Project Report

TEAM ID	PNT2022TMID37209
PROJECT NAME	Smart waste management system for metropolitan cities

1.INTRODUCTION

1.1 Project Overview

Urban India generates ton es of wastes annually. Our country faces major challenges associated with waste management. Conventional garbage collection is not efficient since the authorities are not notified until the waste bin is full, and this leads to overflow of waste material. Efficient way of waste disposal and collection of disposed garbage is essential for a sustainable and clean India. This paper presents smart waste management using IoT based waste bin for collection and monitoring the level of waste inside bin. The system is implemented using two ultrasonic sensors which is being controlled by Node MCU. One of the ultrasonic sensor detects the level of the waste in the bin and other detects the person approaching the bin to dispose the waste. This detection helps in automatic opening and closing of the lid. Servo motor is connected to the lid which serves the action of closing and opening of the lid. In this system, level of waste in the bin will be sent to concerned authorities. The proposed system is reliable, cost effective and can be easily implemented.

1.2 Purpose

In Metropolitan cities, an efficient waste management system is crucial. To address the waste garbage management system this paper proposes an Internet of Things (IoT) based waste management system. Solutions for smart cities, of course, go through IoT technology, making it easier for us to perceive objects and communicate. From day to day, countries, regions, cities, and municipalities embrace the ‘’smart’’ systems and solutions in their operations. Accordingly, key waste management players are already operating with digitized solutions. So, IoT technology is a crucial step to embed in your operations.

2.LITERATURE SURVEY

2.1 Existing Problem

In Metropolitan cities, it is difficult for the Corporation workers to check the status of the garbage bins physically located in different geographical locations in the cities. The work time is wasted for the corporation workers on the process of checking the garbage bins regularly. It is difficult for the workers to empty the garbage bins on the correct time, which leads to the interruption for public residing on the city to dispose the garbage in the garbage bins.

2.2 References

Literature survey SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITIAN CITIES USING IOT

1. IoT-Enabled Smart Waste Management Systems for Smart Cities: A Systematic Review

Author: INNA SOSUNOVA 1 AND JARI PORRAS 1,2, (Member, IEEE) 1Department of Software Engineering, Lappeenranta–Lahti University of Technology, 53850 Lappeenranta, Finland 2Department of Communications and Networking, Aalto University, 00076 Aalto, Finland Corresponding author: Inna Sosunova (inna.sosunova@lut.fi) ABSTRACT: With urbanization, rising income and consumption, the production of waste increases. One of the most important directions in the field of sustainable development is

the design and implementation of monitoring and management systems for waste collection and removal. Smart waste management (SWM) involves for example collection and analytics of data from sensors on smart garbage bins (SGBs), management of waste trucks and urban infrastructure; planning and optimization of waste truck routes; etc. The purpose of this paper is to provide a comprehensive overview of the existing research in the field of systems, applications, and approaches vis-à-vis the collection and processing of solid waste in SWM systems. To achieve this objective, we performed a systematic literature review. This study consists of 173 primary studies selected for analysis and data extraction from the 3,732 initially retrieved studies from 5 databases.

We 1) identified the main approaches and services that are applied in the city and SGB-level SWM systems,

2) listed sensors and actuators and analyzed their application in various types of SWM systems,

3) listed the direct and indirect stakeholders of the SWM systems,

4) identified the types of data shared between the SWM systems and stakeholders, and

5) identified the main promising directions and research gaps in the field of SWM systems. Based on an analysis of the existing approaches, technologies, and services, we developed recommendations for the implementation of city level and SGB-level SWM systems.

2. Smart Waste Management System using IOT

Author: Tejashree Kadus 1 , Pawankumar Nirmal 2 , Kartikee Kulkarni 3 Department of Mechanical Engineering MIT Academy of Engineering, Pune Savitribai Phule University Abstract: The paper is based on the concept of Automation used in waste management system under the domain of Cleanliness and Hygiene. Dumping garbage onto the streets and in public areas is a common synopsis found in all developing countries and this mainly end up affecting the environment and creating several unhygienic conditions. In order to deal with these problems Smart netbin is an ideology put forward which is a combination of hardware and software technologies i.e. connecting Wi-Fi system to the normal dustbin in order to provide free internet facilities to the user for a particular period of time. The technology awards the user for keeping the surrounding clean and thus work hand in hand for the proper waste management in a locality. Smart netbin uses multiple technologies firstly the technology for measuring the amount of trash dumped secondly the movement of the waste and lastly sending necessary signals and connecting the user to the Wi-Fi system. The proposed system will function on client server model, a cause that will assure clean environment, good health, and pollution free society. Keywords: Loadcell, IOT, load sensing plate, Arduino, Wi-Fi, Internet.

3.IoT based Smart Waste Management System using Arduino

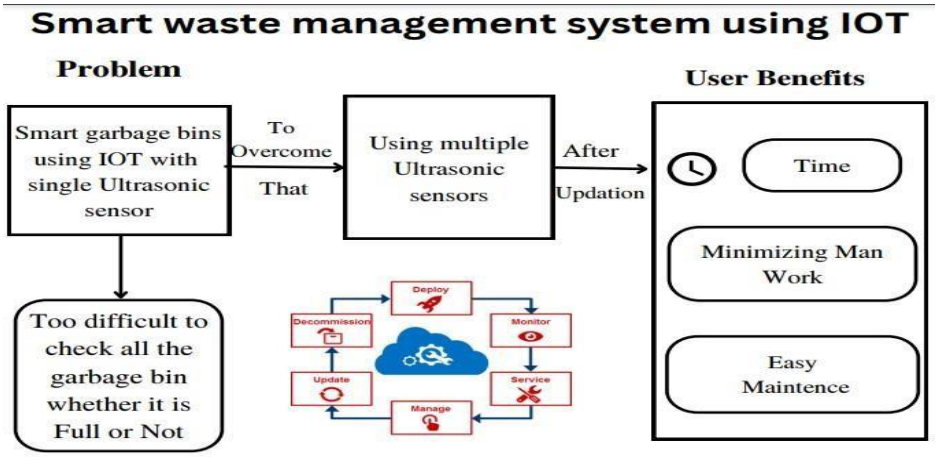
Abstract: In this paper, a system is introduced to manage waste in big cities effectively without having to monitor the parts 24×7 manually. Here the problem of unorganized and non-systematic waste collection is solved by designing an embedded IoT system that will monitor each dumpster individually for the amount of waste deposited. Here an automated system is provided for segregating wet and dry waste. A mechanical setup can be used for separating the wet and dry waste into separate containers here sensors can be used for separating wet and dry. For detecting the presence of any waste wet or dry can be detected using an IR sensor in the next step for detecting wet waste a moister sensor can be used. In this process, if only IR is detected motor will rotate in the direction of the dry waste container if both the sensor detects the waste then it will go to the wet container. Both these containers are embedded with ultrasonic sensors at the top, the ultrasonic sensor is used for measuring distance. This makes it possible to measure the amount of waste in the containers if one of the containers is full then an alert message will be sent to the corresponding person.

