HOUSEHOLD WASTE MANAGEMENT SYSTEM

AGB1211 DESIGN THINKING

PROJECT WORK

Submitted by

AKSHAYA J (8115U23AM007)
MOHANASRI SK (8115U23AM027)
SAVITHASRI N (8115U23AM046)
VINOTHA R (8115U23AM058)

in partial fulfilment for the award of the degree

of

BACHELOR OF ENGINEERING

IN

COMPUTER SCIENCE AND ENGINEERING

(ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

Under the Guidance of

Mr. PONNI VALAVAN. M

Department of Artificial Intelligence and Data Science

K. RAMAKRISHNAN COLLEGE OF ENGINEERING

K. RAMAKRISHNAN COLLEGE OF ENGINEERING

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Under
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BONAFIDE CERTIFICATE

Certified that this project report titled **"HOUSEHOLD WASTE MANAGEMENT SYSTEM"** is the bonafide work of **AKSHAYA J (8115U23AM007), MOHANA SRI SK (8115U21AD027) , SAVITHA SRI N (8115U20AD046) , VINOTHA R (8115U21AD058)** who carried out the work under my supervision.

Dr. B. KIRAN BALA M.E,Ph.D,

HEAD OF THE DEPARTMENT

ASSOCIATE PROFESSOR,

Department of Artificial Intelligence and Machine Learning,
K. Ramakrishnan College of Engineering, (Autonomous)
Samayapuram, Trichy.

Mr.M.PONNI VALAVAN M.E

SUPERVISOR

ASSISTANT PROFESSOR,

Department of Artificial Intelligence and Data science,
K. Ramakrishnan College of Engineering,(Autonomous)
Samayapuram, Trichy.

SIGNATURE OF INTERNAL EXAMINER

NAME:
DATE:

SIGNATURE OF EXTERNAL EXAMINER

NAME:
DATE:

K. RAMAKRISHNAN COLLEGE OF ENGINEERING

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DECLARATION BY THE CANDIDATES

We declare that to the best of our knowledge the work reported here in has been composed solely by ourselves and that it has not been in whole or in part in any previous application for a degree.

Submitted for the project Viva- Voce held at K. Ramakrishnan College of Engineering on _____

SIGNATURE OF THE CANDIDATES

ACKNOWLEDGEMENT

We thank the almighty GOD, without whom it would not have been possible for us to complete our project.

We wish to address our profound gratitude to **Dr.K.RAMAKRISHNAN**, Chairman, K. Ramakrishnan College of Engineering(Autonomous), who encouraged and gave us all help throughout the course.

We extend our hearty gratitude and thanks to our honorable and grateful Executive Director **Dr.S.KUPPUSAMY, B.Sc., MBA., Ph.D.,** K. Ramakrishnan College of Engineering(Autonomous).

We are glad to thank our Principal **Dr.D.SRINIVASAN, M.E., Ph.D., FIE., MIIW., MISTE., MISAE., C.Engg,** for giving us permission to carry out this project.

We wish to convey our sincere thanks to **Dr.B.KIRAN BALA, M.E., M.B.A., Ph.D.,** Head of the Department, Artificial Intelligence and Machine Learning for giving us constant encouragement and advice throughout the course.

We are grateful to **M.PONNI VALAVAN M.E.**, Artificial Intelligence and Data Science, K. Ramakrishnan College of Engineering (Autonomous), for his guidance and valuable suggestions during the course of study.

Finally, we sincerely acknowledged in no less terms all our staff members, our parents and, friends for their co-operation and help at various stages of this project work.

AKSHAYA J (8115U21AD007)
MOHANA SRI SK (8115U21AD027)
SAVITHA SRI N (8115U21AD046)
VINOTHA R (8115U21AD058)

INSTITUTE VISION AND MISSION

VISION OF THE INSTITUTE:

To achieve a prominent position among the top technical institutions.

MISSION OF THE INSTIITUTE:

M1: To best standard technical education par excellence through state of the art infrastructure, competent faculty and high ethical standards.

M2: To nurturere search and entrepreneurial skills among students in cutting technologies.

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To create eminent professionals of Computer Science and Engineering by imparting quality education.

