A
Mini Project Report
On

SMART WASTE MANAGEMENT SYSTEM

Submitted to CMR ENGINEERING COLLEGE

In Partial Fulfillment of the requirements for the Award of Degree of

BACHELOR OF TECHNOLOGY
IN
COMPUTER SCIENCE AND ENGINEERING

Submitted
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CERTIFICATE

This is to certify that the project entitled **" SMART WASTE MANAGEMENT SYSTEM"** is a bonafide work carried out by

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in partial fulfillment of the requirement for the award of the degree of **BACHELOR OF TECHNOLOGY** in **COMPUTER SCIENCE AND ENGINEERING** from CMR Engineering College, affiliated to JNTU, Hyderabad, under our guidance and supervision.

The results presented in this Mini project have been verified and are found to be satisfactory. The results embodied in this Mini project have not been submitted to any other university for the award of any other degree or diploma.

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This is to certify that the work reported in the present Mini project entitled **‘‘SMART WASTE MANAGEMENT SYSTEM”** is a record of bonafide work done by us in the Department of Computer Science and Engineering, CMR Engineering College, JNTU Hyderabad. The reports are based on the project work done entirely by us and not copied from any other source. We submit our project for further development by any interested students who share similar interests to improve the project in the future.

The results embodied in this Mini project report have not been submitted to any other University or Institute for the award of any degree or diploma to the best of our knowledge and belief.

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ABSTRACT

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Urban waste management remains one of the most critical challenges faced by rapidly developing nations like India. With exponential urbanization, the volume of daily solid waste generation has surged, placing immense pressure on existing infrastructure. Traditional waste management systems often suffer from inefficiencies such as delayed collection, inaccurate waste categorization, minimal community involvement, and a lack of real-time monitoring. To address these limitations, this project proposes a Smart Waste Management System that leverages modern web technologies and artificial intelligence to enhance efficiency, transparency, and citizen participation. The system is developed using HTML, CSS, and JavaScript for the frontend, providing a clean and user-friendly interface, and Python Django for the backend, enabling secure and efficient data handling. Users can report waste sightings through the web portal by submitting descriptions and uploading images. These reports are then analyzed using an integrated AI model (such as Google Gemini or a custom-trained image classification model), which verifies the authenticity and type of waste before forwarding it to authorities for action. A reward system is implemented to encourage active participation among citizens. Verified reports earn users points, which are displayed on a public leaderboard to promote community engagement. This gamification approach not only improves reporting frequency but also fosters environmental responsibility. Additionally, administrative users can monitor submissions, update collection statuses, and view analytics on reported waste hotspots. The system architecture is modular and scalable, supporting future integration with technologies like IoT-enabled smart bins, predictive route optimization, and mobile applications. Security features such as input validation, admin controls, and database integrity checks ensure a robust platform. Testing of the platform demonstrated smooth user interactions, accurate AI verification rates, and increased reporting activity during pilot runs. Overall, the Smart Waste Management System bridges the gap between citizens, waste collection agencies, and municipal authorities through a centralized, real-time digital platform. It not only streamlines the waste reporting and verification process but also cultivates a culture of cleanliness and civic responsibility. In conclusion, this project offers a practical and scalable solution to modern waste management problems. By combining digital technologies with active citizen engagement, it contributes meaningfully to building smarter, cleaner, and more sustainable cities.

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INTRODUCTION

1. INTRODUCTION

1.1 INTRODUCTION AND OBJECTIVES

Urban waste management has become one of the most critical challenges faced by modern cities across the world, especially in rapidly developing nations like India. With the exponential growth in population, urbanization, and industrial activities, the generation of solid waste has surged significantly. Metropolitan cities and even smaller towns are witnessing an alarming increase in the daily volume of waste, much of which is not managed efficiently. Unattended waste piles, irregular collection schedules, lack of real-time monitoring, and minimal citizen involvement contribute to unhygienic conditions, environmental degradation, and severe health hazards.

The traditional methods of waste collection and disposal are becoming obsolete and inefficient. Municipal bodies are often under-resourced and unable to handle the logistical complexities associated with daily waste collection, segregation, and disposal. Manual monitoring, paper-based reporting systems, and delayed response to public complaints lead to public dissatisfaction and inefficiency in service delivery. In addition, the lack of real-time data analytics and feedback loops prevent authorities from identifying problem areas, optimizing routes, or managing resources effectively.

Smart cities demand smart solutions. The integration of digital technologies into urban infrastructure provides an opportunity to reimagine waste management through a more connected, automated, and data-driven approach. This is where the Smart Waste Management System (SWMS) comes into play—a modern, web-based platform designed to empower citizens, municipal workers, and city administrators with tools to manage urban waste more efficiently and transparently.

`The proposed system leverages web technologies such as HTML, CSS, JavaScript for the front end and Django (Python) for the backend to create a responsive and user-friendly platform. The objective is to enable citizens to report waste-related issues in real time, allow municipal staff to view and verify these reports, and use AI assistance (like Google Gemini AI) to automatically validate image-based submissions. Through this integration, the system not only encourages community participation but also ensures timely verification and action.

In traditional systems, citizen feedback is either ignored or significantly delayed in terms of response. Our platform introduces a reward-based system that motivates users to report waste, clean surroundings, and even participate in cleanliness drives. Each verified report earns users points, which could be redeemed or used for recognition on a public leaderboard.

Moreover, the Smart Waste Management System includes real-time dashboards for monitoring ongoing issues, categorizing waste types, and generating heat maps for problem areas. It helps authorities take data-informed decisions regarding the allocation of waste bins, deployment of collection vehicles, and planning of waste segregation units. A streamlined communication system ensures transparency, accountability, and quicker resolution of complaints.

This system aims to redefine how urban environments deal with waste—not just as a disposal problem but as a community-driven, digitally managed process that contributes to sustainability, hygiene, and quality of life.

To Digitize Waste Reporting and Tracking One of the primary goals of the system is to provide an intuitive web interface for citizens to report waste-related issues like overflowing bins, illegal dumping, or uncollected garbage. Each report is logged in real-time with geolocation, image evidence, and timestamps. This ensures transparency and accuracy in the issue-reporting process. By digitizing the reporting mechanism, the platform eliminates the traditional inefficiencies of manual complaint filing and provides a centralized system for tracking waste problems citywide.

To Enable Real-Time Verification Using to avoid false or duplicate reports, the system uses an AI-based verification module powered by tools like Google Gemini AI. The AI model analyzes submitted images and contextual data to determine whether the report is valid. This reduces manual load on administrators and ensures that only genuine reports reach the authorities for further action.

To Motivate Public Participation Through Rewards the project emphasizes community engagement by introducing a reward system for users who actively report verified waste issues. Each valid report earns points that can be redeemed for small rewards or recognized via leaderboards. This gamified model incentivizes citizen participation and transforms passive observers into active contributors to urban cleanliness.

To Streamline Communication Between Citizens, Workers, and Authorities, the platform serves as a bridge between the public and municipal bodies. Reports submitted by users are directly visible to assigned municipal staff, who can update the status (e.g., “Under Review”, “Resolved”, “Rejected”). Admins can monitor all activities via dashboards, ensuring no issue is overlooked. This closed-loop system increases accountability and ensures timely resolution of complaints.

To Categorize and Analyze Waste Types for Better Resource Planning by tagging each report with a type of waste—organic, plastic, electronic, etc.—the platform provides insights into the waste profile of specific areas. This helps urban planners in strategizing the placement

of dedicated bins, planning recycling efforts, and implementing area-specific waste segregation policies.

To Promote Environmentally Responsible Behavior by giving visibility to cleanliness efforts and rewarding good behavior, the system promotes environmental awareness among users. It also includes educational popups, cleanliness tips, and reminders, all of which contribute to instilling a cleaner and greener mindset in the urban population.

To Enable Real-Time Monitoring and Visualization for Authorities Municipal bodies often operate without sufficient visibility into city-wide issues. Our system includes administrative dashboards that provide real-time analytics, location-based tracking of complaints, charts showing resolution rates, and maps highlighting waste hotspots. These tools empower decision-makers to plan waste collection routes, allocate workforce effectively, and prioritize high-complaint zones.

To Minimize Waste Collection Delays, traditional collection routes are often fixed and inefficient, failing to account for high-density waste areas or urgent issues. By analyzing user reports and real-time waste data, the system helps optimize routes for waste collection vehicles. Dynamic allocation ensures faster response and reduces overflow situations.