4. Smart waste management system

Author: Shyamala S.C, 2Kunjan Sindhe, 3Vishwanth Muddy, 4Chitra C N Assistant Professors, ECE Department PESITM, Shivamogga.karnataka,India.

Abstract: SMART WASTE MANAGEMENT SYSTEM which is proposed here is to implement a smarter way of conventional waste management using smart sensors to gather fill-level data, presence of garbage around the dustbin and stinking condition from containers and garbage bins, and send it to servers in real time. An authorized phone number which are present in Waste Management Centers gather fill-level and other information sent from multiple containers which are situated throughout a city/locality. The data acquired as above, can be used to systematically plan route-map to collect garbage. The information from bins to the authorized number is sent using communicating modules (GSM/GPRS module). The entire operation is controlled using Atmega328P 8-bit microcontroller. This report showcases a potential design for an IoT gateway that can be used to provide a framework for a smart waste management system. IndexTerms- Moisture sensor, Ultrasonic sensor, ATmega328pmicrocontroller and GSM/GPRS900A module.

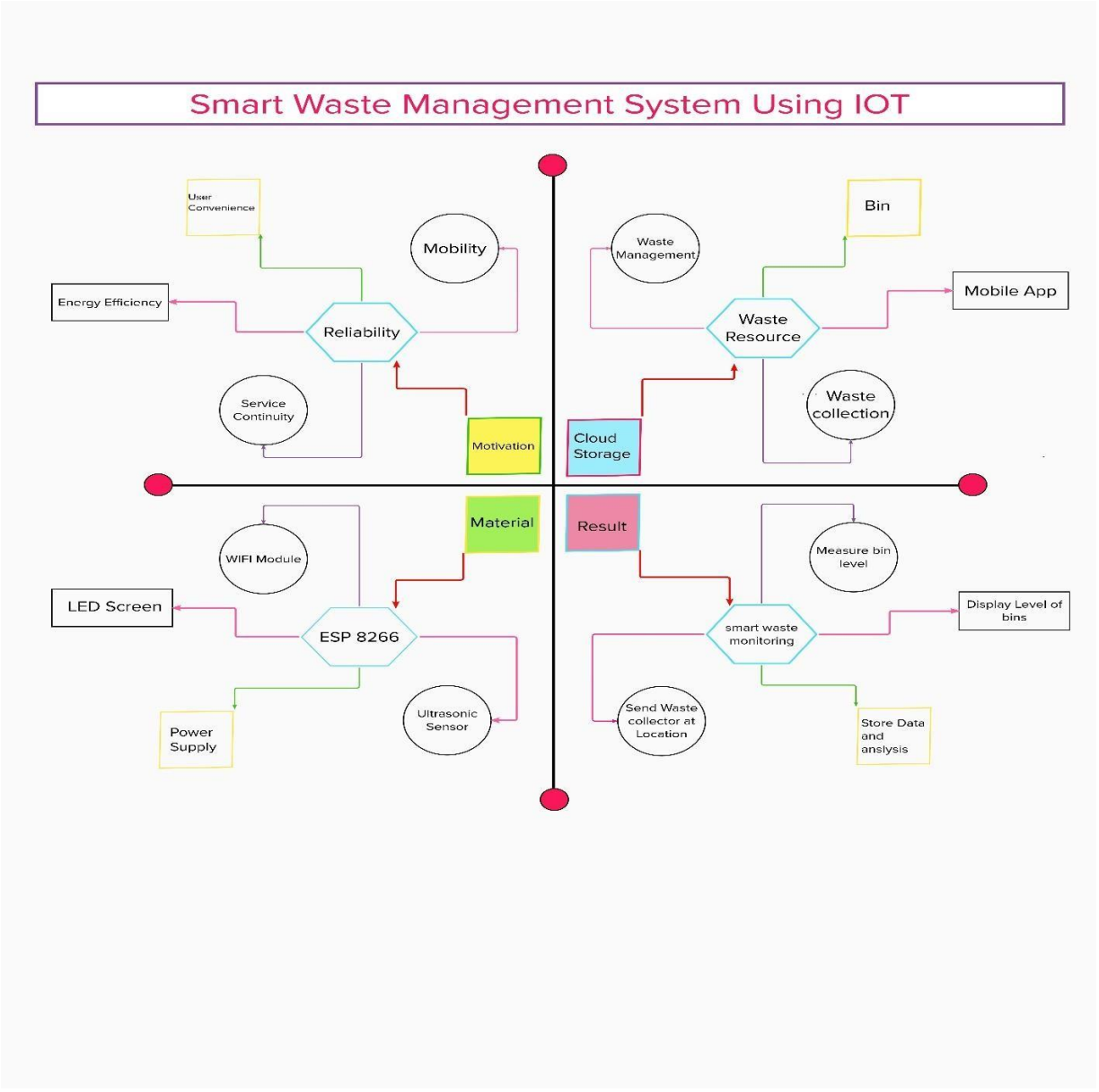
2.3 Problem Statement Definition



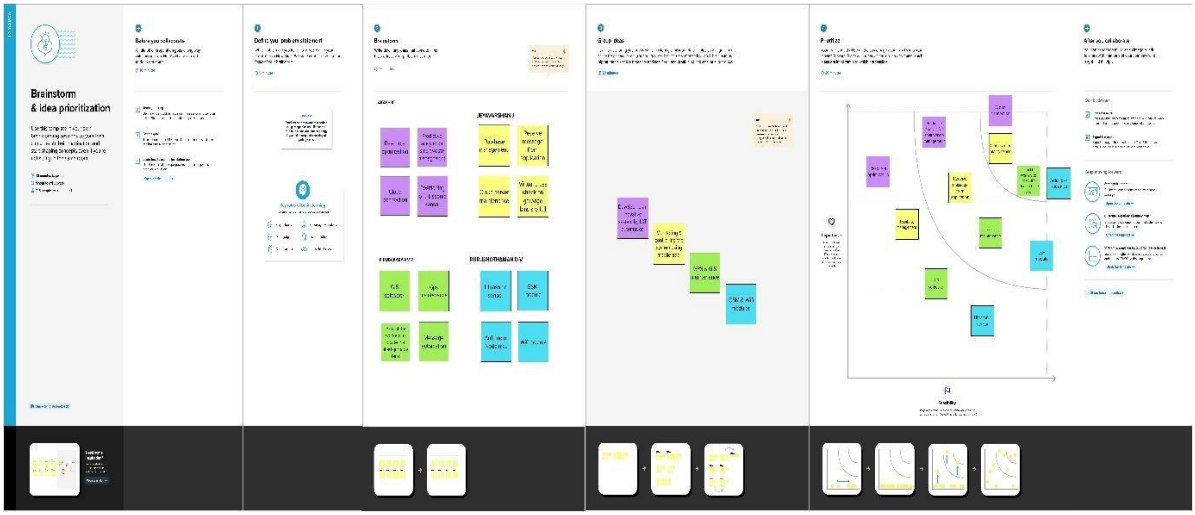
To overcome the problem faced by the Corporation workers in the metropolitan cities to check the level of garbage in the garbage bins a IOT based kit is developed using multiple number of Ultrasonic sensors connected with the Arduino board. Using the hardware application the level of garbage bins is detected and the garbage's are removed from the garbage bin on time.

