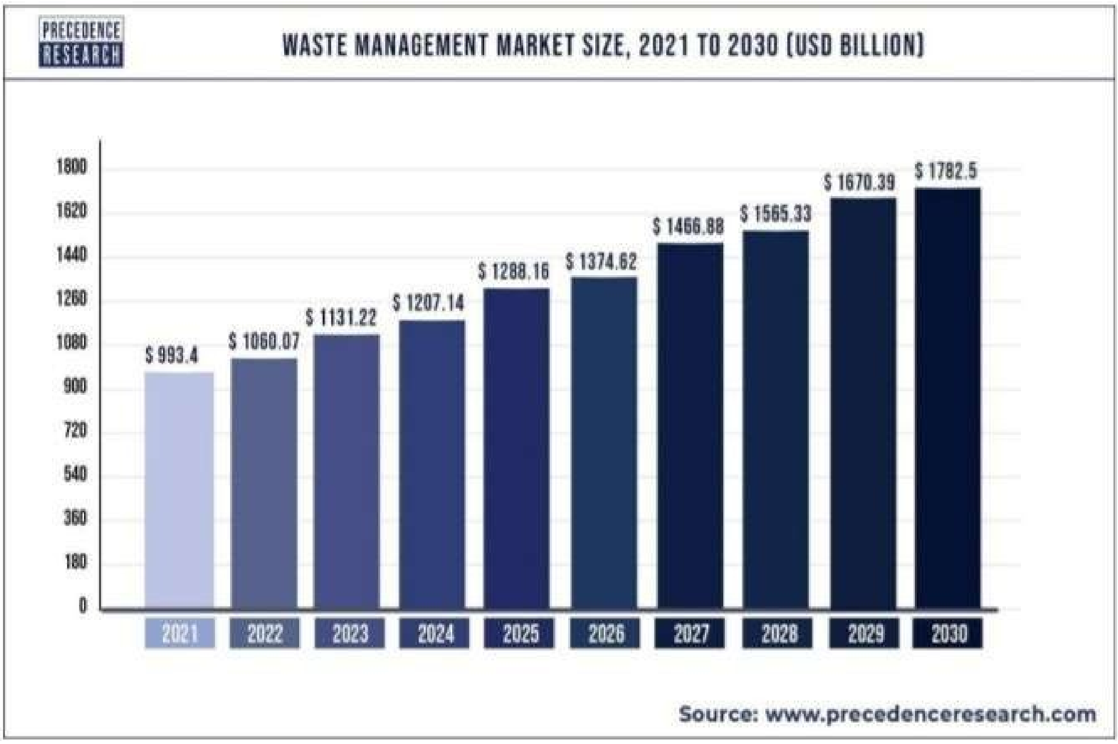
7. CODING & SOLUTIONING

7.1 Feature



8. RESULTS

8.1 Performance Metrics



9. ADVANTAGES & DISADVANTAGES

Advantages

- No Missed Pickups.
- Reduced Overflows.
- Waste Generation Analysis.
- CO2 Emission Reduction.
- Reduction in Collection Cost.

Disadvantages

- Setting up the sensor
- Non-optimized truck routes
- Non-uniform waste distribution of waste in bins