To Build a Scalable and Modular Platform the system is designed using Django's scalable architecture, which allows for future enhancements such as mobile app integration, sensor-based IoT data collection, or third-party APIs for weather or pollution. Modular code design ensures that new features can be added with minimal disruption to existing services.

To Provide an Inclusive Platform Accessible to All With a simple frontend built using HTML, CSS, and JavaScript, the platform is designed to be accessible even to users with low digital literacy. Mobile-responsiveness ensures compatibility with smartphones, which are the primary access devices for most users in India. Multilingual support (in future updates) can make the system usable by a broader demographic.

The Smart Waste Management System is not just a digital complaint portal but a community-centric, real-time waste handling solution. It aims to redefine cleanliness and urban hygiene by creating an ecosystem where every citizen is empowered to act, every waste report is verified and resolved swiftly, and every decision is driven by data. Through digitization, AI verification, community engagement, and transparency, the system seeks to build cleaner, smarter cities—one report at a time.

1.2 PURPOSE OF THE PROJECT

The primary purpose of the Smart Waste Management System project is to address the growing inefficiencies and challenges in conventional urban waste collection and disposal methods through the development of a technology-driven, community-oriented platform. With the rapid pace of urbanization, cities around the globe, especially in developing nations, are struggling to keep up with the demands of effective waste management. This project aims to create a smarter, cleaner, and more sustainable urban environment by harnessing modern web technologies, artificial intelligence, and citizen participation.

Redefining Waste Reporting and Public Engagement A major objective of this project is to simplify and digitalize the process of waste reporting. Traditional methods of reporting uncollected garbage, illegal dumping, or overflowing bins often involve manual intervention, delayed response, and inefficient handling. Citizens either have to call municipal helplines or visit local offices, which often leads to frustration and apathy. By introducing a web-based waste management portal, the system empowers citizens to report waste-related issues from their homes using a smartphone or computer.

Each report is accompanied by image uploads, location coordinates, and timestamps, which make the data accurate and actionable. This not only improves transparency but also encourages more users to participate in maintaining cleanliness. The integration of a reward points system for verified reports further motivates public involvement and fosters a culture of cleanliness and accountability.

Leveraging Artificial Intelligence for Report Verification The project incorporates AI-powered tools such as Google Gemini AI to automatically verify submitted reports. By analyzing image content, the system can determine whether the image truly represents waste or is a false or irrelevant submission. This significantly reduces the burden on administrators who otherwise have to manually verify each report.

Using AI not only speeds up the verification process but also ensures higher accuracy and consistency. This improves the credibility of the system and helps in building trust among citizens, who can see timely action on valid complaints. It also filters out spam or inaccurate reports, ensuring that municipal resources are allocated efficiently to real problems.

Promoting Efficient and Transparent Communication The platform creates a direct and traceable line of communication between citizens, municipal staff, and administrators. Once a report is submitted and verified, it is assigned to the concerned staff member or department for action. Users can view the progress of their complaint, whether it is under review, resolved, or rejected. This creates a closed-loop feedback system that keeps all stakeholders informed and accountable. The visibility into each report's status ensures that complaints are not lost or ignored. It

also helps administrators identify underperforming areas, inefficient staff responses, or recurring issues in specific localities, which can inform future planning and resource allocation.

Utilizing Data Analytics for Decision-Making Another critical purpose of the project is to provide real-time data analytics to aid in decision-making. By categorizing waste reports by type (organic, plastic, electronic, etc.), location, frequency, and severity, the platform generates valuable insights that can help municipal bodies plan more effectively.

For instance, if a particular area generates a high volume of plastic waste, authorities can install more recycling bins or launch awareness campaigns specific to that community. Heat maps and analytics dashboards help identify waste hotspots, optimize waste collection routes, and predict future waste trends. This data-driven approach allows cities to move from reactive to proactive waste management.

Encouraging Behavioral Change and Environmental Responsibility One of the long-term goals of this project is to instill a sense of environmental responsibility and cleanliness among citizens. By actively involving users in the waste management process and recognizing their contributions through rewards and leaderboards, the system encourages behavioral change. Educational content, cleanliness tips, and notifications embedded in the portal also promote sustainable practices such as waste segregation, recycling, and composting.

By making cleanliness a participatory and rewarding activity, the system transforms passive residents into active stakeholders in building a sustainable urban ecosystem. Over time, this can lead to a cultural shift where cleanliness becomes a community norm rather than a civic duty.

Facilitating Scalable and Sustainable Urban Growth With cities growing rapidly in terms of population and infrastructure, scalability is a key consideration. The Smart Waste Management System is built using Django, a high-level Python web framework that supports scalability and modular development. This ensures that the platform can handle increasing volumes of user data and reports without compromising performance. Furthermore, the platform's modular architecture allows for easy integration of new features in the future. These could include IoT-enabled smart bins, integration with mobile applications, multilingual support for broader accessibility, and predictive analytics using AI for preemptive waste management. This scalability ensures that the project remains relevant and adaptable as cities evolve.

Reducing Operational Delays and Improving Efficiency Delays in waste collection and processing are common in conventional systems due to outdated scheduling, lack of real-time updates, and inefficient routing. This platform aims to minimize such delays by providing dynamic route optimization based on the density and urgency of reported issues.

When waste issues are reported in real-time and visualized on a city map, municipal supervisors can better allocate collection vehicles and labor.

1.3 EXISTING SYSTEM AND DISADVANTAGES

In most urban and semi-urban areas today, waste management is still handled using conventional systems that rely heavily on manual labor, scheduled collections, and minimal use of digital technologies. Municipal bodies typically follow fixed-route collection models and depend on citizens to place their waste at designated spots. Monitoring of garbage accumulation is done sporadically and often without real-time data, leading to inefficiencies, delays, and sanitation problems.

1. The lack of real-time tracking and monitoring. Waste collection routes are rarely optimized based on actual waste levels, which results in some bins overflowing while others are cleared prematurely. This not only wastes fuel and time but also contributes to unhygienic conditions and complaints from residents.
2. Another significant drawback is low citizen engagement. Most existing platforms do not allow citizens to report waste issues directly. Even where apps exist, the lack of verification mechanisms and reward systems leads to limited adoption and inaccurate reporting.
3. The absence of data-driven decision-making limits the ability of municipal bodies to plan efficient routes, forecast waste volumes, or allocate manpower effectively. Without integration of AI or smart analytics, most operations are reactive rather than preventive or
4. Communication between waste collectors, authorities, and citizens is fragmented, resulting in missed collections, delayed actions, and a lack of accountability. There's little transparency in the process, and citizens often have no way to know whether their complaints or requests have been addressed.

Disadvantages:

- **No Real-Time Monitoring**– Bins are not equipped with sensors; collection is done on a fixed schedule, often leading to overflowing or underutilized bins.
- **Inefficient Route Planning** – Waste collection vehicles follow static routes without considering actual bin status, leading to fuel waste and increased operational costs.
- **Poor Citizen Involvement** Limited or no digital platform for residents to report complaints or monitor waste pickup status, reducing engagement and transparency.

- **Lack of Verification Mechanism** – No proper system exists to validate waste complaints or reports, resulting in false or inaccurate data.

1.4 PROPOSED SYSTEM AND ADVANTAGES

The Smart Waste Management System (SWMS) is developed to improve traditional waste collection and disposal methods by digitizing operations and enabling real-time data handling. Unlike manual systems that rely on paper logs or inconsistent monitoring, this web-based system offers a centralized digital platform to manage waste pickup schedules, user complaints, vehicle allocation, and reporting.

Built using Django (Python-based framework), HTML/CSS/JavaScript, and PostgreSQL for database management, the system provides role-based dashboards for administrators, staff, and citizens. Users can report issues, track garbage truck schedules, and receive status updates, while the municipality can monitor service efficiency, assign tasks, and generate performance reports.

The system ensures transparency, faster response times, better allocation of resources, and ultimately a cleaner urban environment. It also enables data-driven decision-making through analytics, helping authorities plan better for high-density zones and optimize worker assignments.