3.IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming

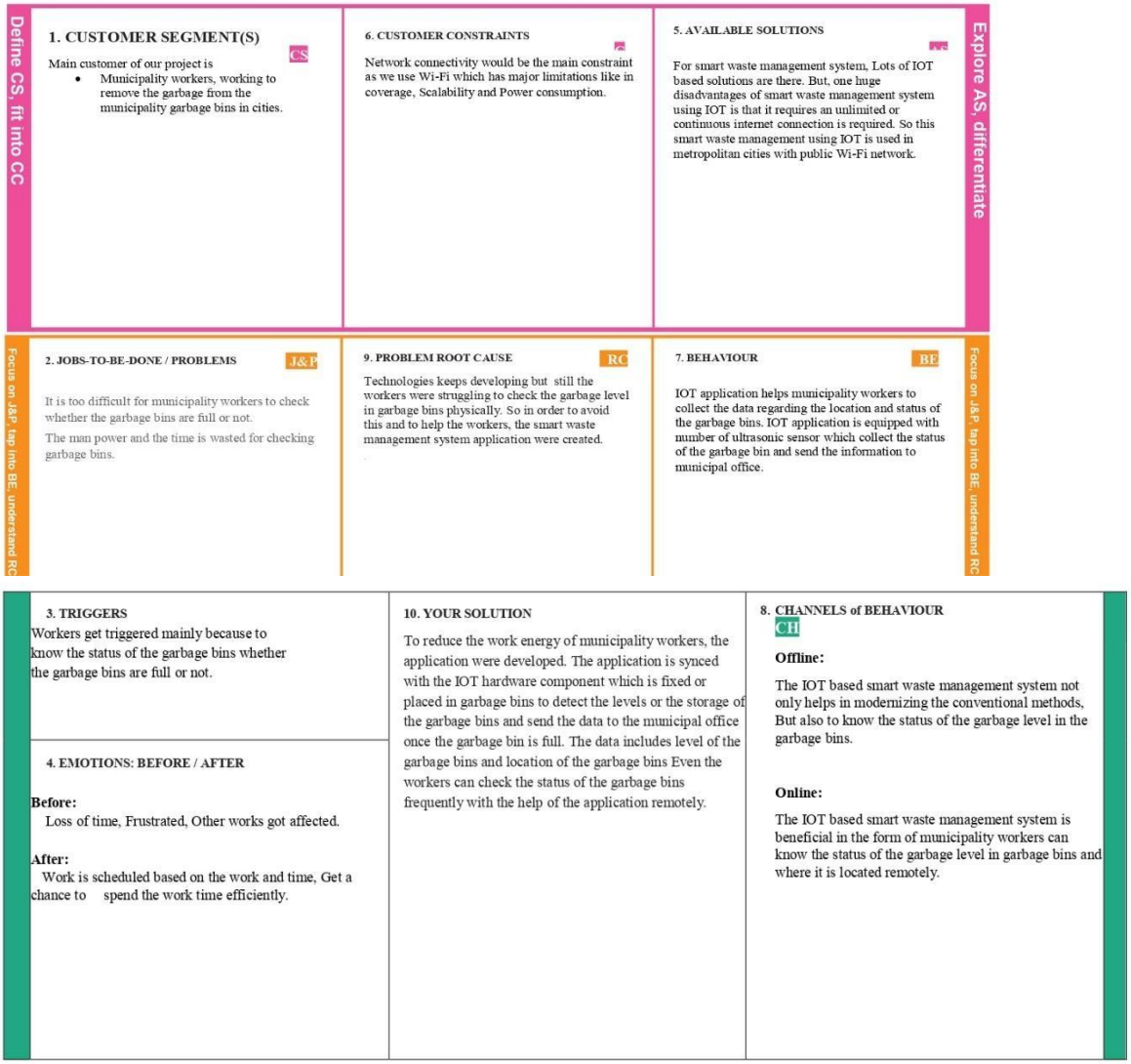


3.3 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Smart Waste Management System for Metropolitan Cities.
2.	Idea / Solution description	Managing the garbages in the garbagebins placed in the streets. When the bins are full a message will be send to Municipality. They get information where the bins is full and send the workers to empty the bin again.
3.	Novelty / Uniqueness	No man power is essential to check whether the garbage bins are full or not.
4.	Social Impact / Customer Satisfaction	Once the bins are full it starts overflowing of garbages from the bin. So, Once the bin is filled with garbages it is removed and the bin is made empty. So, that the public can put their garbages on the bin without any disturbance.
5.	Business Model (Revenue Model)	This is the model to empty the garbage bins for next public use.
6.	Scalability of the Solution	This decrease the man power energy on frequent check on the garbage bins. This makes easy to know about the garbage bin status

3.4 Problem Solution fit

Project Title: Smart Waste Management System For Metropolitan Cities Using IOT
Project Design Phase-I - Solution Fit Template
Team ID: PNT2022TMID37209



4. REQUIREMENT ANALYSIS

4.1 Functional requirement

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Gmail
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Log in to system	Check Credentials Check Roles of Access.
FR-4	Manage Modules	Manage sensor dataManage Garbage bins location data Control Full System
FR-5	Log out	Exit

