GOVERNMENT COLLEGE OF TECHNOLOGY

COIMBATORE-641 013

SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITAN CITIES

DOMAIN-Internet of things

IBM-NALAIYATHIRAN

PROJECT REPORT

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Project Report Format

INTRODUCTION

Proper waste management is one of the major problems for densely populated urban areas. It is getting difficult day by day to lead a healthy, sustainable living in urban areas because of environmental contamination. Due to the lack of proper waste management approach, problems like an overflow of waste occurs that badly harm our environment. Polluted surroundings result in the spread of various kinds of diseases in an epidemic form. For developed and developing countries, waste management is a challenge to long-term development. Proper management of waste is getting tougher because of increasing population, urbanization and industrialization. In this modern era of technology, we need to apply technology-based solutions to handle large amounts of waste for overpopulated urban areas.

This project reviewed several recent research articles related to the smart waste management system, and almost all of them have some major limitations as well as progress. To ensure environmental hygiene and sustainable urban life, this project presented a smart IoT based garbage system which is located at the different places. All the dustbin does not get filled at the same duration, depending upon the population in the area amount of domestic waste gets varied because of this collection of waste at the appropriate time is difficult. This system talks about the duration required for every bin to get filled.

Arduino Uno is used as a microcontroller to synchronize all of the four systems. Sensors are used for measuring the garbage level. The system provides the facility of continuous monitoring of the status of waste inside the garbage bin and shows the distance filled up. The communication system uses database to store data and the level of the bin can be seen in the website.

The proposed waste management system is much more efficient than any other conventional waste management system as it reduces the use of manpower, avoids overflow of waste, saves time, more economical and most importantly, it is a completely automated system

PURPOSE

To design an IoT based garbage system that updates the level of the dustbin to the website and helps to interpret the average time taken by the bin to get filled which is placed at various places.

Managing solid waste efficiently will be a huge leap towards greener, cleaner and smart cities. It saves time and money by using smart waste collection bins and systems equipped with fill level sensors. Due to lack of proper information about the time taken by the bins to get filled sometimes over flow of the bin occurs in order to avoid this data analysis is done to get the information about the average duration in which the bin gets filled.

LITERATURE SURVEY:

[1] A.Arul Anitha, L.Arockiam, 2020, "Promoting a Clean and Hygienic Environment using IoT", International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8 Issue-5. The project was designed to improve the waste management at an organization level. Large-scale implementation of the project will reduce the service cost associated with the Waste Management System significantly. This system does not display the real time value of the bin. So, the exact level of the bin is unknown at any particular time.

[2] Parkash and V. Prabu, 2016, "IoT based waste management for smart city," International Journal Research Computer and Communication Engineering, vol. 4, no. 2. In this proposed System there are multiple dustbins located throughout the city or the Campus, these dustbins are provided with low cost embedded device which helps in tracking the level of the garbage bins and an unique ID will be provided for every dustbin in the city. So, that it is easy to identify which garbage bin is full. When the level reaches the threshold limit, the device will transmit the level along with the unique ID provided. These details can be accessed by the concern authorities from their place with the help of Internet and an immediate action can be made to clean the dustbins.

[3] Pramanik, Jitendra & Samal, Abhaya Kumar & Sahoo, Kabita & Pani, Dr.Subhendu. 2019, "Exploratory Data Analysis using Python",

International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8, Issue-12.

This article explains the details about explorative data analysis. In this, Amazon review data set is used. The data is analyzed using the result decisions, the example taken for the article is recommendation system, ranking of the page, demand fore casting, prediction of purchase of the product. The first step is data exploration, which includes error correction and visualization. Then data cleaning and the model is built. Model building includes model diagnostics and residual diagnostics. Finally, the result is obtained from the graphs and table

EXISTING PROBLEM

With the web application, the administrator will be able to search for dustbins. The result will be based on the criteria the user inputs. There are several search criteria, and it will be possible for the administrator of the system to manage the options for those criteria that have that.

The result of the search will be viewed either in a list view or in a map view, depending on what criteria are included in the search. The list view will have one list item for each dustbin matching the search criteria and show a small part of the dustbin information, so the user can identify the dustbin. The administrator will be able to either select a dustbin as a target destination or get information on how to get there or view the information of a specific dustbin.