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M1: To provide technical exposure in the field of Computer Science and Engineering through state of the art infrastructure and ethical standards.

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M3: To empower the learners to involve in industrial and multi-disciplinary projects for addressing the societal needs.

M4: To provide an enjoyable environment for pursuing excellence while upholding strong personal and professional values.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

Our graduates shall,

PEO1: Analyze, design and create innovative products for addressing social needs.

PEO2: Equipthemselves for employ ability,higher studies and research.

PEO3: Nurture the leadership qualities and entrepreneurial skills for theirsuccessful career

PROGRAM SPECIFIC OUTCOMES (PSOs):

Students will be able to,

PSO1: Apply the basic and advanced knowledge in developing software, hardware and firmware solutions addressing real life problems.

PSO 2: Design, develop ,test and implement product-based solutions for their career enhancement.

PROGRAM OUTCOMES(POs)

Engineering students will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problemanalysis:**Identify,formulate,reviewresearchliterature,andanalyzecomplex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

3. **Design/developmentofsolutions:**Designsolutionsforcomplexengineeringproblems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issuesand the consequent responsibilities relevant to the professional engineering practice

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and

demonstrate the knowledge of, and need for sustainable development

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply theseto one's own work, as a member and leader in a team, to manage projects andin multidisciplinary environments.

12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

ABSTRACT

The Household Waste Management System is a smart and efficient solution designed to streamline the process of waste collection, segregation, and disposal at the household level. By leveraging IoT-based smart bins equipped with sensors, the system monitors waste levels in real-time and notifies authorities when bins are full, ensuring timely collection. A user-friendly mobile or web application allows households to schedule pickups, access waste segregation guidelines, and track collection schedules. The system also utilizes data analytics and AI-driven route optimization to improve the efficiency of waste collection, reducing fuel consumption and operational costs. Additionally, it promotes recycling and composting by offering incentives and providing educational resources to encourage sustainable waste disposal practices. This project aims to foster cleaner communities, enhance environmental sustainability, and contribute to global efforts in reducing pollution and waste mismanagement.

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LIST OF ABBREVATIONS

MSW Municipal Solid Waste

SWM Solid Waste Management

RDF Refuse-Derived Fuel

MRF Material Recovery Facility

EPR Extended Producer Responsibility

WTE Waste-to-Energy

C&D Construction and Demolition (Waste)

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

A Household Waste Management System is a solution designed to effectively handlethe generation, collection, segregation, and disposal of waste at the domestic level. As urbanization and population growth increase, managing waste efficiently has become a critical environmental and social challenge. Improper waste management contributes to pollution, health hazards, and environmental degradation, making it essential to adopt systematic approaches for handling household waste.The system aims to streamline waste management processes by promoting segregation at the source (e.g., biodegradable, recyclable, and non-recyclable waste),optimizing collection schedules, and ensuring proper disposal or recycling. Additionally, modern systems often incorporate technology like IoT sensors, mobile apps, and AI to track waste generation, monitor bin levels, and encourage communityparticipation.

1.2 PROBLEM STATEMENT

In many households, the management of waste is often inefficient and unorganized, leading to significant environmental, health, and logistical challenges. Improper segregation of waste at the source, irregular waste collection schedules, and inadequate recycling practices contribute to pollution, increased landfill usage, and the wastage of recyclable resources. Residents often face difficulties in understanding and implementing proper waste management practices, while waste management authorities struggle with tracking, monitoring, and optimizing collection and disposal processes. This lack of a structured and technology-driven solution results in overflowing garbage bins, unhygienic living conditions, and a failure to achieve sustainability goals. There is a pressing need for a comprehensive system that

addresses these inefficiencies and promotes responsible waste management at the household level.

1.3 OBJECTIVE

The primary objective of the Household Waste Management System is to design and implement a structured and efficient solution for the management of domestic waste, ensuring environmental sustainability and public well-being. The key objectives include:

1. Facilitate Waste Segregation:

   Promote proper segregation of biodegradable, recyclable, and non-recyclable waste at the source.

2. Optimize Waste Collection:

   Ensure timely and efficient collection of household waste using smart tools and scheduling mechanisms.