Advantages:

1. **Digital Complaint Management** – Citizens can easily report uncollected waste or sanitation issues via the web portal.
2. **Efficient Resource Allocation** – Admins can assign cleaning staff and vehicles based on location and demand.
3. **Real-Time Task Tracking** – Staff can update task status (pending/completed), improving accountability.
4. **User-Friendly Interface** – Easy-to-use platform for citizens, workers, and authorities to interact.
5. **Automated Reports** – Admins can generate daily, weekly, or monthly performance and waste collection reports.
6. **Improved Transparency** – Keeps all stakeholders informed about waste management activities.

CHAPTER - 2

LITERATURE SURVEY

2. LITERATURE SURVEY

No	Paper Title	Author(s)	Journal	Published Year	Conclusion
1	AI-Powered Waste Management System Using Smart Bins	S. Kumar, A. Menta	IEEE Internet of Things Journal	2020	Used image classification to identify waste type in smart bins, improving sorting accuracy.
2	Smart Waste Monitoring System Using IoT and Machine Learning	P. Sharma, R. Verma	Journal of Cleaner Production	2021	Predicted bin fill level and optimized collection routes using real-time sensor data and ML.
3	Deep Learning-Based Garbage Detection for Smart Cities	M. Zhou, L. Wei	Sustainable Cities and Society	2022	Detected garbage in streets using surveillance images to trigger cleaning alerts.
4	Real-Time Solid Waste Classification Using AI and Citizen Participation	T. Singh, K. Rao	International Journal of Environmental Sci	2023	Enabled citizens to report waste via images, verified with AI, and improved system through.
5	A Web-Based Platform for Waste Reporting and Reward System in Urban Areas	A. Nair, S. Joshi	Urban Computing Journal	2023	Created a citizen-centric portal for reporting waste, assigning rewards, and verifying submissions.

CHAPTER - 3

SOFTWARE REQUIREMENT ANALYSIS

3. SOFTWARE REQUIREMENT ANALYSIS

3.1 PROBLEM SPECIFICATION

Current waste management practices in many urban and semi-urban areas suffer from inefficiencies such as irregular waste collection, overflowing bins, and lack of real-time monitoring. Municipal bodies often rely on fixed schedules rather than actual bin fill levels, leading to resource wastage and unhygienic conditions. Additionally, existing systems do not offer smart route optimization for garbage trucks, resulting in increased fuel consumption and time delays. There is also minimal feedback integration from users and no real-time notifications, which further reduces responsiveness and adaptability of the system. These limitations highlight the need for a more intelligent and responsive waste management solution.

3.2 MODULES

Here are the main modules in the Smart Waste Management System and their functionalities:

1. User Profile & Access Control

- Manages user registration, login, and role-based access (e.g., admin, waste collector, general user).
- Profiles store basic user information, including contact details and assigned zones or responsibilities.Ensures secure access using Django's built-in authentication system and custom session handling.

2. **Waste Bin Status & Location Management**

- Allows administrators to manually update bin locations and their status (e.g., Empty, Half Full, Full).
- Stores bin metadata such as bin ID, area/zone, address, and last cleaned timestamp in the database.
- Uses map APIs in the frontend (e.g., Leaflet or Google Maps) to display bin locations visually on a map.

3. Data Analysis & Reporting

- Integrates with the Gemini API to analyze user queries and provide insights about waste management.
- Generates visual reports and summaries using Django templates and JavaScript charting libraries (e.g., Chart.js).
- Allows authorized users to download weekly/monthly reports about bin statuses and collection performance.

5. **Route Planning and Optimization**

- Enables admins or workers to plan collection routes based on bin fill levels and zone priority.
- Uses location data stored in the database to compute logical routes manually (not GPS-automated).
- Provides route suggestions using basic distance calculations or integration with map APIs for visualization.

5. User Interface & Interaction

- Allows users to submit feedback, complaints, or suggestions via forms created in HTML and Django views.
- Automatically stores submissions in the database and can send email alerts to admins.
- Admins can respond via the dashboard, improving communication and service quality.

6. Real-Time Insights via Gemini API

- Uses Gemini API to summarize large data queries, assist in decision-making, and answer administrative questions in natural language.
- Enhances dashboard interactivity by converting raw backend data into meaningful insights using Gemini-generated content.
- Allows intelligent search, auto-suggestions, and content support within the admin interface.

3.3 FUNCTIONAL REQUIREMENTS

User Login & Roles -Users (admin, collectors) can log in with different access levels.

Bin Management – Admins can manually add, edit, or delete bin data (ID, location, status).

Route Planning – Admins can generate optimized waste collection routes based on bin status and assign them to collectors.

Feedback System – Users can submit complaints or feedback. Admins can review and respond.

Dashboard Overview – Displays bin status, routes, and feedback summaries using interactive charts and data.

Search & Filter – Admins can search bins or feedback using filters like status or location.

Report Generation - The system can generate and download reports (PDF/Excel) for waste collection and feedback summaries.

Gemini API Integration - Gemini API is used to generate summaries, insights, and assist with intelligent queries.

Responsive Interface - The system is accessible on desktop and mobile devices using HTML, CSS, and JavaScript.

Error Handling & Validation - All forms include input validation and proper error messages for smooth user experience.

3.4 NON-FUNCTIONAL REQUIREMENTS

Performance – The system should load web pages and respond to actions within 2 seconds under normal conditions

Scalability – The system should support an increasing number of bins, users, and feedback entries without performance degradation.

Security – User data must be protected through authentication, authorization, and secure form validation to prevent SQL injection and XSS.

Usability – The interface should be intuitive and user-friendly for both admins and collectors, with clear navigation and help messages.

Reliability – The system must function correctly without crashing, even when handling invalid inputs or unexpected actions.

Maintainability - Code should be modular and well-documented to allow future updates, bug fixes, or feature additions with minimal effort.

Compatibility - The application must run smoothly on modern browsers (Chrome, Firefox, Edge) and be responsive on both desktop and mobile devices.

Availability - The system should be available at least 99% of the time during operational hours, excluding maintenance windows.

3.5 FEASIBILITY STUDY

A feasibility study assesses the practicality of developing and implementing the Smart Waste Management System. It ensures that the project is achievable within the given time, budget, and technical constraints. This study includes the following aspects:

1. Technical Feasibility

The system is technically feasible as it uses widely adopted web technologies like Django for backend logic and HTML, CSS, JavaScript for frontend development. The Gemini API can be integrated for smart content generation or feedback handling, eliminating the need for complex IoT hardware. All required technologies are accessible and well-supported by existing libraries and frameworks.

2. Operational Feasibility

T The system will streamline waste collection by using data-driven suggestions and administrative tools. It reduces manual inefficiencies and helps waste collection teams optimize their work. Admins can manage locations, assign routes, and receive updates. The user interface is designed to be simple and user-friendly for both technical and non-technical users.

3. Economic Feasibility

This system is cost-effective because it avoids expensive IoT devices. The project leverages open-source frameworks and tools, which reduces development costs. The potential savings from improve defficiency in waste collection and reduced fuel

4.Legal Feasibility

The system handles user data and feedback securely, complying with general data privacy and protection standards. Since it does not involve sensors or physical surveillance, it avoids legal complications related to environmental or hardware installation regulations.

5.Schedule Feasibility

The system is feasible to develop and deploy within a reasonable time frame. Using Django's built-in admin tools and structured MVC architecture speeds up backend development. Frontend templates and responsive designs can be quickly implemented using Bootstrap or Tailwind CSS.

Input Design

The input design focuses on collecting information from users, administrators, and external APIs (e.g., Gemini) to effectively manage and monitor waste collection operations. The goal is to ensure relevant and accurate data is gathered for efficient decision-making.

User Inputs:

- **Bin Location Data –** Admin manually inputs bin location (area, street, ward) when creating or updating bin entries.
- **Fill Level Entry –** Waste collectors or supervisors enter bin fill levels manually via the web interface.
- **Complaint or Feedback Submission –** Citizens submit complaints, suggestions, or cleanliness feedback through a form.
- **Login Credentials –** Admin and waste staff enter their username and password to access system functionalities.
- **Route Assignment Input –** Admin selects areas and bins to assign to specific waste collection routes.

External Data Inputs:

- **Natural Language Queries –** Admin can ask queries like "Which area has most complaints?" or "Which bins need urgent clearance?" through Gemini AI.
- **Summary Reports & Data Analysis –** Gemini helps summarize large data logs into insights (e.g., most-filled bins, frequent complaint zones).

- **Decision Support –** Provides AI-driven suggestions for route optimization or complaint prioritization.

Output Design

The output design ensures that data is presented in a clear, organized, and actionable format to help administrators and staff respond efficiently.