The web portal will provide the functionality to manage the system and the dustbin information. It will also provide information about the system, for example, showing when there is a new update.

REFERENCES

[1] A.Arul Anitha, L.Arockiam, 2020, “Promoting a Clean and Hygienic Environment using IoT”, International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8 Issue-5.

[2] Parkash and V. Prabu, 2016, “IoT based waste management for smart city,” International Journal Research Computer and Communication Engineering, vol. 4, no. 2.

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PROBLEM STATEMENT

Garbage Management and Collection in Cities, Town and Villages is a major concern and emerging problem in Smart City paradigm. Also lack of proper resource distribution in the process of Garbage collection is great risk to sanitation, cleanliness and health.

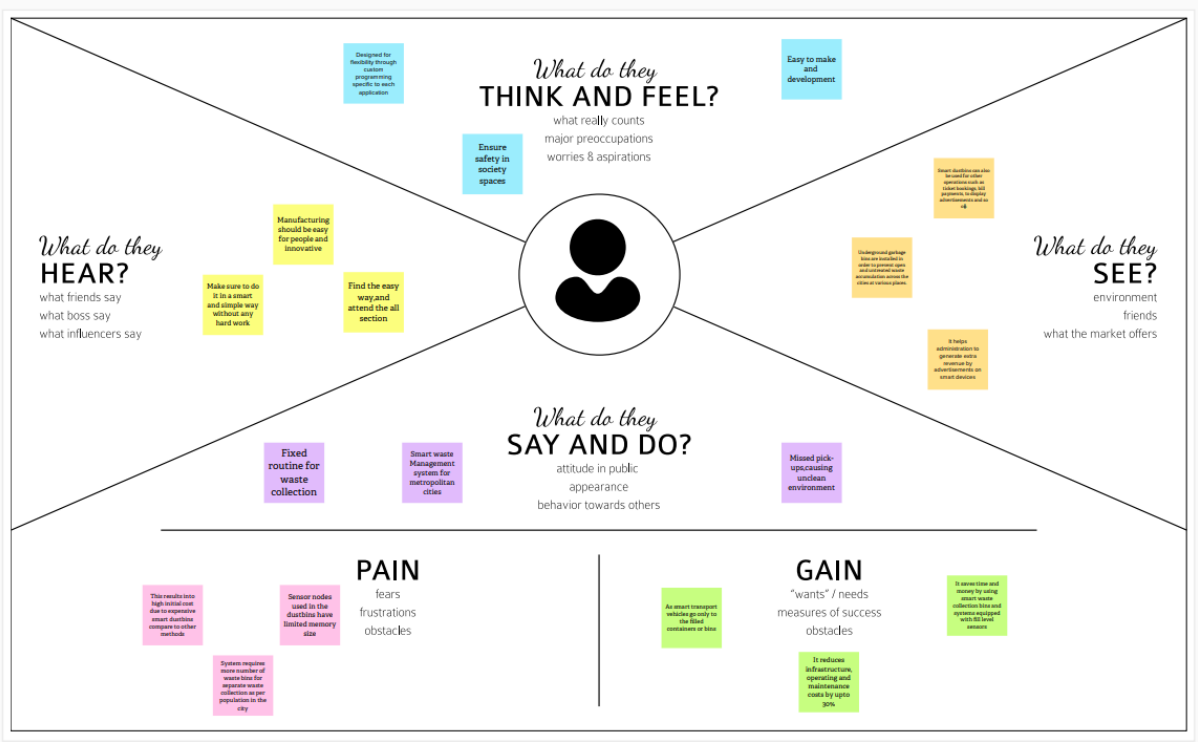
IDEATION & PROPOSED SOLUTION

Ideation is expressed via graphical, written, or verbal methods , and arises from the past or present knowledge , influences , opinions, experiences and personal convictions.