3. Minimize Environmental Impact:

   Reduce pollution by promoting eco-friendly disposal and recycling practices.

CHAPTER 2
PROJECT METHODOLOGY

The **system architecture** for the Household Waste Management System is designed to provide an efficient, scalable, and user-friendly solution for managing waste collection and disposal. It integrates multiple components to streamline operations, ensure proper data handling, and provide real-time interaction between users, administrators, and service providers.

The architecture consists of the following layers and components:

1. User Interface (Frontend)

Web or Mobile App: For users to register, log in, schedule waste pickups, report issues, and view collection status.

Admin Dashboard: For waste management authorities to monitor and manage operations.

2. Application Layer (Backend)

User Management Module: Handles user accounts, authentication, and role-based access.

Scheduling Module: Allows users to book waste pickup times and routes for collection vehicles to be optimized.

Waste Categorization Module: Handles input from users for segregating waste (e.g., biodegradable, recyclable, hazardous).

Notification System: Sends reminders or updates to users via SMS, email, or app notifications.

3. Database Layer

User Database: Stores user profiles, addresses, and account details.

Waste Records Database: Logs waste categories, pickup history, and disposal methods.

Vehicle Management Database: Tracks collection vehicles, routes, and maintenance data.

4. IoT Integration

Smart Bins: Equipped with sensors to monitor waste levels and send data to the system.

GPS Tracking: For real-time location tracking of collection vehicles.

5. AI and Data Analytics

Route Optimization: Uses AI to calculate the most efficient collection routes based on location and traffic.

Predictive Analytics: Forecasts waste generation trends to improve resource allocation.

6. Integration with Recycling/Disposal Centers

Tracks waste from collection to disposal/recycling centers to ensure proper processing and compliance.

7. Reporting and Monitoring

Generates reports for authorities on collection efficiency, recycling rates, and waste reduction.

8. Communication Layer

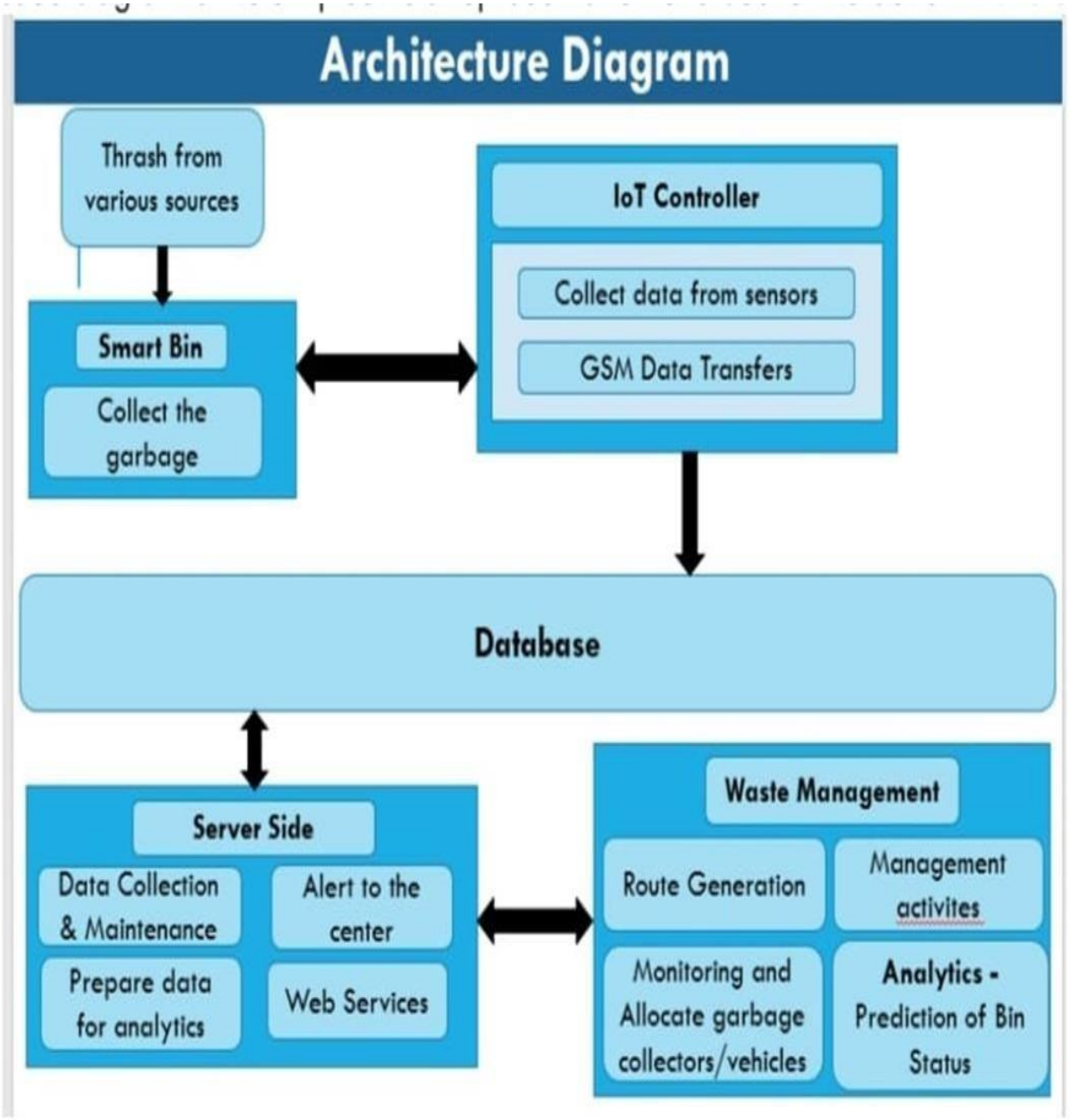
APIs: To integrate with external systems, such as municipal waste management or third-party recycling services.

