

**IOT BASED SMART WASTE MANAGEMENT
FOR METROPOLITAN CITIES**

A PROJECT REPORT

Submitted by

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1. INTRODUCTION

- a. Project Overview
- b. Purpose

2. LITERATURE SURVEY

- a. Existing problem
- b. References
- c. Problem Statement Definition

3. IDEATION & PROPOSED SOLUTION

- a. Empathy Map Canvas
- b. Ideation & Brainstorming
- c. Proposed Solution d. Problem Solution fit

4. REQUIREMENT ANALYSIS

- a. Functional requirement
- b. Non-Functional requirements

5. PROJECT DESIGN

- a. Data Flow Diagrams
- b. Solution & Technical Architecture
- c. User Stories

6. PROJECT PLANNING & SCHEDULING

- a. Sprint Planning & Estimation
- b. Sprint Delivery Schedule
- c. Reports from JIRA

7. CODING & SOLUTIONING (Explain the features added in the project along with code)

- a. Feature 1
- b. Feature 2
- c. Database Schema (if Applicable)

8. TESTING

- a. Test Cases

b. User Acceptance Testing

9. RESULTS a. Performance Metrics

10. ADVANTAGES & DISADVANTAGES

11. CONCLUSION

12.FUTURE SCOPE

13. APPENDIX Source Code GitHub & Project Demo Link

1.Introduction

1.1 Project Overview

With rapid increase in population, the issues related to sanitation with respect to garbage management are degrading immensely. It creates unhygienic conditions for the citizens in the nearby surrounding, leading to the spread of infectious diseases and illness. To avoid this problem, IoT based “Smart Waste Management” is the best and trending solution. In the proposed system, public dustbins will be provided with embedded device which helps in real time monitoring of level of garbage in garbage bins. The data regarding the garbage levels will be used to provide optimized route for garbage collecting vans, which will reduce cost associated with fuel. The load sensors will increase efficiency of data related to garbage level and moisture sensors will be used to provide data of waste segregation in a dust bin. The analysis of ceaseless data gathered will help municipality and government authorities to improve plans related to smart waste management with the help of various system generated reports.

1.2 Purpose

Smart waste management focuses on solving the previously mentioned solid waste management problems using sensors, intelligent monitoring systems, and mobile applications. The first smart waste management solution to make the

waste collection process more efficient is sensors. Sensors can measure the fill level of the containers and provide updated information at any time and notify waste management services to empty them when they are full or almost full. These devices help optimize the best possible route containing fully filled containers and create smart schedules for drivers. The selection of the containers also minimizes the need for trash collection staff because their duties are deduced. They can also alert the waste management companies or municipalities if an undesirable incident happens such as sudden temperature rise or displacement of the container by their GPS features.

2. Literature survey:

2.1 Existing system

Around 80% of waste collections happen at the wrong time. Late waste collections lead to overflowing bins, unsanitary environments, citizen complaints, illegal dumping, and increased cleaning and collection costs. Early waste collections mean unnecessary carbon emissions, more traffic congestion, and higher running costs. The old way of doing waste management is highly inefficient. And in today's ever-technological world, an innovative and data-driven approach is the only way forward.

Traditionally, municipalities and waste management companies would operate on a fixed collection route and schedule. This means that waste collection trucks would drive the same collection route and empty every single waste container – even if the waste container did not need emptying. This means high labor and fuel costs – which residents ultimately foot the bill for. This is also an unsustainable way of working - the more vehicles on the road carrying out unnecessary collections means more carbon emissions are released into our planet's atmosphere.

2.2 Reference

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2.3 Problem Statement Solution

The nation and world are facing a huge problem today of disposal, segregation, and recycling of solid waste and improper management of these wastes are hazardous and dangerous to human health and ecological system. The generation and disposal of waste in large quantities has created a greater concern over time for the world which is adversely affecting the human lives and environmental conditions. Wastes are the one which grows with the growth of the country. A voluminous amount of waste that is generated is disposed of by means which have an adverse effect on the environment. The common method of disposal of the waste is by unplanned and uncontrolled open dumping at the landfill sites. This method is injurious to human health, plant and animal life. This harmful method of waste disposal can generate liquid leachate which can contaminate the surface and ground waters; can harbor disease vectors which spread harmful diseases, can degrade the aesthetic value of the natural environment and is an unavailing use of land resources. Segregation of waste is important for proper disposal of the vast amount of garbage modern society produces in an environmentally sensible mode. People became adapted to tossing things away and never realize the consequences of their action. The common method of disposal of the industrial waste is by