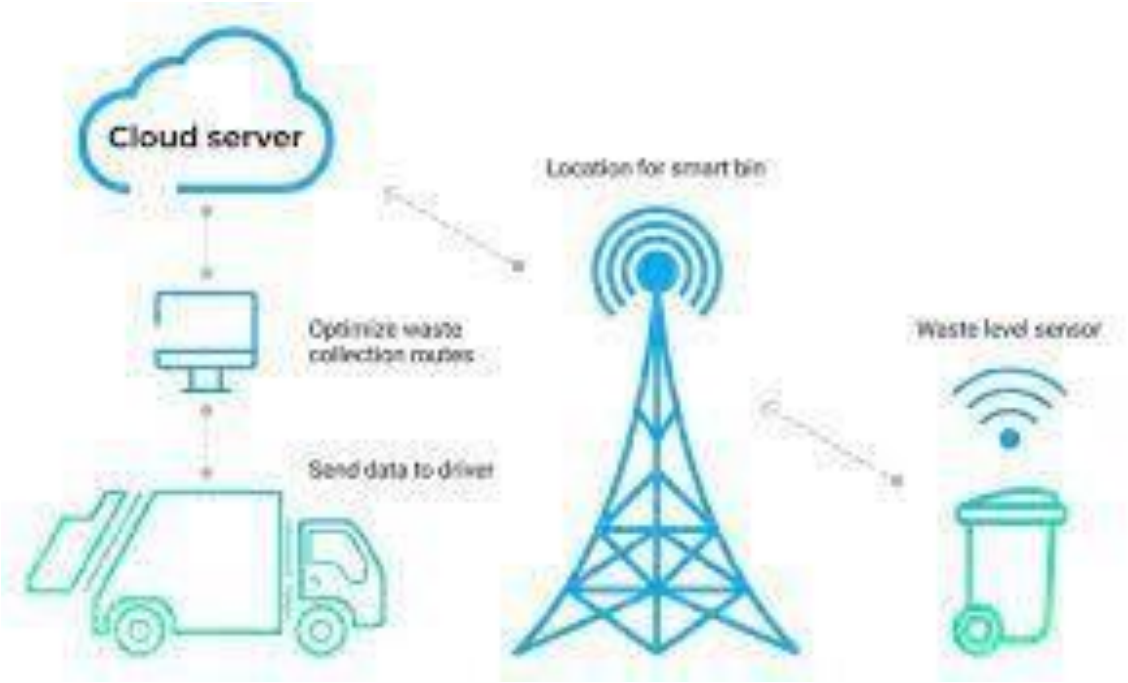
4.2 Non-Functional requirements

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Usability includes easy learn ability, efficiency in use, remember ability, lack of errors inoperation and subjective pleasure.
NFR-2	**Security**	Sensitive and private data must be protected from their production until the decision-making and storage stages.
NFR-3	**Reliability**	The shared protection achieves a better trade-offbetween costs and reliability. The model uses dedicated and shared protection schemes to avoid workers service outages.

NFR-4	**Performance**	The idea of implementing integrated sensors onthe top of the Garbage bin detects the status of the Garbage bin and trigger the message to Corporation.
NFR-5	**Availability**	Automatic checking of the Garbage level in the garbage bin reduced work energy, time and efficiency of the workers.
NFR-6	**Scalability**	Scalability is a major concern for IoT platforms.It has shown that different architectural choices of IoT platforms affect system scalability and that automatic real time decision-making is feasible in an environment composed of dozensof thousand.

5.PROJECT DESIGN

5.1 Data Flow Diagrams



5.2 Solution & Technical Architecture

Component & Technologies:

S.No	Component	Description	Technology
1.	User Interface	How user interacts with application e.g.WebUI, MobileApp, Chatbotetc.	HTML,CSS,JavaScript/ AngularJs/Re actJs etc.
2.	Application Logic-1	Logic for a process in the application	Python
3.	Application Logic-2	Logic for a process in the application	IBM Watson IOTservice
4.	Application Logic-3	Logic for abprocess in the application	IBMbWatsonAssistant
5.	Database	DataType,Configurationsetc.	MySQL,NoSQL,etc.
6.	Cloud Database	Database Service on Cloud	IBMDB2,IBMCloudant etc.
7.	File Storage	File storage requirements	IBM Block Storage or Other StorageServiceor Local Filesystem
8.	External API-1	Purpose of ExternalAPI used in the application	IBMWeatherAPI,etc.
9.	Machine Learning Model	Purpose of Machine Learning Model	ObjectRecognitionMo del,etc.
10.	Infrastructure(Server/Cloud)	Application Deployment on Local System / CloudLocal Server Configuration: CloudServer Configuration:	Local,CloudFoundry,Ku bernetes,etc.

Application Characteristics:

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	List the open-source frame works used	Technology of Openbsource framework
2.	Security Implementations	Sensitive and private data must be protected fromtheir production until the decision-making andst orage stage s.	e.g.Node-Red,Openweather App API,MIT App Inventor, etc.
3.	Scalable Architecture	scalability is a major concern for IoTplatforms.It has been shown that different architectural choices of IoT platforms affect system scalabilityand that automatic real time decision-making isfeasiblein an environment composed of dozens of thousand.	Technology used
4.	Availability	Automatic adjustment of frequent readings takenby the kit and prepare the message to the corporation to know about the status of the Garbage bin.	Technology used
5.	Performance	The idea of implementing integrated sensors withsensing level of garbage bins and environmental or ambient parameters will be more efficient for overall monitoring.	Technology used

5.3 User Stories

1. As a user, I can register in the application and get the login credentials to log onto different devices.

2. Python code has to be developed to connect the application with NodeRed serivces to get connections.
3. After successful connection of Python code with Node-Red serivces. Connect Node-Red to Cloudant Database.
4. Development of user interface design and Finally Deploy the application.