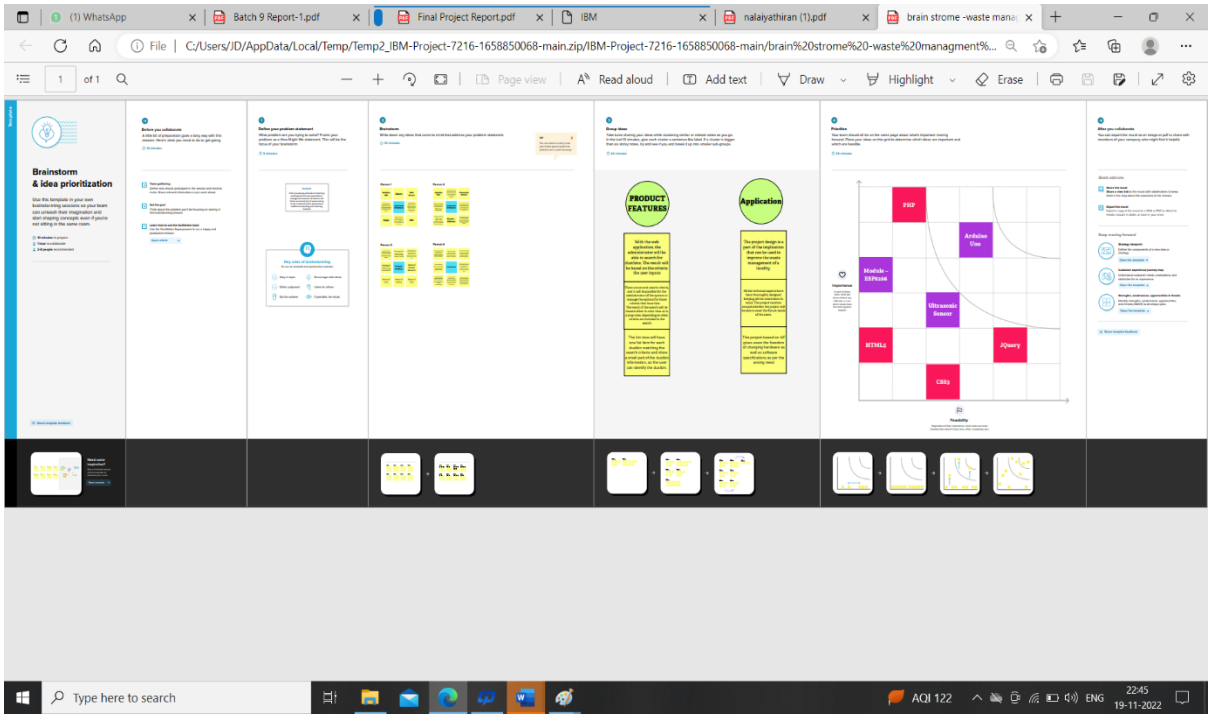
Empathy Map Canvas

13.1 Ideation & Brainstorming

13.2 Ideation & Brainstorming



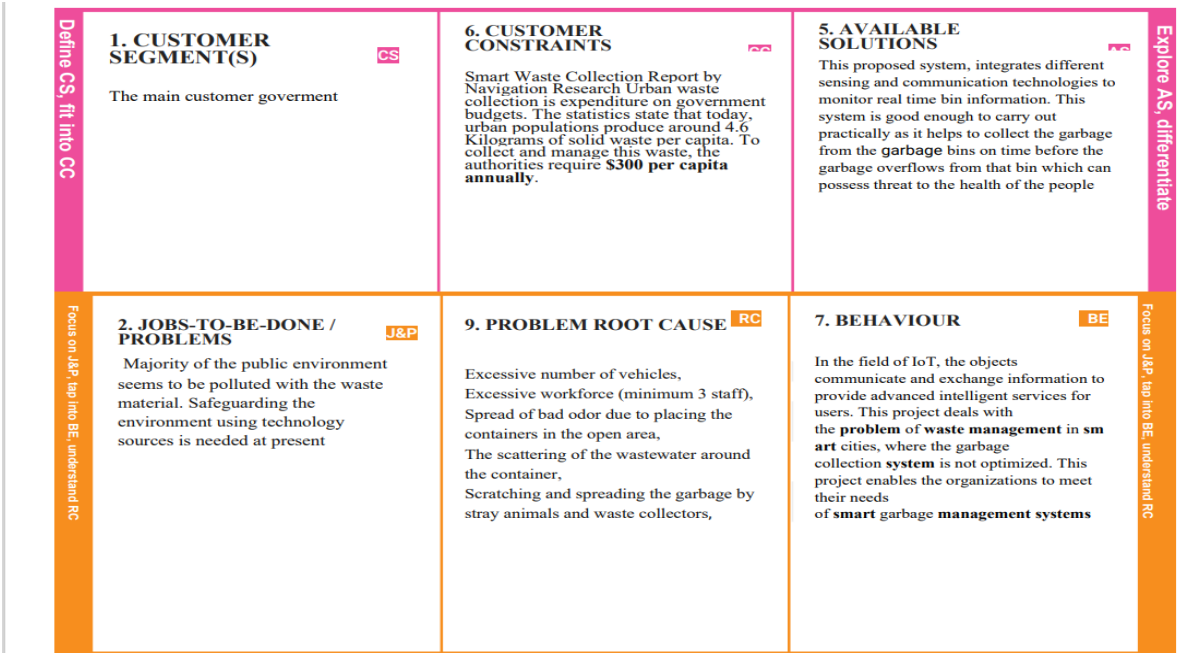
Ideation & Brainstorming



Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	The municipal workers who are engaged in the collection of garbage require a sustainable, streamlined process for an efficient waste collection system and to integrate the databases containing information about waste from each of the municipal offices to design an improvised system where the garbage collectors or municipal workers will be given an alert regarding the availability of waste.
2.	Idea / Solution description	Smart waste management helps to **reduce the waste**, create waste to energy source also it helps to keep the environment clean and neat. All the city's urban local bodies depending upon the available technology have to spend the money and innovate the new concept of waste management that is the main purpose of smart waste management.
3.	Novelty / Uniqueness	**Sensoneo Analytics:** Sensoneo Analytics has a smart process for waste management, which includes placing sensors on garbage collection bins to monitor which of them are full or not. This integrates with their analytics software to help automate and optimize when and how waste is collected in the city
4.	Social Impact / Customer Satisfaction	➢ raise public awareness of utilizing renewable energy ➢ improve street sanitation ➢ collect and analyze area-specific data on waste volumes for better planning
5.	Business Model (Revenue Model)	As a result, time and fuel consumption are achieved and garbage collection operations are performed in a much more fluid way
6.	Scalability of the Solution	The device can use in all metropolitan cities. Major efficiency of device: Easily identify the level of waste in garbage because it has a sensor

Problem Solution fit



REQUIREMENT ANALYSIS

FUNCTIONAL:

Functional Requirements:

Following are the functional requirements of the proposed solution.

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	**GPS Access**	GPS access to know the location
FR-4	**Bin level Analysing**	Acquire the levels of Waste bins in a regular interval of time.
FR-5	**Transport Router**	To make a efficient route for the collection of garbages around a area.

NON FUNCTIONAL:

Non-functional Requirements:

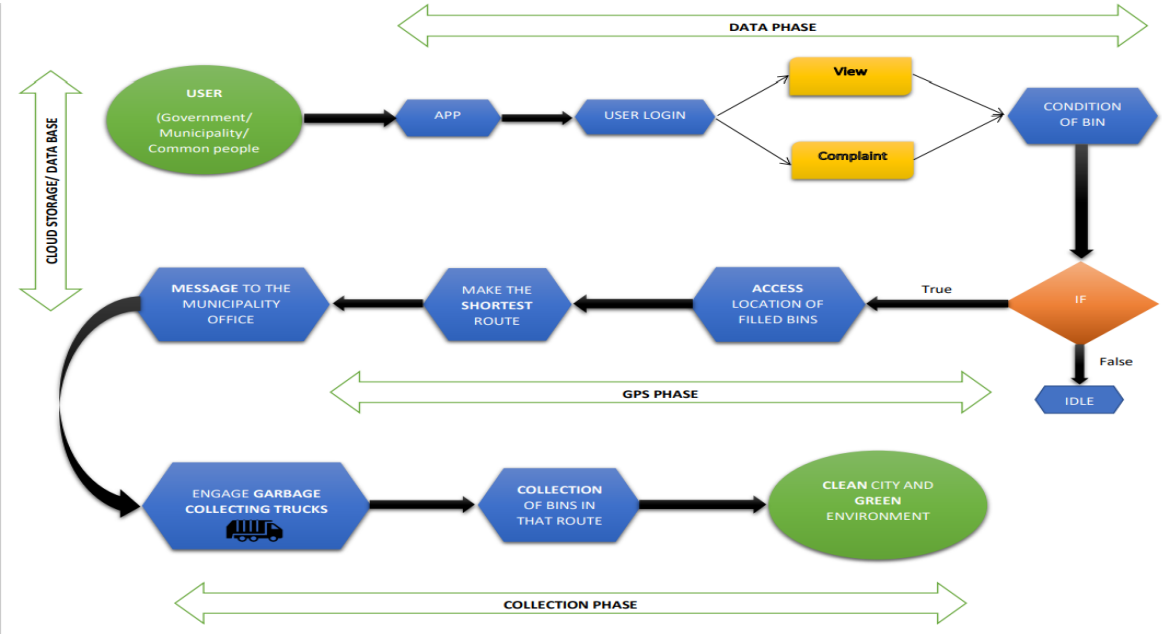
Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	➢ A smart solution has been proposed to make the waste sorting more simple and accurate , and improve the user experience, usability, and satisfaction. ➢ It aims to optimize ease of use while offering maximum functionality.
NFR-2	**Security**	➢ The information of the users will be highly secured,the accounts are verified with Gmail. ➢ If the products are misplaced then the GPS driven sensor gives an alert.
NFR-3	**Reliability**	➢ Operates in a defined environment without failure resulting in less manpower, emissions, fuel use and traffic congestion.
NFR-4	**Performance**	➢ The system will provide accurate reports, thus increasing the efficiency of the system. ➢ The real-time monitoring of the garbage level with the help of sensors and wireless communication will reduce the total number of trips required of Garbage collecting truck. ➢ This will reduce the total expenditure associated with the garbage collection.

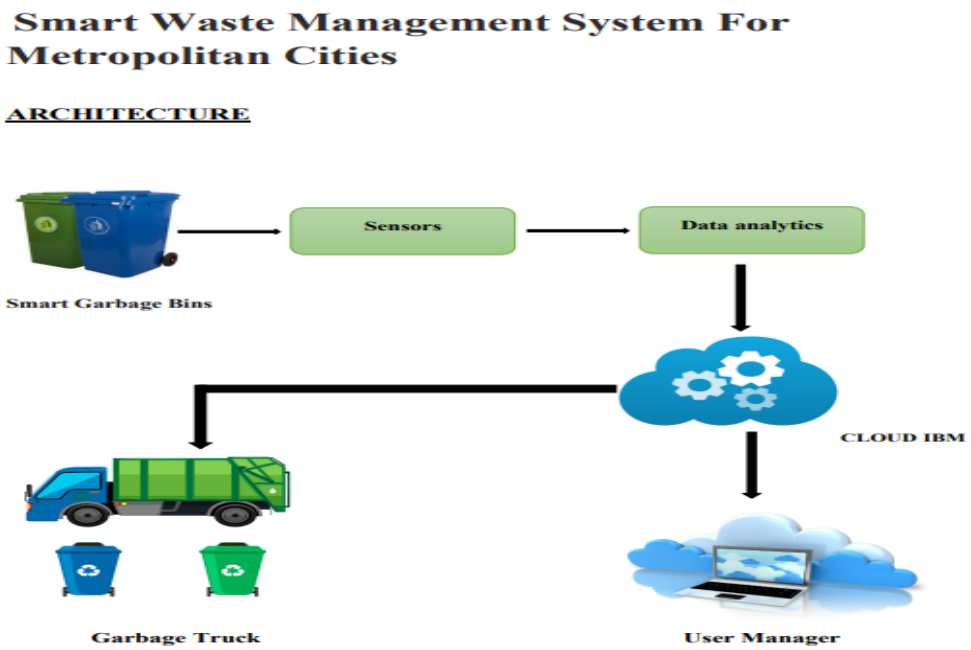
PROJECT DESIGN:

Project design is an early phase of the project life cycle where ideas, processes,resources and deliverables are planned out.