uncontrolled and unplanned and exposed dumping at the river sites and open areas. This method is injurious to plants, human and animal life. There is a rapid increase in capacity and categories of solid as a result of urbanization, constant economic growth and industrialization. Global Waste Market reported that the amount of waste generated worldwide produced is 2.02 billion tonnes.”Wastes are not always waste, it has to be handled, segregated, transported and disposed of as to reduce the risk to the public lives and sustainable environments. The economic value of waste is best comprehended when it is segregated. There is no such system employed of segregation of glass, plastic and metallic wastes at, the industrial level. Dry waste consisting of cans, Aluminium foils, plastics, metal, glass and paper could be recycled. If we do not dispose of the waste in a more systematic manner, more than 1400 sq.km of land, which is the size of the city of Delhi, would be required in the country by the year 2047 to dispose of it.

3. Ideation and proposed solution:

3.1 Empathize & Discover

Empathy Map Canvas:

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user’s behaviours and attitudes. 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 Brainstorm & Idea Prioritization Template

Step-1: Team Gathering, Collaboration and Select the Problem Statement

Template



Conducting a brainstorm


Executing a brainstorm isn't unique; holding a productive brainstorm is. Great brainstorms are ones that set the stage for fresh and generative thinking through simple guidelines and an open and collaborative environment. Use this when you're just kicking-off a new project and want to hit the ground running with big ideas that will move your team forward.

⌚ 15 minutes to prepare

🕒 30-60 minutes to collaborate

👥 3-8 people recommended

Co-creation with the



Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

⌚ 15 minutes

Choose your best "How Might We" Questions

Create 5 HMW statements before the activity to propose them to the team.

Set the stage for creativity and inclusivity

Go over the brainstorming rules and keep them in front of your team while brainstorming to encourage collaboration, optimism, and creativity.

1. **Encourage wild ideas** (If none of the ideas sound a bit ridiculous, then you are filtering yourself too much.)
2. **Defer judgement** (This can be as direct as harsh words or as subtle as a condescending tone or talking over one another.)
3. **Build on the ideas of others** ("I want to build on that idea" or the use of "yes, and...")
4. **Stay focused on the topic at hand**
5. **Have one conversation at a time**
6. **Be visual** (Draw and/or upload to show ideas, whenever possible.)
7. **Go for quantity**

Interested in learning more?

Check out the Meta Think Kit website for additional tools and resources to help your team collaborate, innovate and move ideas forward with confidence.

[Open the website →](#)

1

Choose your best "How Might We" Questions

Share the top 5 brainstorm questions that you created and let the group determine where to begin by selecting one question to move forward with based on what seems to be the most promising for idea generation in the areas you are trying to impact.

⌚ 10 minutes

Problem Statement

Depending on the fill level, the system sends appropriate notification message to alert relevant authorities and concerned citizen(s) for necessary action.

Problem Statement

Design a smart waste collection system that allows citizens to segregate the various types of solid waste they want to dispose and the municipal authorities to efficiently collect the same. The system should be mobile app (Android) based.

Problem Statement

Individuals disposed of solid waste in a huge heap in urban centers of most developing countries and a given nation faces a terrible issue of the waste. Access to reliable data on the state of solid waste at different locations allows the city planning for the local authorities and the citizens to effectively manage the waste.

Problem Statement

Nowadays, the Garbage Collecting Vehicle (GCV) collects the waste twice or thrice in a week. So, the problem is over flowing of wasteguns on the roads. Hence, to overcome this situation, in this paper a scheme or smart waste management

Step-2: Brainstorm, Idea Listing and Grouping

2

Brainstorm solo

Have each participant begin in the "solo brainstorm space" by silently brainstorming ideas and placing them into the template. This "silent-storming" avoids group-think and creates an inclusive environment for introverts and extroverts alike. Set a time limit. Encourage people to go for quantity.