6. PROJECT PLANNING & SCHEDULING

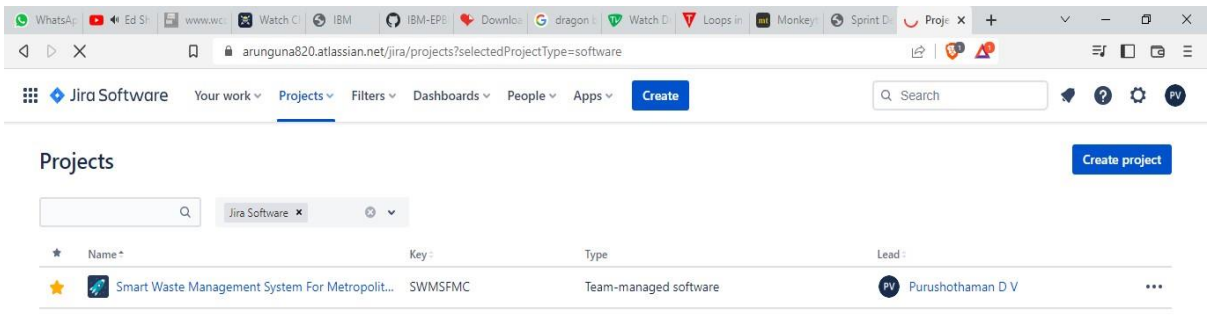
6.1 Sprint Planning & Estimation

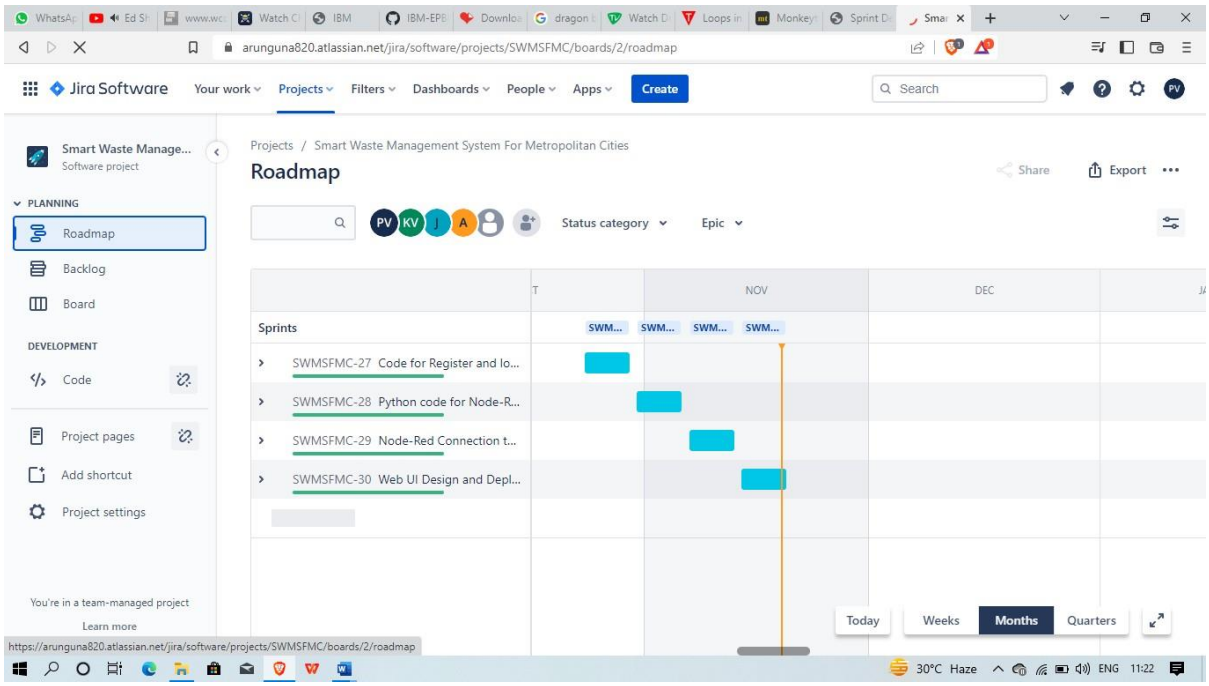
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint 1	Code for Register and login credentials	USN-1	As a user, I can register in the application and get the login credentials to log onto different devices.	18	High	Akash K
Sprint 2	Python code for Node-Red Connection	USN-2	Python code has to be developed to connect the application with Node- Red serivces to get connections.	18	Low	Jeyavarshan J
Sprint 3	Node-Red Connection to the IBM Cloudant DB	USN-3	After successful connection of Python code with Node-Red serivces. ConnectNode-Red to Cloudant Database.	18	High	Kirubakaran V V
Sprint 4	Web UI Design and Deploy	USN-4	Development of user interface design and Finally Deploy the application.	18		Purushothaman D V

6.2 Sprint Delivery Schedule

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (ason Planned End Date)	Sprint Release Date(Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	18	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	18	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	18	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	18	19 Nov 2022