Cloud Services: For scalable storage and processing.

9. Security Layer

Implements data encryption, secure APIs, and access control to ensure the safety of user and operational data.

2.1 BLOCK DIAGRAM



CHAPTER 3
KEY PHASES OF DESIGN THINKING

3.1 Empathize

The goal of this phase is to deeply understand the needs, challenges, and motivations of the stakeholders involved in household waste management.

Stakeholders:

- Residents: They produce waste daily but often lack awareness or tools to segregate and dispose of it efficiently.
- Waste Collectors: They face challenges with unorganized waste collection, overflowing bins, and unsafe working conditions.
- Municipal Authorities: They require data-driven systems to monitor and optimize waste collection and disposal processes.

Methods of Empathy Building:

- Surveys and Questionnaires: Conduct surveys among residents to identify their awareness of segregation, recycling, and composting practices.
- Interviews: Interact with waste collectors to understand logistical problems, delays, and health hazards they face.
- Observation: Observe waste disposal habits in households and analyze common mistakes (e.g., mixing wet and dry waste).

Insights Gained:

1. A lack of awareness about segregation rules and their importance.
2. Overflowing community bins due to irregular collection.
3. Waste collectors facing health risks due to improper segregation at the source.

4. Municipalities not having real-time data to streamline operations effectively.

3.2 Define

This phase focuses on synthesizing the information gathered during the "Empathize" phase into a clear and actionable problem statement.

Problem Statement:
Households often lack proper systems and tools for segregating, disposing, and recycling waste effectively. This leads to environmental pollution, health risks for waste collectors, inefficient collection processes, and missed opportunities for recycling and composting. A comprehensive solution is needed to address these inefficiencies by educating residents, enabling systematic waste segregation, and optimizing collection and monitoring processes.

3.3 Ideate

This phase involves brainstorming and exploring innovative solutions to address the defined problem.

Possible Solutions:

1. Mobile Application:
    - A user-friendly app that provides waste segregation guides, collection schedules, and recycling tips.
    - Alerts and reminders for residents to separate waste properly.
    - A dashboard for municipalities to track bin statuses and collection routes.
2. IoT-Enabled Smart Bins:
    - Smart bins with sensors to monitor waste levels and notify collection teams.

- Categorization compartments for wet, dry, and recyclable waste.

3. Incentivization Program:
    - A reward system for households following proper segregation practices.
    - Points redeemable for discounts on utility bills or local store purchases.
4. Composting Units:
    - Small, affordable composting kits for households to manage organic waste.
    - Tutorials and guides included in the app to teach residents how to compost effectively.
5. Awareness Campaigns:
    - Community-driven workshops or webinars to educate residents about the environmental and health impacts of improper waste disposal.