🕒 10 minutes

Karthika R			Diya Bharathi P S			Zannara Fatima			Nivetha		
No external storage	Easy to design	Includes software present in college waste	Time consumption	Low power consumption	Low cost	Cost effective	Easy to design	Based on IoT app	Use wireless sensor	Obtain qualitative information	Light weight and reliable
Stores the location to garbage collector	Cost effective	High efficiency	High accuracy	Light weight and reliable	No need external storage	Waste is cleaned	Efficient system	Time consumption	High accuracy	Monitoring is easy	To check garbage level using sensor

3

Brainstorm as a group

Have everyone move their ideas into the "group sharing space" within the template and have the team silently read through them. As a team, sort and group them by thematic topics or similarities. Discuss and answer any questions that arise. Encourage "Yes, and..." and build on the ideas of other people along the way.

🕒 15 minutes

TIP

You can use the **Voting session** tool above to focus on the strongest ideas.

Indicate a authorize person to collect waste	share the location to garbage collector	To check garbage level using sensor
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Step-3: Idea Prioritization

4

Decide your focus

Give each person two icons to vote which idea should your team focus on.

🕒 5 minutes

karthika



DivyaBharathi



Zennera Fathima



Nivethitha



After you collaborate

A brainstorm like this typically results in a handful of promising ideas that you can carry forward and act upon.

Quick add-ons



Cluster related ideas

Look for patterns or similarities in the standout ideas. Could any be combined together to form a stronger concept? Cluster similar ideas and label each cluster with a theme.



Vote on the most promising ideas

Narrow your focus to only the strongest few ideas by holding a **Voting Session**. Give each person 2 votes

Keep moving forward



2x2 Prioritization matrix

Build shared understanding and make collective decisions for moving ideas forward.

[Open the template →](#)



Storyboarding

Show existing and/or future consumer experiences through the act of sketching.

[Open the template →](#)



Pre-mortem

Harness the collective experience and wisdom of the team, before the project even starts

[Open the template →](#)

[🗨️ Share template feedback](#)

3.3 Proposed Solution:

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	<ul style="list-style-type: none">✓ The manual monitoring of wastes in waste bins is a cumbersome process and utilises more human effort, time and cost.✓ Irregular disposal of wastes causing trouble to people.✓ Foul smell around the place with uncollected wastes or garbage.
2.	Idea / Solution description	<ul style="list-style-type: none">✓ This process is achieved by using a ultrasonic sensor to know the levels of garbage bin through cloud connection.✓ Creating an app, there by the corporation of a particular locality inside a metropolitan city can check the garbage bins whether they are filled or not.
3.	Novelty / Uniqueness	<ul style="list-style-type: none">✓ Unlike the conventional methods for collecting garbage bins, this method tells us to use the transport only in required places✓ To reduce the human-effort and difficulty in monitoring the garbage bins.
4.	Social Impact / Customer Satisfaction	<ul style="list-style-type: none">✓ People can experience a clean environment.✓ Reduces the human effort involving in the garbage disposal process.✓ This idea will be very much beneficial for a city corporation for monitoring the cleanliness of various parts of the city.
5.	Business Model (Revenue Model)	<ul style="list-style-type: none">✓ This reduces a huge fuel cost to the city corporations by reducing the unwanted

		<p>transport expenses to unnecessary places.</p> <ul style="list-style-type: none"> ✓ This project aims to support the municipal corporations. ✓ Provide a clean environment.
6.	Scalability of the Solution	<ul style="list-style-type: none"> ✓ A huge time is saved from frequent monitoring of garbage bins through human labours. ✓ It can be updated to automated garbage collection through vehicles. ✓ There is no need of new establishment of things. ✓ Already present garbage bins are modified slightly.

3.4 Problem solution fit:

Define CS fit to CC	1. CUSTOMER SEGMENT(S) CS -Trashy Drivers and Workers -Metropolitan Citizens -Waste Holders	6. CUSTOMER CONSTRAINTS CC -Requires recycling and protection against chemical substance -Internet is necessary to use web app	5. AVAILABLE SOLUTIONS AS - Customer can send the message about smart wastes if any damage on the IOT device -Can collect the wastages before getting overflowing	Explore AS, differentiate
Focus on JS to capture BE, understand	2. JOBS-TO-BE-DONE / PROBLEMS JS -Garbage must be collected before getting filled -overflowing should be avoided	9. PROBLEM ROOT CAUSE RC -High amount of wastages created by citizens -waste management is not properly handled by management	7. BEHAVIOUR BE -Sensor sense the amount of garbage level -Send notification to the respected garbage collector	Focus on JS to capture BE, understand
	- Insufficient applications and tools for managing wastages TR 4. EMOTIONS: BEFORE / AFTER EM	-The main solution is to make a clean environment and well defined smart waste management system ST	8.1 ONLINE Advertising through social media 8.2 OFFLINE Exploring the information about smart waste management	Identify ST & EM