6.3 Reports from JIRA

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SWMSFMC-28 Python code for Node-R...
SWMSFMC-29 Node-Red Connection t...
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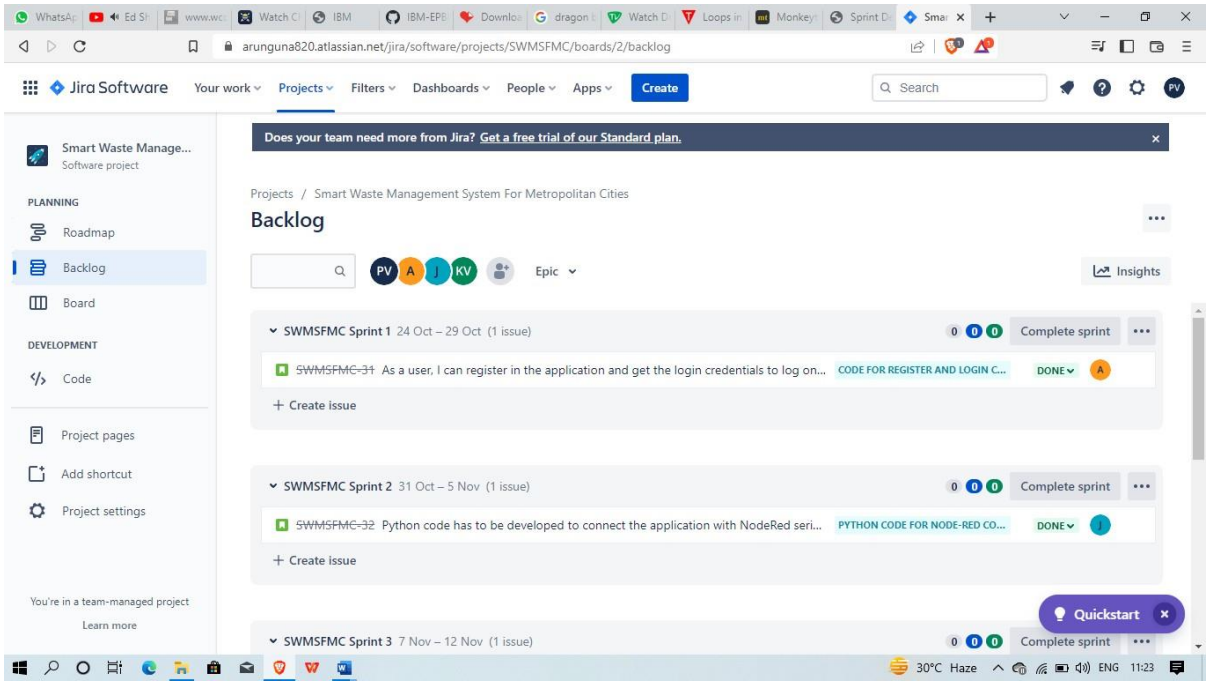
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SWMSFMC Sprint 1 24 Oct – 29 Oct (1 issue)
Complete sprint
SWMSFMC-31 As a user, I can register in the application and get the login credentials to log on...
CODE FOR REGISTER AND LOGIN C...
DONE
Create issue
SWMSFMC Sprint 2 31 Oct – 5 Nov (1 issue)
Complete sprint
SWMSFMC-32 Python code has to be developed to connect the application with NodeRed seri...
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SWMSFMC Sprint 3 7 Nov – 12 Nov (1 issue)
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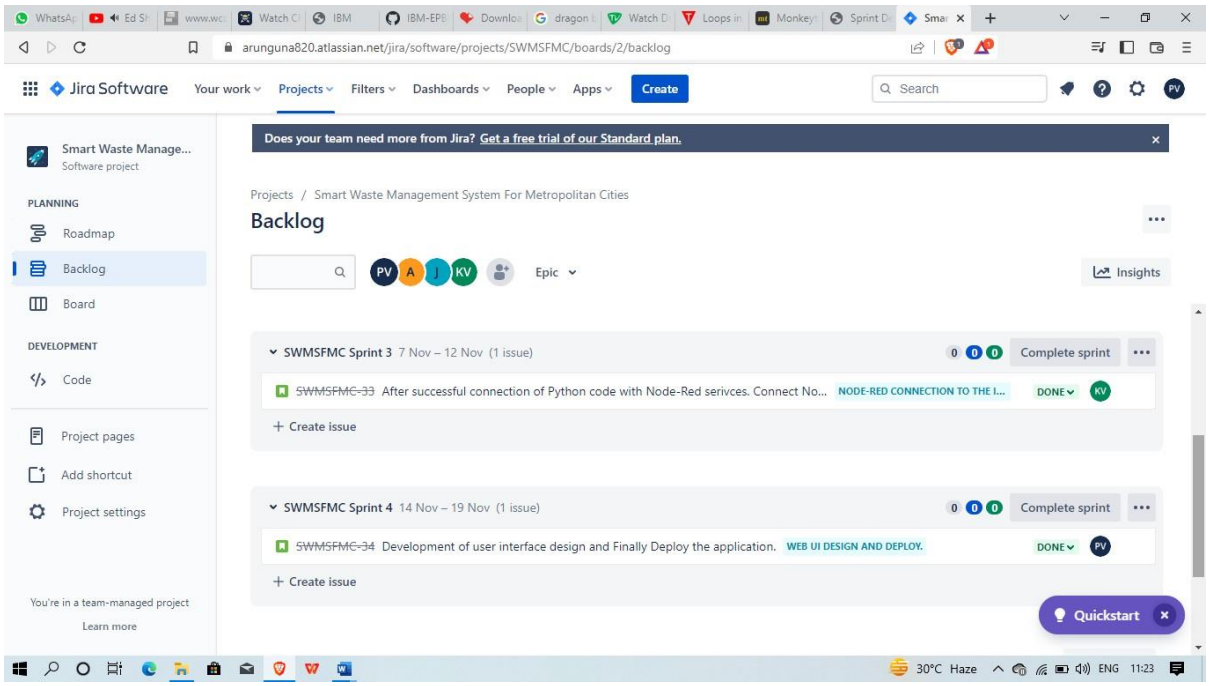