DATA FLOW DIAGRAM:



Solution &Technical Architecture:



USERS STORIES:

User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I created an account in the application provided.	I can access my account / dashboard	High	Sprint-1
		USN-2	As a user, I registered using my gmail.	I can receive confirmation email .	High	Sprint-1
		USN-3	As a user, I successfully installed the app and login to see the bin level in my area.	I can register & access the dashboard .	Low	Sprint-2
	Login	USN-4	As a user, I login using my gmail and password easily.	The login process was easy and simple to access the dashboard.	High	Sprint-1
Customer (Web user)		WUSN-1	As a web user I can see whether the bins in the locality are	The website must work properly so	High	Sprint-2

PROJECT PLANNING& SCHEDULING:

Sprint Planning and Estimation

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	Gogul
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	Sathish
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	Shree Vikash
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	Sreejith
Sprint-4	Dashboard	USN-5	As a Municipality officer, I'll make sure everything is proceeding as planned and without any problems	20	High	Naveen

SPRINT DELIVERY SCHEDULE:

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

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)

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

RESULT:

In smart cities, the conjunction of waste management activities with technology has proved to be **significantly successful**. The monitoring of waste from the initial stage of generation, systematic collection, transportation, and final disposal all the stages through integration with technology can prove to be very efficient.

ADVANTAGE:

- Improved Community Safety Smart bins have advanced features, which provide additional security and protection for the overall community
- More Efficient Collection Smart bins have a galvanised foot pedal that allows you to open the bin without touching the cover.
- Less Air Pollution & Traffic Congestion

DISADVANTAGE:

- 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.

CONCLUSION:

Thus, the project tells about the average duration required for each bin to get filled based on the level of bin measured using ultrasonic sensors. Those readings are sent to the database for every 20 minutes and with the help of the matplotlib, graph is plotted. From which, average filling duration of the bin can be interpreted.

From the graph, only the average duration of the bin can be found. In future, the project can be enhanced by implementing data security and device security at the edge level. The sensor data can also be analyzed for decision making. This system can also be developed with a message indication to the responsible people, when the bin gets filled.

FUTURE SCOPE:

Shortcomings of existing **waste management** practices are highlighted and a conceptual framework for a centralized **waste management system** is proposed, where three interconnected elements are discussed: (1) an infrastructure for proper collection of product lifecycle data to facilitate full visibility throughout the entire lifespan of a product, (2) a set of new business models relied on product lifecycle data to prevent **waste** generation.

APPENDIX:

Esp32 - Microcontroller : ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi and dual-mode

Bluetooth Memory: 320 KiB SRAM

CPU: Tensilica Xtensa LX6 microprocessor @ 160 or 240 MHz

Power: 3.3 V DC

Manufacturer: Espressif Systems

Predecessor: ESP8266

SOURCE CODE:

```
import random
import time
import sys
import ibmiotf.application
import ibmiotf.device


# Provide your IBM Watson Device Credentials

organization = "48az6e"  # repalce it with organization ID
deviceType = "DGGI"  # replace it with device type
deviceId = "1234"  # repalce with device id
authMethod = "token"
authToken = "12345678"  # repalce with token


def myCommandCallback(cmd):
    print("Command received: %s" % cmd.data['command'])
    status=cmd.data['command']
```

```
        if status == 'lighton':
            print("LIGHT ON")
        elif status == 'lightoff':
            print("LIGHT OFF")
        else:
            print ("please send proper command")


    try:
        deviceOptions = {"org": organization, "type": deviceType, "id":
deviceId, "auth-method": authMethod,
                         "auth-token": authToken}
        deviceCli = ibmiotf.device.Client(deviceOptions)
    # .....................................

    except Exception as e:
        print("Caught exception connecting device: %s" % str(e))
        sys.exit()

    deviceCli.connect()

    while True:
        w= random.randint(0,100)
        l = random.randint(0,100)

        # Send Temperature & Humidity to IBM Watson
        data = {'weight': w,'level':l}
```

```
        # print data
        def myOnPublishCallback():
            print("Published data",data, "to IBM Watson")


        success = deviceCli.publishEvent("event", "json", data, 0,
myOnPublishCallback)
        if not success:
            print("Not connected to IoTF")
        time.sleep(5)

        deviceCli.commandCallback = myCommandCallback

    # Disconnect the device and application from the cloud
devicecli.disconnect()
```

GITHUB LINK: https://github.com/IBM-EPBL/IBM-Project-7216-1658850068