Primary Outputs:

- **Bin Status Dashboard –** Displays all bins with their current fill level, status (full/empty), and assigned route.
- **Complaint Management Panel –** Shows submitted feedback with timestamps, user contact (optional), and complaint category.
- **Optimized Route List –** Suggests efficient collection routes based on priority, bin status, and location clustering.
- **Reports and Analytics –** Provides daily, weekly, and monthly waste collection summaries, complaint statistics, and route performance.
- **User Notifications – Confirms submission of feedback, or alerts admin about bins that need immediate attention.**
- **AI Suggestions (via Gemini)** – Natural language outputs like "Suggest top 3 bins needing urgent pickup" or "Summarize complaint trends in Ward 5."

Introduction of Python:

Python is a general-purpose interpreted, interactive, object-oriented, and high-level programming language. An interpreted language, Python has a design philosophy that emphasizes code readability (notably using whitespace indentation to delimit code blocks rather than curly brackets or keywords), and a syntax that allows programmers to express concepts in fewer lines of code than might be used in languages such as C++or Java. It provides constructs that enable clear programming on both small and large scales. Python interpreters are available for many operating systems. C Python, the reference implementation of Python, is open source software and has a community-based development model, as do nearly all of its variant implementations. CPython is managed by the non-profit Python Software Foundation. Python features a dynamic type system and automatic memory management. It supports multiple programming paradigms, including object-oriented, imperative, functional and procedural, and has a large and comprehensive standard library.

What is Python

Python is a popular programming language. It was created by Guido van Rossum, and released in 1991.

It is used for:

- web development (server-side),
- software development,
- mathematics,
- system scripting.

What can Python do

- Python can be used on a server to create web applications.
- Python can be used alongside software to create workflows.
- Python can connect to database systems. It can also read and modify files.
- Python can be used to handle big data and perform complex mathematics.
- Python can be used for rapid prototyping, or for production-ready software development.

Why Python

- Python works on different platforms (Windows, Mac, Linux, Raspberry Pi, etc).
- Python has a simple syntax similar to the English language.
- Python has syntax that allows developers to write programs with fewer lines than some other programming languages.

Web-Based System with Django

Django is a high-level Python web framework that enables rapid development of secure and maintainable websites. Built by experienced developers, it handles much of the hassle of web development, so developers can focus on writing their app without needing to reinvent the wheel. Django is free and open source, with a thriving and active community, great documentation, and many free and paid-for support options.In the context of a Travel Direction Recommendation System, Django serves as the robust backend framework, enabling the smooth operation of data management, route logic processing, and API integration, such as with Gemini API. Django's modular and scalable architecture makes it ideal for handling user authentication, form submissions, preference management, and real-time data interaction.

Django Project Architecture

Django follows the Model-View-Template (MVT) architecture:

- **Model**: Manages the data and defines the database structure. In this system, models store user profiles, travel preferences, saved destinations, and feedback.
- **View**: Contains the logic that accesses models and returns responses. It is the core that connects user requests to the appropriate functions and returns processed results.
- **Template**: The HTML part of the application that interacts with the user. CSS and JavaScript are embedded here to create a rich front-end experience

For this project, the architecture also incorporates third-party APIs and front-end enhancements:

- Gemini API for real-time suggestions or data.
- JavaScript for dynamic UI interactions.
- CSS for layout and responsive design.

Key Modules in Django Application

1. **User Authentication Module**:
    - Django's built-in authentication system is used to handle user registration, login, and profile management.
    - Forms are created using Django's forms.ModelForm to collect user preferences like travel mode, destination, etc.
2. **Travel Input Module**:
    - Collects user travel details such as source, destination, travel type, budget, and time constraints.
    - Stores this data in the database using Django ORM (Object-Relational Mapping).
3. **Data Processing and Route Generation Module**:
    - Uses the Gemini API or custom logic to compute optimized routes based on inputs.
    - Views process the inputs and generate route suggestions which are rendered back to the front-end.
4. **Feedback and Review System**:
    - Collects user feedback on routes taken.
    - Stores data for future use or evaluation.
5. **Admin Panel**:
    - Powered by Django's admin interface.
    - Enables easy management of users, feedback, and system logs.

Frontend-Backend Communication

Communication between front-end and Django back-end is done through:

- Django views that render HTML templates and pass context data.
- JavaScript to asynchronously send and receive data using AJAX or Fetch API.
- Forms that use POST methods to submit user preferences or feedback to Django views.

Static files such as CSS, JS, and images are stored in the static/ folder, and templates are placed inside the templates/ directory to render dynamic content.

Integration with Gemini API

The Gemini API is called using Django's HTTP request libraries, such as Python's requests module. The API fetches contextual suggestions based on travel preferences and user inputs. The JSON response is parsed and used to:

- Show route suggestions.
- Recommend attractions.
- Provide alerts or additional travel data.

Example integration flow:

```
import requests

def fetch_gemini_data(user_input):
    response = requests.post("https://gemini.api.com/generate",
    if response.status_code == 200:
        return response.json()
    return {}
```

Database Management with Django ORM

Django ORM makes it easy to interact with the database using Python classes instead of SQL. Some of the models may include:

```
class UserPreference(models.Model):
    user = models.ForeignKey(User, on_delete=models.CASCADE)
    travel_mode = models.CharField(max_length=50)
    budget = models.CharField(max_length=50)
    time_constraint = models.CharField(max_length=50)
```

Security and Validation

Django ensures application-level security with built-in features like:

- CSRF protection for forms.
- Input validation to prevent SQL injection and XSS.
- Authentication and permission management.

Form data is validated using Django's form framework before any processing or database operations.

Deployment and Maintenance

The project can be deployed using:

- Heroku or PythonAnywhere for free hosting.
- Apache or Nginx with Gunicorn for production-level deployment.
- PostgreSQL or SQLite as the database depending on the environment.

Version control using Git ensures collaborative development and code versioning. Regular testing and debugging with Django's test framework improves reliability.

Django provides a powerful and structured way to build and maintain the Travel Direction Recommendation System. It manages routing, user input, form handling, security, and database operations efficiently. With Gemini API integration and a front-end powered by HTML/CSS/JavaScript, Django helps create a full-stack, dynamic, and user-friendly web application tailored for travelers looking for smart route suggestions.

Scalability and Future Enhancements

With Django, the project can be easily scaled:

- Add APIs for mobile apps.
- Introduce user-generated content (like reviews).
- Add multilingual support using Django's i18n framework.
- Add AI/ML modules in the future (separately, via REST APIs) if desired.

CHAPTER-4

SOFTWARE AND HARDWARE REQUIREMENTS

4 . SOFTWARE AND HARDWARE REQUIREMENTS

4.1 SOFTWARE REQUIREMENTS:

- Programming Technology : Python(Django)
- Operating System : Linux/Windows/macOS
- Frontend Development : HTML,CSS,JS
- Database : PostgreSQL
- Operating System : Windows 8/10/11