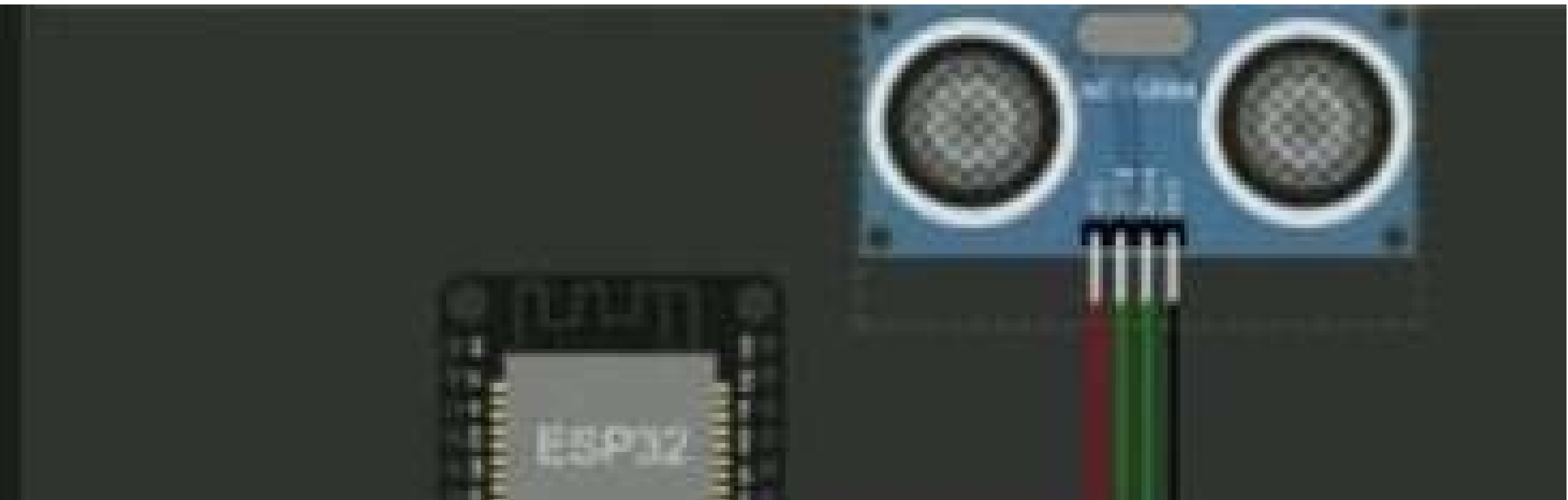
10. CONCLUSION

This proposed system, integrates different sensing and communication technologies to monitor real time bin information. This system is good enough to carry out practically as it helps to collect the garbage from the garbage bins on time before the garbage overflows from that bin which can possess threat to the health of the people leaving in nearby area. This project can avoid such situations of overflowed dustbin and the message can be sent directly to the cleaning vehicle instead of the contractor's office (Authority). In Smart system design main is Development of web portal and applications for city administration, municipal staff and public.

11. FUTURE SCOPE

Total of approximately 143,449 MT of municipal waste is generated daily. However, only 35,062 tons of waste is treated. A report from MNRE says that **waste generation is expected to reach 300 million tons annually by the year 2047**. There are four tiers to waste management to reduce its environmental impact: pollution prevention and source reduction; reuse or redistribution of unwanted, surplus materials; treatment, reclamation, and recycling of materials within the waste; and disposal through incineration, treatment, or land burial.

```
#include <WiFi.h>
#include <PubSubClient.h>
#include <ArduinoJson.h>

WiFiClient wifiClient;

#define ORG "[illegible]"
#define DEVICE_TYPE "raspberrypi"
#define DEVICE_ID "[illegible]"
#define TOKEN "[illegible]"
#define speed 0.034

char server[] = ORG ".messaging.internetofthings.ibmcloud.com";
char publishTopic[] = "iot-2/evt/Data/fmt/json";
char topic[] = "iot-2/cmd/home/fmt/String";
char authMethod[] = "use-token-auth";
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
PubSubClient client(server, 1883, wifiClient);
void publishData();

const int trigpin=5;
const int echopin=18;
String command;
String data="";
String lat="[illegible]";
String lon="[illegible]";
String name="[illegible]";
String icon="fa-trash-o";
String color="green";
long duration;
int dist;

void setup()
{
  Serial.begin(115200);
```


ESP32
trash","FillPercent":88,"Color":"red"}
Publish OK
Sending payload:
{"Name":"point2","Latitude":"13.167558","Longitude":"80.244510","Icon":"fa-
trash","FillPercent":88,"Color":"red"}
Publish OK