3.4 Prototype

The goal here is to create a working model of the most promising solutions.

Prototype Features:

1. Mobile Application:
    - Waste categorization tools (images and AI to identify waste types).
    - Daily reminders to separate waste.
    - Real-time tracking of waste collection trucks.
2. Smart Bin System:
    - Bins with sensors that send notifications when they are full.
    - LED indicators to guide proper waste segregation.

3. Data Dashboard:
    - For authorities: Monitor bin status, collection efficiency, and recycling rates.
    - For residents: Track their contributions to recycling and waste reduction goals.
4. User Rewards System:
    - Integrate reward points in the app for compliance with segregation and recycling guidelines.

Implementation in a Pilot Area:

- Select a small residential neighborhood to test the prototype.
- Equip homes with smart bins and provide access to the app.

3.5 Test

The final phase involves testing the prototype in real-world scenarios to gather feedback and measure its effectiveness.

Testing Process:

1. Deploy the prototype (smart bins and app) in the pilot area for 4-6 weeks.
2. Monitor the following metrics:
    - Segregation Accuracy: Measure the percentage of waste properly segregated.
    - Collection Efficiency: Track whether waste is collected on time and bins are not overflowing.
    - User Engagement: Measure app usage rates and participation in recycling programs.
3. Conduct interviews and feedback sessions with residents, waste collectors, and authorities.

Expected Outcomes:

- Increased segregation accuracy at the household level.
- Reduction in overflowing bins due to optimized collection schedules.
- Improved recycling rates and reduced waste sent to landfills.
- Greater awareness among residents about sustainable waste practices.

Next Steps After Testing:

- Refine the prototype based on feedback.
- Expand the system to a larger area or community.
- Integrate advanced features like AI-based waste identification or route optimization for collection vehicles.

This iterative approach ensures the solution addresses the stakeholders' needs effectively while promoting sustainability and efficiency in household waste management.

CHAPTER 4

MODULE DESCRIPTION

4.1 Module 1: Waste Segregation and Awareness

Explanation:

This module is dedicated to educating residents on the importance of proper waste segregation and enabling them to implement it effectively. It ensures that waste is separated at the source into categories like wet, dry, and recyclable materials.

Key Features:

1. Interactive Learning Tools:
    - Visual aids, infographics, and videos explaining waste categories.
    - Step-by-step tutorials for separating different types of waste.
2. Real-Time Guidance:
    - A mobile app feature that uses AI to identify and categorize waste through images.
    - Daily reminders and notifications to encourage consistent segregation.
3. Awareness Campaigns:
    - Educational webinars or community workshops to emphasize the environmental impact of improper waste disposal.
    - In-app articles and tips on reducing waste and reusing materials.
4. Gamification:
    - A reward system where users earn points for successful segregation.
    - Progress tracking to motivate users to maintain good practices.

4.2 Module 2: Waste Collection Management

Explanation:

This module streamlines the collection process, ensuring that waste is picked up efficiently and at the right time. It benefits both residents and waste collection teams by eliminating delays and reducing overflow.

Key Features:

1. IoT-Enabled Smart Bins:
    - Smart bins equipped with sensors to monitor waste levels.
    - Notifications sent to waste collection teams when bins are full.
2. Dynamic Scheduling:
    - Real-time optimization of waste collection routes based on bin statuses.
    - Prioritization of areas with higher waste levels to avoid overflows.
3. Real-Time Tracking:
    - Residents can track the location of collection vehicles through the app.
    - Notifications on the expected time of arrival for waste pickups.
4. Missed Pickup Alerts:
    - Automatic alerts sent to authorities if waste is not collected on schedule.

4.3 Module 3: User Incentivization System

Explanation:

To encourage active participation, this module rewards residents who follow proper waste segregation and disposal practices. It fosters community engagement and motivates individuals to contribute to sustainable waste management.