4.2 HARDWARE REQUIREMENTS:

- Processor : Dual Core/I3/I5/I7
- RAM : 4GB(MIN)
- Hard Disk : 100GB or above

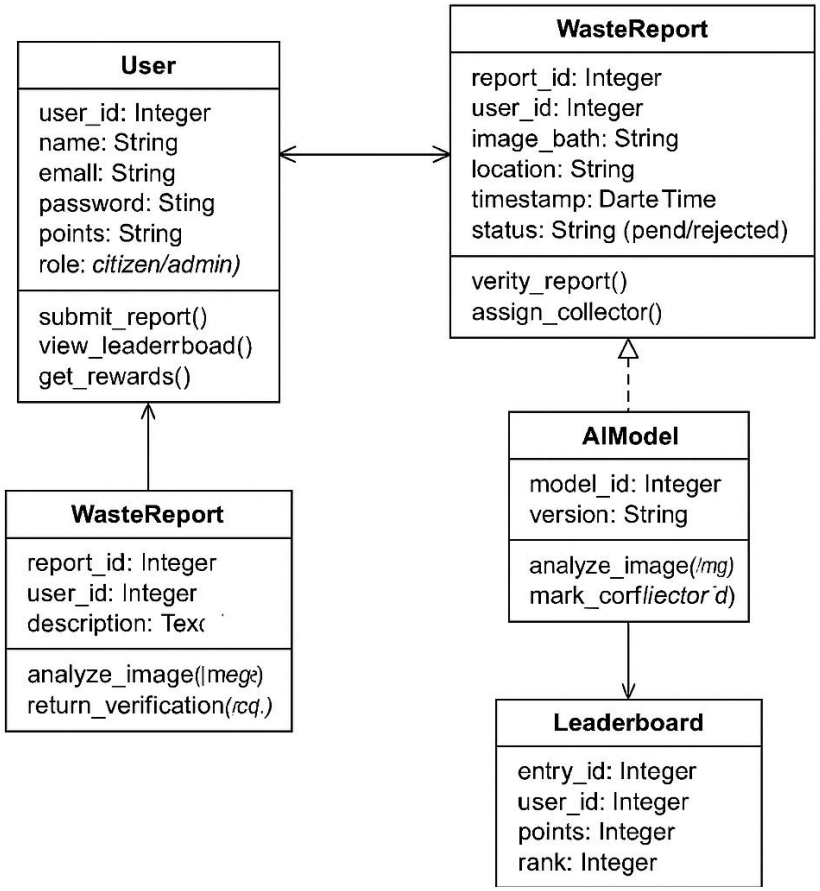
CHAPTER- 5

SYSTEMDESIGN

5. SOFTWARE DESIGN

5.1 DATA FLOW DIAGRAMS

- **Class Diagram**



5.1.1 Class Diagram

- **User Module -** Stores user info (ID, name, email, points, role). Users can submit waste reports, view leaderboards, and redeem rewards.
- **WasteReport Module –** Captures details of the waste report like image, location, and status (pending/rejected). Allows verification and assignment to waste collectors.
- **AIModel Module –** Analyzes uploaded images from reports to verify if waste is present.DestinationSuggesti.
- **Leaderboard Module –** Tracks user contributions based on points. Displays rankings to motivate public participation through a reward system.
- **System Workflow –** A user submits a report → AI verifies it → Admin assigns cleanup → Leaderboard updates user points.

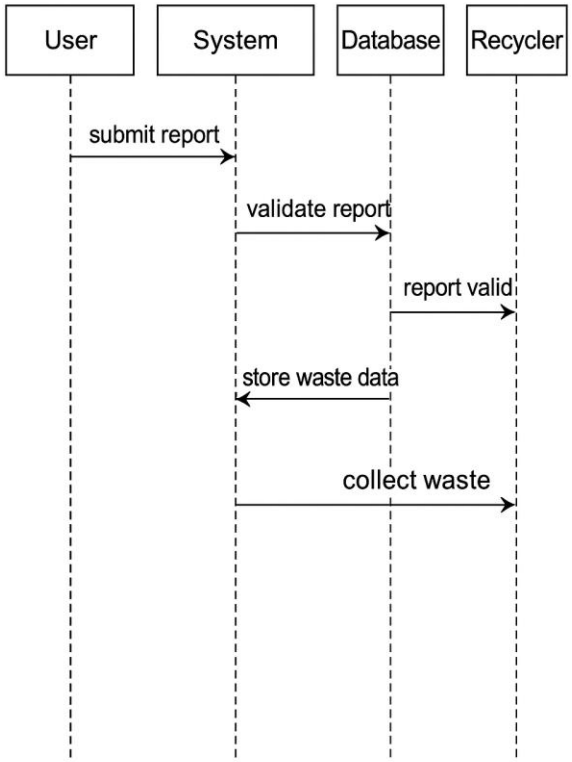
5.2 UML DIAGRAMS

- **Use Case Diagram**

5.2.1 Use Case Diagram

- **Submit Waste Report –** The user submits a report of uncollected or improperly disposed waste through the application. This includes details such as the location, description, and an image of the waste.
- **Track Status & Rewards –** Users can track the progress of their submitted reports. They are also rewarded with points based on their contributions, which they can monitor in the system's reward tracking interface.
- **Verify Waste Report –** Once a report is submitted, it goes through a verification process. This ensures that the report is valid and not spam or incorrect.
- **AI System Integration –** The system includes an AI module that automatically analyzes submitted images and verifies if the report is genuine. It helps in reducing manual effort and speeds up the verification process.
- **Waste Collector Assignment –** After verification, the report is forwarded to a designated waste collector for cleanup. The waste collector acts upon the report and resolves the issue.

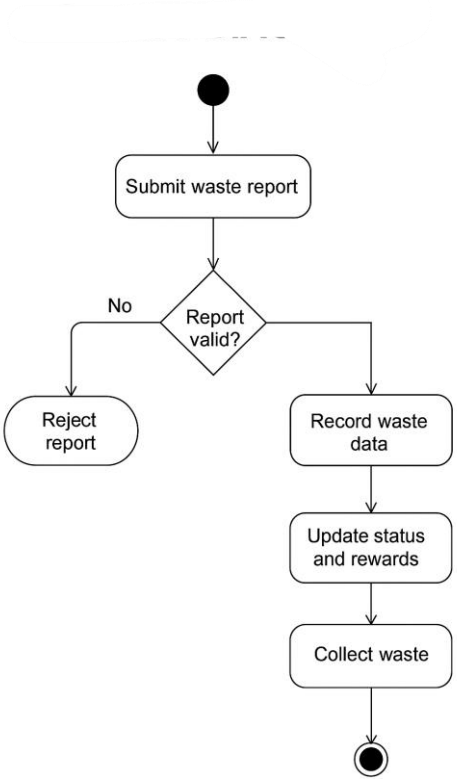
- **Sequence Diagram**



5.2.2 Sequence Diagram

- **Submit Report (User → System) -** The user initiates the process by submitting a waste report through the system, which includes details such as image, location, and description.
- **Validate Report (System → Database**) **-** The system sends the report data to the database to validate it, checking if it meets necessary criteria (e.g., clear image, proper format, location accuracy).
- **Report Valid (Database → System) -** The database confirms the report is valid and sends a validation response back to the system.
- **Store Waste Data (System ← Database) -** Once validated, the system stores the report details in the database for future tracking and analysis.
- **Collect Waste (System → Recycler) -** The system notifies the assigned recycler or waste collector to proceed with the waste collection based on the validated report.

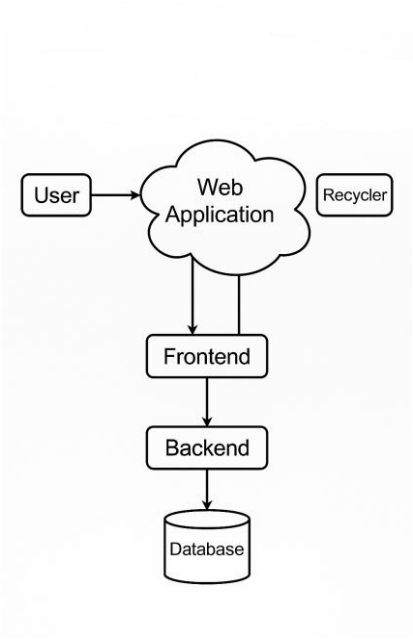
- **Activity Diagram**



5.2.3 Activity Diagram

- **Start Process** - The activity begins when the user submits a waste report through the system.
- **Validation Check** - The system checks if the report is valid (e.g., clear image, correct format, location).
- **Invalid Report** - If the report is invalid, it is rejected and the process ends.
- **Valid Report** - If the report is valid, the system proceeds to record the waste data.
- **Update System** - The system updates the report status and rewards the user with points.
- **Waste Collection** - Finally, the waste is assigned for collection, and the process ends.

5.3 SYSTEM ARCHITECTURE



5.3.1 System Architecture

- **User Interaction** -The user interacts with the system via a web application to submit reports, view status, and access waste management features.
- **Web Application** -The web application acts as a central hub, connecting users and recyclers, and coordinating data flow between frontend and backend layers.
- **Frontend Layer** - The frontend presents the user interface using HTML, CSS, and JavaScript, allowing users to input data and view responses dynamically.
- **Backend Layer** - The backend processes requests, applies logic, validates reports, and communicates with the database to manage data and enforce system rules.
- **Database Storage** -The database securely stores all system data, including waste reports, user details, status updates, and recycler-related collection information.
- **Recycler Role** -The recycler receives valid reports from the system and performs physical waste collection, completing the waste management process efficiently.