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Complete sprint
SWMSFMC-33 After successful connection of Python code with Node-Red serivces. Connect No...
NODE-RED CONNECTION TO THE I...
DONE
Create issue
SWMSFMC Sprint 4 14 Nov – 19 Nov (1 issue)
Complete sprint
SWMSFMC-34 Development of user interface design and Finally Deploy the application.
WEB UI DESIGN AND DEPLOY.
DONE
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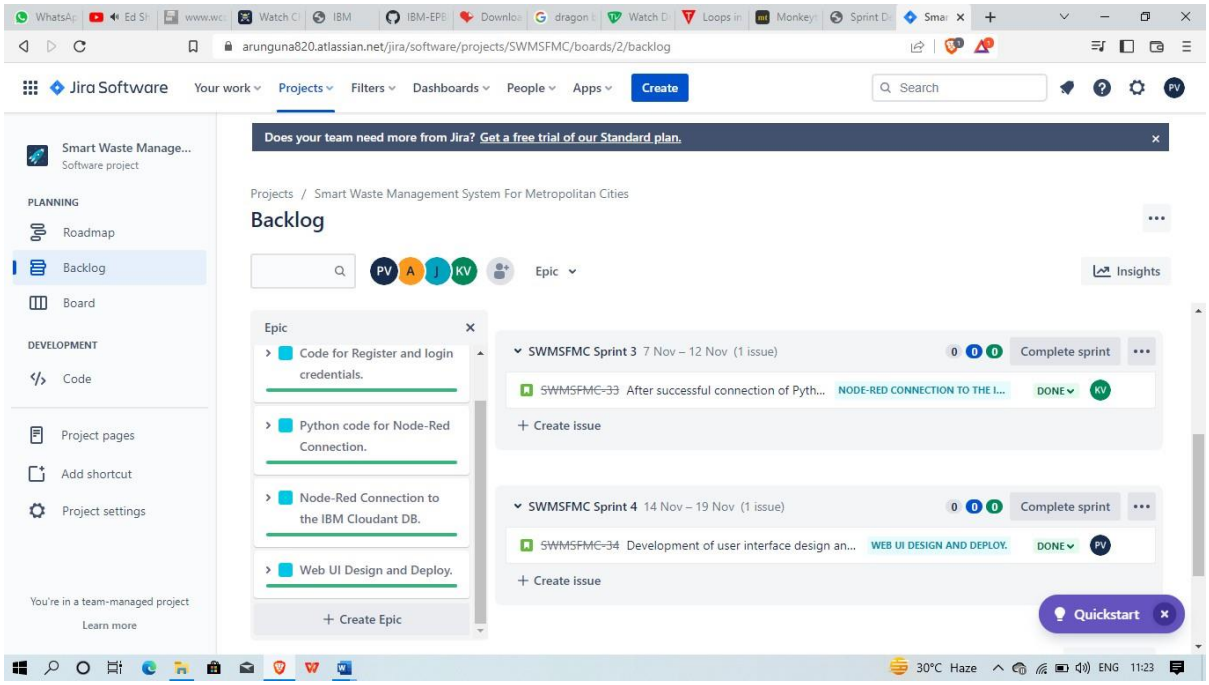
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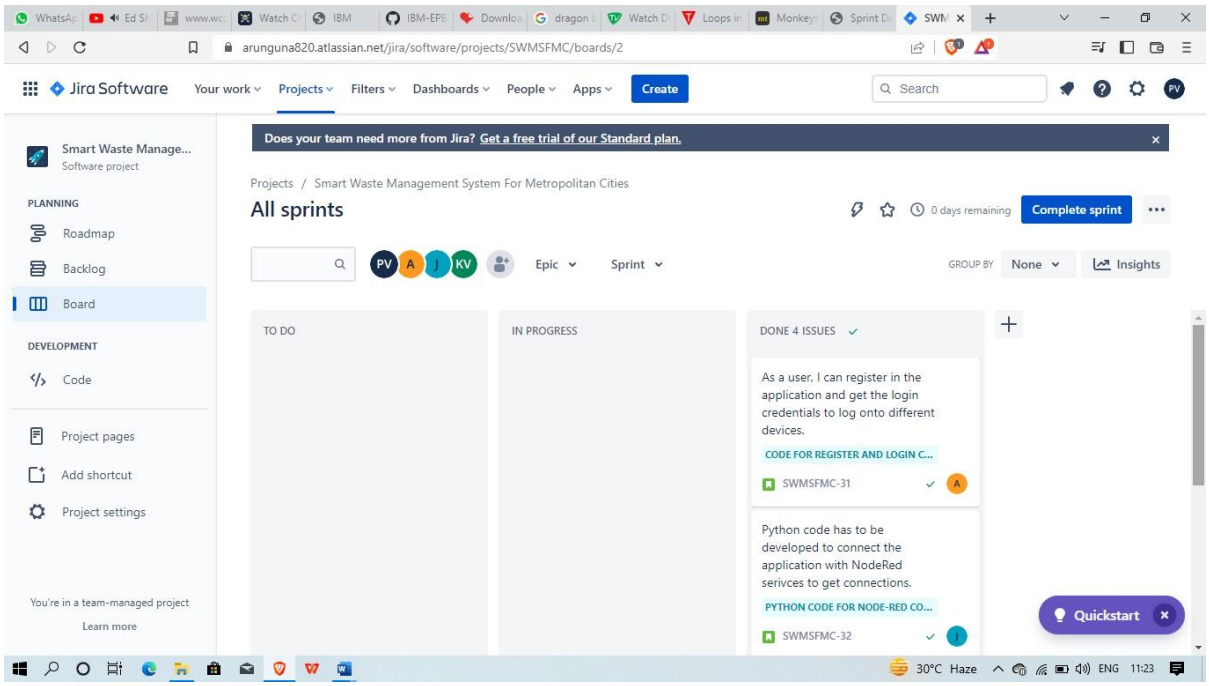
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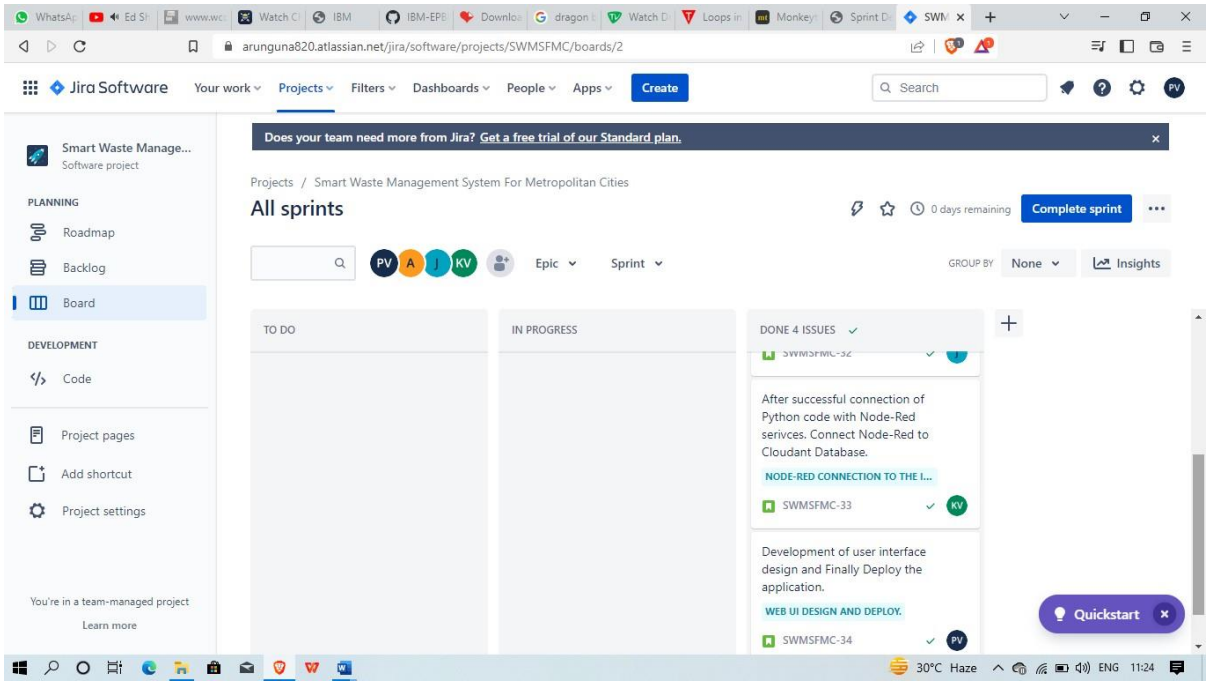
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Development of user interface design and Finally Deploy the application.
WEB UI DESIGN AND DEPLOY.
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7. CODING & SOLUTIONING