Key Features:

1. Points-Based System:
    - Users earn points for segregating waste correctly and adhering to collection schedules.
    - Points are awarded through app verification or by waste collectors.
2. Redeemable Rewards:
    - Points can be exchanged for discounts on utility bills, grocery stores, or local businesses.
    - Partnerships with municipal bodies and companies to offer attractive incentives.
3. Community Leaderboard:
    - A ranking system showcasing top-performing households or communities.
    - Encourages friendly competition and raises awareness about waste

management.

4. Periodic Recognition:
    - Certificates or awards for consistent top performers.
    - Public acknowledgment of contributions to community cleanliness.

4.4 Module 4: Data Analytics and Monitoring

Explanation:

This module focuses on providing waste management authorities with actionable insights. By leveraging data, it helps optimize waste collection and disposal while identifying areas for improvement.

Key Features:

1. Centralized Dashboard:
    - A dashboard for authorities to view bin fill levels, collection routes, and waste trends.
    - Filters for analyzing data by region, waste type, or time period.
2. Performance Metrics:
    - Metrics such as collection efficiency, recycling rates, and segregation accuracy.
    - Heatmaps showing high and low-performing areas for targeted interventions.
3. Predictive Analytics:
    - Use of AI to forecast waste generation patterns based on historical data.
    - Helps in planning resource allocation and collection schedules.
4. Alerts and Notifications:
    - Immediate alerts for bins that are at risk of overflowing.
    - Notifications for missed pickups or system anomalies.

4.5 Module 5: Recycling and Composting Support

Explanation:

This module promotes sustainable practices by helping users recycle and compost their waste. It provides tools and guidance to reduce landfill contributions and promote a circular economy.

Key Features:

1.Recycling Integration:

- A directory of nearby recycling centers with details on accepted materials.
- Scheduling pickups for recyclable waste through the app.

2.Composting Guidance:

- Tutorials on setting up composting units at home.
- Recommendations for composting equipment and troubleshooting tips.

3.Marketplace for Recycled Goods:

- An online marketplace where users can sell or buy recycled goods.
- Promotes the reuse of materials and supports local eco-friendly businesses.

4.Sustainability Tips:

- In-app suggestions for reducing waste generation.
- Ideas for reusing household items creatively to minimize disposal.

CHAPTER 5
CONCLUSION

The Household Waste Management System is a comprehensive and innovative solution designed to address the critical challenges of waste segregation, collection, and disposal. By integrating technology, community engagement, and sustainable practices, the system promotes efficient waste management while fostering environmental responsibility. Through features like IoT-enabled smart bins, dynamic collection scheduling, data-driven analytics, and a user-friendly mobile application, it ensures proper segregation at the source, reduces inefficiencies in waste collection, and encourages recycling and composting. Incentive-basedmechanisms, such as reward points and leaderboards, actively engage residents and create awareness about the importance of responsible waste disposal. This project not only optimizesoperations for authorities but also significantly reduces the environmental impact by minimizing landfill usage and encouraging a circular economy. With the ability to scale and adapt to diverse community needs, the system has the potential to transform waste management practices globally. By bridging the gap between individual efforts and systemicprocesses, the project serves as a stepping stone toward a cleaner, greener, and more sustainable future.