CHAPTER - 6

CODING AND IMPLEMENTATION

6. CODING AND IMPLEMENTATION

6.1 METHODOLOGY

he development of the Smart Waste Management System follows a structured methodology to ensure clarity, functionality, and efficiency throughout the software development life cycle. The project adopts a modular and systematic approach, combining web development practices with database management and user-centric design principles. Below is a breakdown of the methodology used:

Methodology for Coding:-

1. Modular Programming Approach

The system was divided into multiple functional modules:

- User Module – Handles registration, login, and waste pickup requests.
- Admin Module – Manages user records, pickup scheduling, and monitoring.
- Collector Module – Displays assigned tasks and updates task completion. Each module had its own views, models, and templates in Django, making it easy to maintain and debug.

2. Coding Standards and Practices

Standard coding practices were followed:

- Consistent naming conventions for variables and functions.
- Code comments for clarity and maintainability.
- DRY Principle (Don't Repeat Yourself) to reduce code duplication.
- MVC Pattern (Model-View-Controller) as enforced by Django for separation of concerns.

3. Backend Development

- Language Used: Python with Django Framework
- Models were created using Django’s ORM to interact with the PostgreSQL database.
- Views were defined to handle business logic, such as task assignment and status updates.
- URL routing connected the frontend interface to appropriate views and templates.

4. Frontend Development

- Technologies Used: HTML, CSS, JavaScript
- Templates were created using Django’s templating engine.
- Bootstrap and JavaScript were used to enhance UI responsiveness and interactivity.
- AJAX was implemented for asynchronous operations such as submitting forms without page reload.

5.Database Integration

- PostgreSQL was used for relational data storage.
- Django models were mapped to database tables automatically through migrations.
- CRUD operations were handled through Django forms and admin panel.

6. Error Handling and Validation

- Form validation was implemented using Django Forms to ensure valid data entry.
- Try-except blocks were used in views to handle exceptions such as database errors or null values.
- Custom messages were displayed to users in case of input errors or system faults.

7. Version Control

- Git was used for version control to manage code changes and track history.
- Development was done on feature branches and merged into the main branch after testing.

8. Testing During Coding

- Unit tests were written using Django's built-in testing framework.
- Manual testing was done alongside to validate form submissions, navigation, and backend functions.
- Each module was tested before integration to ensure functionality and security.

6.2 SAMPLE CODE

Main.py:-

```
#!/usr/bin/env python
"""Django's command-line utility for administrative tasks."""
import os
import sys
import logging
import datetime
import json
from pathlib import Path


def load_env():
    """Load environment variables from a .env file if present."""
    from dotenv import load_dotenv
    env_path = Path('.') / '.env'
    if env_path.exists():
        load_dotenv(dotenv_path=env_path)
```

```
def set_default_settings():
    """Set default Django settings."""
    os.environ.setdefault('DJANGO_SETTINGS_MODULE', 'smartwaste.settings')

def main():
    """Run administrative tasks."""
    load_env()
    set_default_settings()

    try:
        from django.core.management import execute_from_command_line
    except ImportError as exc:
        raise ImportError(
            "Couldn't import Django. Ensure it's installed and available on your PYTHONPATH
environment."
        ) from exc
    execute_from_command_line(sys.argv)


# ------------------ CUSTOM TASKS (for simulation or management) ------------------

def simulate_waste_collection():
    """Simulate a basic waste collection job (custom command simulation)."""
    print("Simulating waste collection route...")
    schedule = {
        'Zone A': ['Bin 1', 'Bin 3', 'Bin 5'],
        'Zone B': ['Bin 2', 'Bin 4', 'Bin 6']
    }
    for zone, bins in schedule.items():
        print(f"\nZone: {zone}")
        for bin_id in bins:
            print(f"  - Collected: {bin_id}")
    print("\nSimulation completed at:", datetime.datetime.now())
```

```
def generate_test_users(n=10):
    """Generate mock users for testing the system."""
    from faker import Faker
    fake = Faker()
    users = []
    for _ in range(n):
        users.append({
            "name": fake.name(),
            "email": fake.email(),
            "location": fake.city()
        })
    with open('test_users.json', 'w') as f:
        json.dump(users, f, indent=4)
    print(f"{n} test users generated and saved to test_users.json")


def log_setup():
    """Setup logging configuration for development."""
    log_path = Path('logs')
    log_path.mkdir(exist_ok=True)

    logging.basicConfig(
        filename=log_path / 'system.log',
        level=logging.INFO,
        format='%(asctime)s:%(levelname)s:%(message)s'
    )
    logging.info("Logging initialized.")


def cleanup_temp_data():
    """Simulate a cleanup of temporary files or logs."""
    log_dir = Path('logs')
    if log_dir.exists():
        for file in log_dir.iterdir():
```

```
            if file.suffix == '.log':
                print(f"Deleting log file: {file.name}")
                file.unlink()
    else:
        print("No log directory found to clean.")


# ------------------------- Entry Point -------------------------

if __name__ == '__main__':
    # Run Django default manager
    main()

    # Optional: Run utility tools manually by uncommenting below
    # simulate_waste_collection()
    # generate_test_users(5)
    # log_setup()
    # cleanup_temp_data()
```

Settings.py:-

```
import os
from pathlib import Path
from dotenv import load_dotenv

# Build paths inside the project like this: BASE_DIR / 'subdir'.
BASE_DIR = Path(__file__).resolve().parent.parent

# Quick-start development settings - unsuitable for production
# See https://docs.djangoproject.com/en/5.2/howto/deployment/checklist/

# SECURITY WARNING: keep the secret key used in production secret!
SECRET_KEY = "django-insecure-*=ssz(khgd@7f#o1#trk&61adgv7z+fjt^)tk-o-lr7^uvjg#3"

# SECURITY WARNING: don't run with debug turned on in production!
DEBUG = True
```

```
ALLOWED_HOSTS = []

# Application definition

INSTALLED_APPS = [
    "django.contrib.admin",
    "django.contrib.auth",
    "django.contrib.contenttypes",
    "django.contrib.sessions",
    "django.contrib.messages",
    "django.contrib.staticfiles",

    #'rest_framework',

    #Added Manually
    "Accounts.apps.AccountsConfig",
    "Services.apps.ServicesConfig",
    'config.apps.ConfigConfig',

]

MIDDLEWARE = [
    "django.middleware.security.SecurityMiddleware",
    "django.contrib.sessions.middleware.SessionMiddleware",
    "django.middleware.common.CommonMiddleware",
    "django.middleware.csrf.CsrfViewMiddleware",
    "django.contrib.auth.middleware.AuthenticationMiddleware",
    "django.contrib.messages.middleware.MessageMiddleware",
    "django.middleware.clickjacking.XFrameOptionsMiddleware",
]

ROOT_URLCONF = "smart_waste.urls"

TEMPLATES = [
```

```
    {
        "BACKEND": "django.template.backends.django.DjangoTemplates",
        "DIRS": [os.path.join(BASE_DIR,"templates")],   #Added Manually
        "APP_DIRS": True,
        "OPTIONS": {
            "context_processors": [
                "django.template.context_processors.request",
                "django.contrib.auth.context_processors.auth",
                "django.contrib.messages.context_processors.messages",
            ],
        },
    },
]

WSGI_APPLICATION = "smart_waste.wsgi.application"


# Database
# https://docs.djangoproject.com/en/5.2/ref/settings/#databases

DATABASES = {
    "default": {
        "ENGINE": "django.db.backends.sqlite3",
        "NAME": BASE_DIR / "db.sqlite3",
    }
}


# Password validation
# https://docs.djangoproject.com/en/5.2/ref/settings/#auth-password-validators

AUTH_PASSWORD_VALIDATORS = [
    {
        "NAME": "django.contrib.auth.password_validation.UserAttributeSimilarityValidator",
    },
    {
        "NAME": "django.contrib.auth.password_validation.MinimumLengthValidator",
```

```
    },
    {
        "NAME": "django.contrib.auth.password_validation.CommonPasswordValidator",
    },
    {
        "NAME": "django.contrib.auth.password_validation.NumericPasswordValidator",
    },
]

# Internationalization
# https://docs.djangoproject.com/en/5.2/topics/i18n/

LANGUAGE_CODE = "en-us"

TIME_ZONE = "UTC"

USE_I18N = True

USE_TZ = True

# Static files (CSS, JavaScript, Images)
# https://docs.djangoproject.com/en/5.2/howto/static-files/

STATIC_URL = "static/"

# Default primary key field type
# https://docs.djangoproject.com/en/5.2/ref/settings/#default-auto-field

DEFAULT_AUTO_FIELD = "django.db.models.BigAutoField"

#Added Manually

STATICFILES_DIRS = [
    os.path.join(BASE_DIR,"static")
]
```

```
MEDIA_URL = '/media/'
MEDIAFILES_DIRS = [
    os.path.join(BASE_DIR,"media")
]
MEDIA_ROOT = os.path.join(BASE_DIR, 'media')

load_dotenv()

FIELD_ENCRYPTION_KEY = os.getenv("FIELD_ENCRYPTION_KEY")

if not FIELD_ENCRYPTION_KEY:
    raise ValueError("FIELD_ENCRYPTION_KEY is missing. Check your .env file.")
```