7.1 feature 1

- Real-time waste monitoring.
- Predictions for bin fulness.
- Detailed database of bins and stands.
- Interactive bin map including Street view.

7.2 feature 2

- Route planning for waste collection.
- Overview of scheduled and executed routes.
- Database of citizen reports.
- Fire and tilt alarm.

8. TESTING

8.1 Test cases

- Verify user is able to see the Login/Signup popup when user clicked on My account button
- Verify the UI elements in Login/Signup popup
- Verify user is able to log into application with Valid credentials
- Verify user is able to log into application with InValid credentials

8.2 User Acceptance testing

1. Purpose of Document

The purpose of this document is to briefly explain the test coverage and open issues of the [ProductName] project at the time of the release to User Acceptance Testing (UAT).

2. Defect Analysis

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved

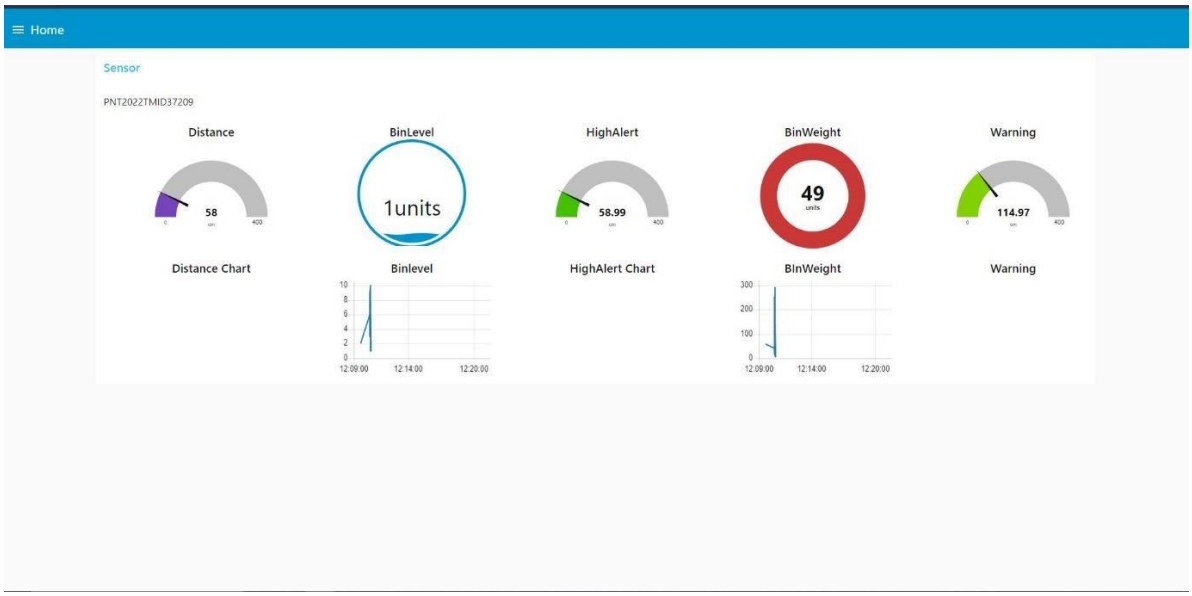
Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	10	4	2	3	20
Duplicate	1	0	3	0	4
External	2	3	0	1	6
Fixed	11	2	4	20	37
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	0	5	2	1	8
Totals	24	14	13	26	77

3. Test Case Analysis

This report shows the number of test cases that have passed, failed, and untested

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	7	0	0	7
Client Application	51	0	0	51
Security	2	0	0	2
Outsource Shipping	3	0	0	3
Exception Reporting	9	0	0	9
Final Report Output	4	0	0	4
Version Control	2	0	0	2

9.RESULTS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10. ADVANTAGES & DISADVANTAGES

10.1 ADVANTAGES

1. Time-saving

By having a more convenient route garbage trucks spend less time on the road, therefore, congestion in smart cities can be decreased. This means that truck drivers and citizens are saving less time stuck in traffic jams. Additionally, using IoT technology for remote diagnostics also means not having to send staff all the way to monitor assets.

2. Cost-saving

With the huge increase in waste, more resources are allocated to waste collection and handling. If unnecessary collections are eliminated, public spending on waste management can be reduced.

This frees up resources for municipalities to allocate to other initiatives. Moreover, waste is properly handled and sorted and turned into recyclable assets, this provides a further potential income stream.

3. Sustainability

Overflowing bins will pollute the environment potentially contaminating areas and harming the general health of the public. An optimized route and system for waste collection will eliminate this risk as well as improving air quality and minimizing CO2 emissions. Smart cities can reduce their overall carbon footprint, bringing them closer to achieving the SDG goals.

4. Improving efficiency

Smart cities are all about using resources efficiently – achieving more by using less input. One of the benefits includes the availability of real-time data, allowing for decisions to be made quickly. This means that action can be taken before having an overflow of containers. Smart cities can remain highly responsive and challenge the current waste hierarchy, breaking patterns of inefficiency and high costs.

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

- It reduces man power requirements which results into increase in unemployment for unskilled people.
- The training has to be provided to the people involved in the smart waste management system.

11. CONCLUSION

Smart waste management system operations to unprecedented levels with IoT technology. With the IoT based waste management for smart city, you can quickly achieve operational excellence. Utilizing above mentioned solutions in your operations will boost your revenue and bring your business to a respected place. But technology alone is not enough for gaining respect. When IoT and smart city are not combined with the sustainability vision, it may not produce the desired result.

This helps the corporation workers to know about the levels of garbage bin and when it need to be emptied. It saves time and manpower of the corporation. The corporation can monitors the entire process remotely.

12. FUTURE SCOPE

1. Transparency

By routes being monitored, the opportunity of the misuse of owned assets is eliminated. Moreover, cities are encouraged to be transparent with their citizens by showing how waste is being managed. By making data publicly available, trust can be built with citizens. Smart cities should be encouraged by their operations and solutions to strive for more sustainable development, not limited by them.

2. Meet the increasing demand for sustainable solutions

As society is becoming more aware of the environmental issues – there is an increasing demand for more sustainable and environmentally friendly solutions, when choosing between services and products. Smart cities infrastructure and intelligent waste solutions have the potential to lead the shift towards a more sustainable future.

13. Appendix

13.1 Github and Project Demo Link

https://github.com/IBM-EPBL/IBM-Project-245-1658225989

https://youtu.be/thsat8lc8f4