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APPENDIX A – SCREENSHOTS

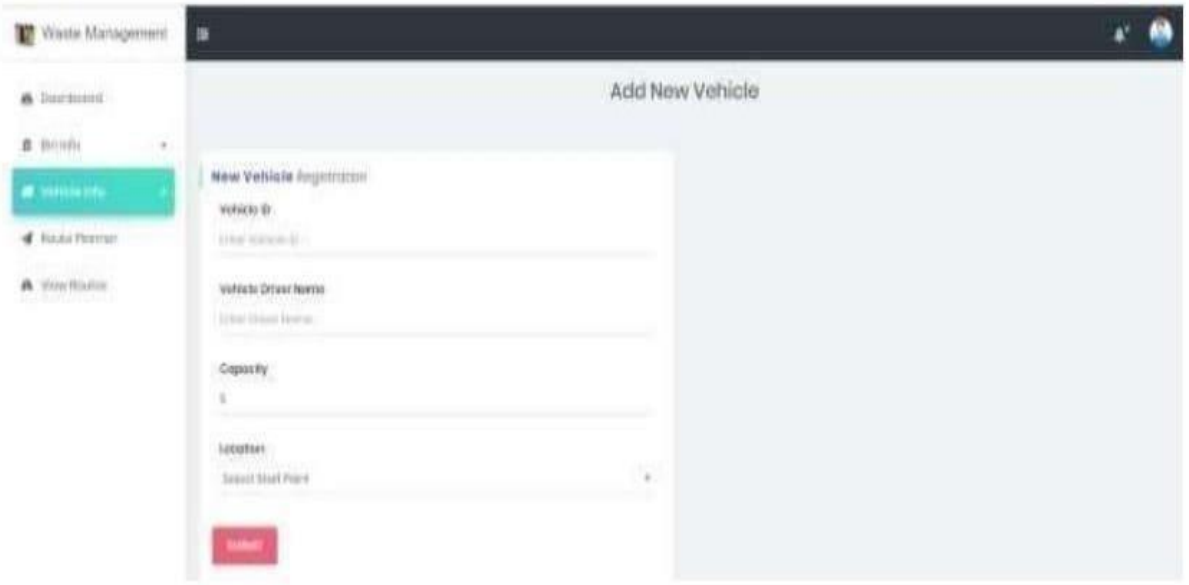

Fig: 7.5 :Add new Vehicle UI

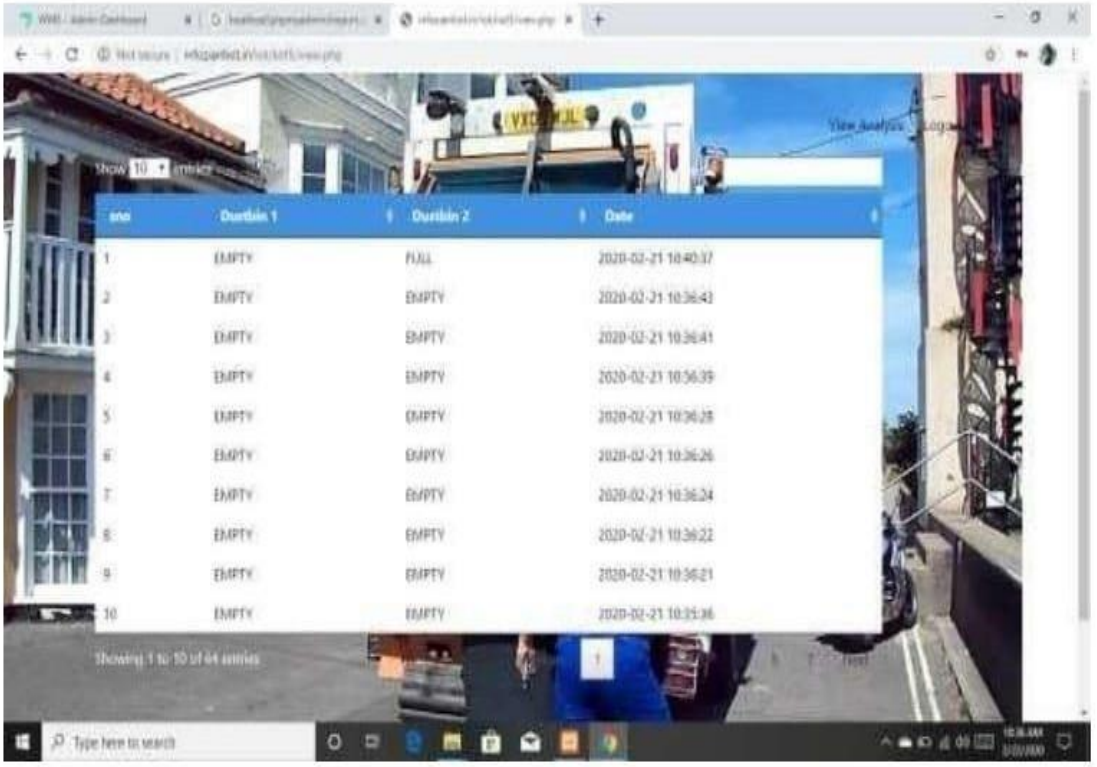

Fig: 7.6 : Server Page