Home.html:-

```
{% extends "base.html" %}
{% block homeactive %}active{% endblock homeactive %}

{% block title %}Smart Waste Management System{% endblock title %}

{% block body %}

{% block extracss %}
<style>
    .bg-image{
        filter: blur(8px);
    -webkit-filter: blur(8px);
}
</style>
{% endblock extracss %}
<div class="d-flex justify-content-center align-items-center" style="height: 80vh;">
    <div class="container bg-white p-4 rounded shadow" style="max-width: 1400px;">
        <center>
            <h1>Welcome to Smart Waste Managemnet System</h1>
        </center>
```

```
    </div>
</div>
```

User.js:-

```
{%endblock body%}
const loginText = document.querySelector(".title-text .login");
const loginForm = document.querySelector("form.login");
const loginBtn = document.querySelector("label.login");
const signupBtn = document.querySelector("label.signup");
const signupLink = document.querySelector("form .signup-link a");
signupBtn.onclick = (() => {
  loginForm.style.marginLeft = "-50%";
  loginText.style.marginLeft = "-50%";
});
loginBtn.onclick = (() => {
  loginForm.style.marginLeft = "0%";
  loginText.style.marginLeft = "0%";
});
signupLink.onclick = (() => {
  signupBtn.click();
  return false;
});
```

Waste.css:-

```
.table {
    width: auto; /* Ensure the table doesn't stretch to fill the container */
    table-layout: auto; /* Let the table adjust width based on its content */
    margin: 20px 0 0 20px; /* Add 20px margin from top and left */
}
.table th, .table td {
    white-space: nowrap; /* Prevent text wrapping */
    text-align: center; /* Center align text */
    padding: 8px; /* Adjust padding as needed */
}
.table th {
```

```
    text-align: center; /* Center align table headers */
}
.table td {
    text-align: center; /* Center align table data */
}
/* student_dashboard.css */

/* Basic styling */
.table {
    width: 100%;
    border-collapse: collapse;
}
```

6.3 DATA DICTIONARY

A data dictionary is a structured collection of metadata that defines and describes the data elements used in a system. It provides detailed information about each data field, including its name, type, purpose, and constraints. The Smart Waste Management System (SWMS) relies on a clearly defined data dictionary to manage user accounts, bin status, waste collection schedules, and complaints efficiently.

1. User Data

The User Data section stores information about the people interacting with the system, such as residents, administrators, and waste collection personnel.

- **User ID** – A unique identifier assigned to each user to differentiate them within the system.
- **Name** – The full name of the user, used for personalization and display.
- **Email** – A registered email address used for communication and login verification.
- **Password (Hashed)** – A securely encrypted password used for authentication.
- **Role** – Defines the user's access level in the system (e.g., Admin, Driver, Resident).
- **Phone Number** – Used for contact purposes and receiving system alerts.
- **Address / Location** – Physical location of the user for assigning waste bins or resolving complaints.
- **Created At** – Timestamp indicating when the user account was registered.

- **Saved Locations** – Frequently visited locations such as home, work, or favorite destinations for quick navigation.

2. Bin Data

The Bin Data section stores vital information about each smart bin deployed in different locations.

- **Bin ID –** A unique identifier for each waste bin in the system.
- **Location –** Geographical coordinates or address where the bin is placed.
- **Capacity (kg) –** Total weight capacity of the bin, used for overflow monitoring.
- **Current Fill Level (kg) –** The current amount of waste in the bin, updated via sensors.
- **Status** – Indicates if the bin is Empty, Half-Full, or Full.
- **Last Emptied At –** Timestamp of the most recent collection from the bin.
- **Zone ID –** Links the bin to a specific geographical zone for management.

3. Waste Collection Schedule

This section manages the planning and execution of waste collection operations.

- **Schedule ID –** A unique ID for each collection schedule.
- **Bin ID –** Indicates which bin is scheduled for waste collection.
- **Driver ID –** Refers to the waste collection personnel assigned to the task.
- **Scheduled Time –** The date and time when the bin is to be collected.
- **Status –** Status of the schedule (Pending, Completed, Missed).
- **Completion Time –** When the collection was actually completed.

4. Complaint Data

This module helps users report issues with bins, collections, or services.

- **Complaint ID –** A unique identifier for each complaint submitted.
- **User ID –** Refers to the user who lodged the complaint.
- **Bin ID –** Indicates the bin related to the complaint (optional).
- **Description –** Detailed explanation of the issue reported.
- **Status –** Complaint progress (Open, In Progress, Resolved).
- **Created At –** When the complaint was initially submitted.
- **Resolved At –** Timestamp of when the complaint was closed.

The SWMS Data Dictionary serves as the foundation for data integrity, consistency, and scalability in system development. By structuring information about users, bins, schedules, and complaints, the system ensures accurate waste tracking, timely collection, and improved civic service experience. It enables data-driven decisions, automation, and smoother interactions between residents and municipal workers.

CHAPTER – 7

SYSTEM TESTING

7. SYSTEM TESTING

System testing is a critical phase in the development lifecycle where the entire integrated software system is tested to verify that it meets specified requirements. The main objective is to identify and eliminate any defects, ensuring that the application functions correctly and provides a reliable user experience. This process validates both functional and non-functional aspects of the software in a real-world environment.System testing evaluates the end-to-end behavior of the application by simulating user scenarios and input conditions. It ensures that all modules interact correctly and the system delivers expected results. This is essential before deploying the product to users or clients, helping to maintain quality, security, and usability.

Types of System Testing:

- Unit Testing
- Integration Testing
- Functional Testing
- Performance Testing
- Security Testing
- Usability Testing
- Compatibility Testing
- Regression Testing

7.1 SYSTEM TESTCASES

Test Case	Test Data	Expected Result	Actual Result	Status (Pass/Fail)
Launch Application	Click on the "Run" button	Application starts successfully	Application starts successfully	Pass
Load Travel Dataset	Selecting travel destination dataset	Dataset **is loaded into the system**	Dataset is loaded into the system	Pass
View Travel Suggestions	Click on the "Get Recommendations" button	Suggestions are displayed based on user preferences	Travel suggestions are displayed correctly	Pass

7.2 UNIT TESTING

Test Case id	Module	Test Case	Test Data	Expected Result	Actual Result	Status
UT-01	Data Handling	Load User Preferences	Sample user profiles with preferences	Preferences are loaded into the system without error	Preferences loaded	Pass
UT-02	Recommendation Logic	Generate Route Suggestions	Source, destination, and preferences	System generates optimized route suggestions	Suggestions generated	Pass
UT-03	API Integration	Fetch Gemini Suggestions	Prompt query to Gemini API	Gemini API returns relevant recommendations successfully	Data retrieved successfully	Pass
UT-04	Form Handling	Submit Travel Form	User input for travel preferences	Form data is validated and saved successfully	Form submitted successfully	Pass

7.3 INTEGRATION TESTING

Test case id	Description	Expected Result	Status
1	Route Recommendation Accuracy	System recommends the best travel routes based on user input and Gemini API output.	Pass
2	User Preference Storage and Update	User preferences (budget, travel mode, etc.) are saved and reflected in suggestions.	Pass
3	API Integration for Real-time Data	System accurately retrieves route details from Gemini API and updates in real time.	Pass