4. Requirements

4.1 Functional Requirements

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Expensive bins	<ul style="list-style-type: none"> ✓ As we are making up bins with sensors and other costly devices , this is somewhat expensive architecture to built. ✓ And so this requires more security settings as it requires more cost if we need to rebuilt it.
FR-2	Implementing proper monitoring system	<ul style="list-style-type: none"> ✓ All bins can be seen on the map, and you can visit them at any time via the Street View feature from Google. Bins are visible on the map as green, orange or red circles. ✓ You can see bin details in the Dashboard capacity, waste type, last measurement, GPS location and collection schedule or pick recognition.
FR-3	Separation of different kind of wastes	<ul style="list-style-type: none"> ✓ Separation of different kind of wastes involves people responsibility too and so, proper education need to be provided. ✓ And bins should be implemented accordingly in each locations. ✓ And especially medical wastes should be disposed in a proper manner.
FR-4	Routing the pickup of trash	<ul style="list-style-type: none"> ✓ Route planning for rubbish pickup is semi- automated using the tool. ✓ You are prepared to act and arrange for garbage collection based on the levels of bin fill that are now present and forecasts of approaching capacity.

		<ul style="list-style-type: none"> ✓ To find any discrepancies, compare the planned and actual routes.
FR-5	Get rid of ineffective picks	<ul style="list-style-type: none"> ✓ Get rid of the collection of half-empty trashcans. ✓ Picks are recognised by sensors. ✓ We are able to show you how filled the bins you collect are by utilizing real-time data on fill- levels and pick recognition. ✓ The report details the bin's initial level of brimmingness. ✓ Any picks below 80% full that are inefficient are seen right away.

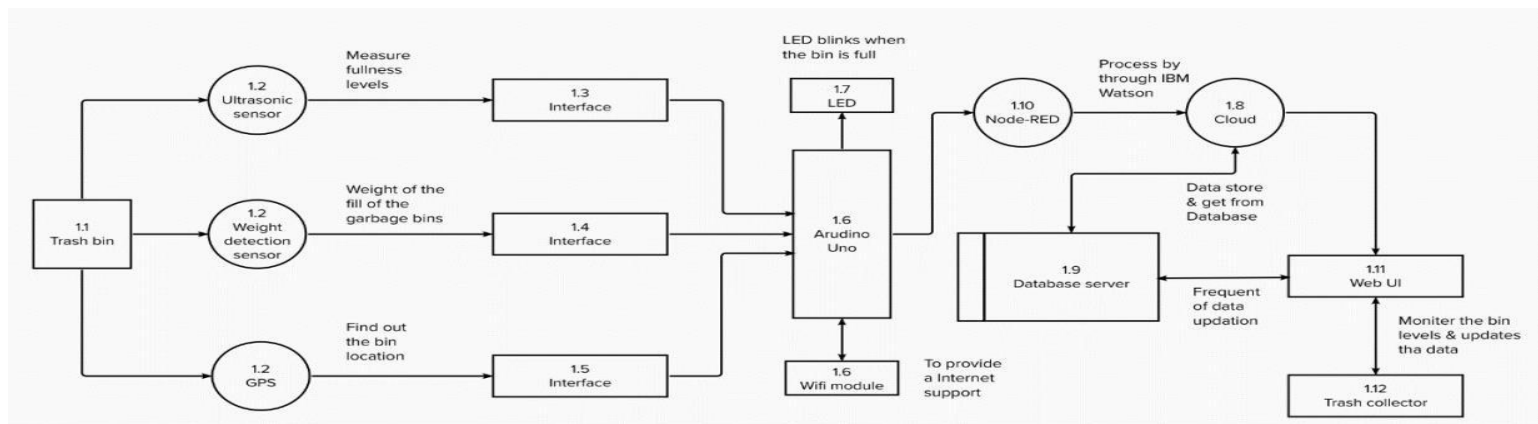
4.2 Non-Functional Requirements

FR No.	Non-Functional Requirement	Description
NFR-1	Usability	<ul style="list-style-type: none"> ✓ The study of customers' product usability can help designers better understand users' possible demands in waste management, behavior, and experience during the design process, which places a focus on the user experience.
NFR-2	Security	<ul style="list-style-type: none"> ✓ 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.

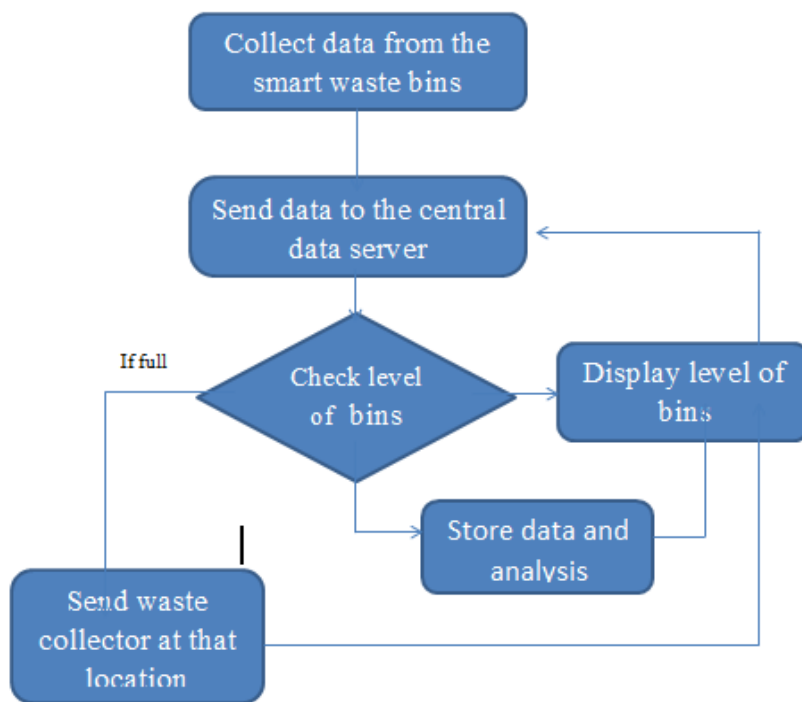
NFR-3	Reliability	<ul style="list-style-type: none"> ✓ Creating better working conditions for waste collectors and drivers is another aspect of smart waste management. Waste collectors will use their time more effectively by attending to empty bins that need service rather than driving the same collection routes.
NFR-4	Performance	<ul style="list-style-type: none"> ✓ The system consist of sensors to measure the weight of waste and the level of waste inside the bin. ✓ 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	<ul style="list-style-type: none"> ✓ By creating and implementing durable hardware and gorgeous software, we enable cities, companies, and nations to manage garbage more intelligently.
NFR-6	Scalability	<ul style="list-style-type: none"> ✓ 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. ✓ Smart waste management aims to optimize resource allocation, reduce running costs, and increase the sustainability of waste service. ✓ Analytics data to manage collection routes and the placement of bins more effectively.

5. Project Design

5.1 Data Flow Diagram



5.2 Solution & Technical Architecture



5.3 User Stories

User Type	Functional	User	User Story / Task	Acceptance criteria	Priorit	Release

	Requirement (Epic)	Story Number			y	
Admin (who manage web server)	Web server login	USN-1	As a admin, I have my user name and password foe every worker and co-workers to manage them.	I can manage web account and direct workers.	High	Sprint-1
Co-admin	Login	USN-2	As a co-admin, I'll manage other monitoring activities like garbage level monitoring, location accuracy, garbage separation and removal of waste within a scheduled time.	I can monitor garbage bins activities.	High	Sprint-1
Customer (Web user)	User	USN-3	Here comes the customer, he/she will have access to mobile apps or login webpages to view progress of bins and to report if any query found.	He/ she has the right to make a query if any	High	Sprint-2
Customer Care Executive	Worker	USN-4	The customer care executive, will try to rectify the queries from customers by contacting coadmin. If case of any critical/ emergency situation query can be conveyed to higher authority.	I can attend calls and respond people by rectifying the problem.	High	Sprint-4

Truck driver	Worker	USN-5	Here, truck driver is a worker who has particular assignments that he has to report when and where the garbage has been picked according to the daily schedule. And should update the happenings in the given website (Webpage login).	I can update my activities on site when the given task has been completed.	Medium	Sprint-5
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6.Project Planning and Scheduling

6.1 Sprint Planning & Estimation