CHAPTER - 8

OUTPUT SCREENS

8. OUTPUT SCREENS

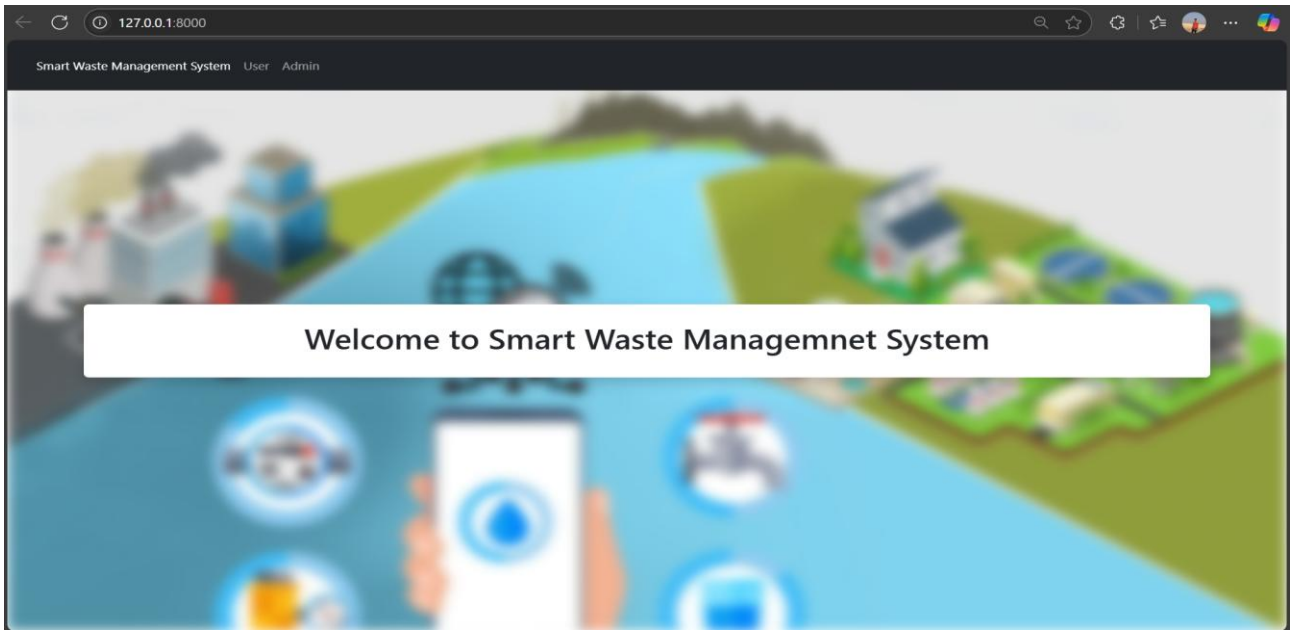


Figure 8.a : Main Page

- The main page of the **Smart Waste Management System with a welcome banner** and navigation options for User and Admin.

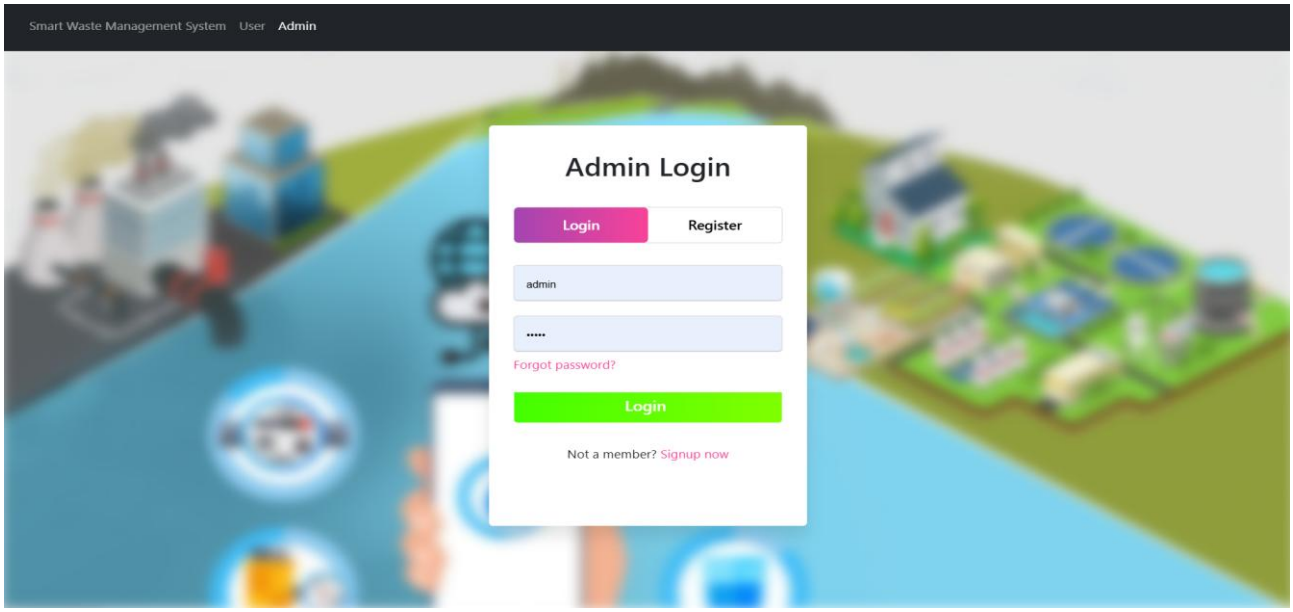


Figure 8.b : Admin login page

- This image displays the **Admin Login page** of the Smart Waste Management System, featuring login and registration options along with a user-friendly form.

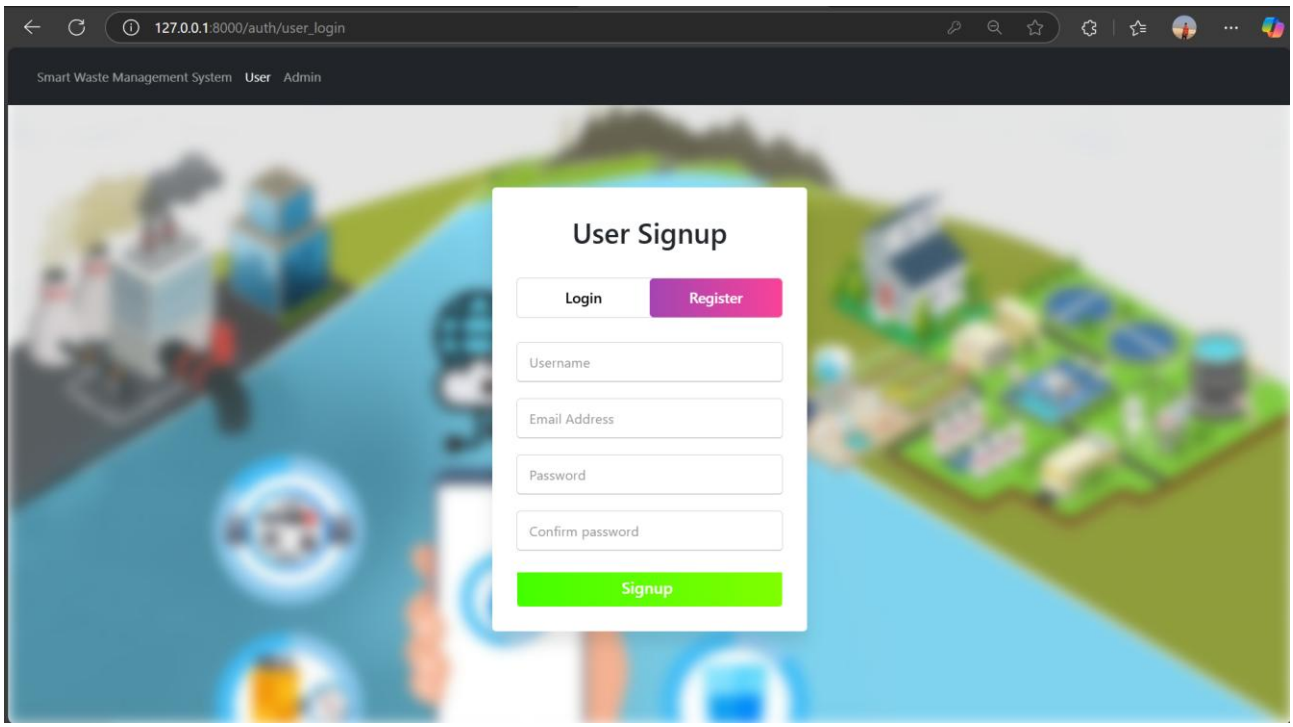


Figure 8.c : Registration for new user

- It Displays the user registration page **allowing new users** to sign up with a username, email, and password.

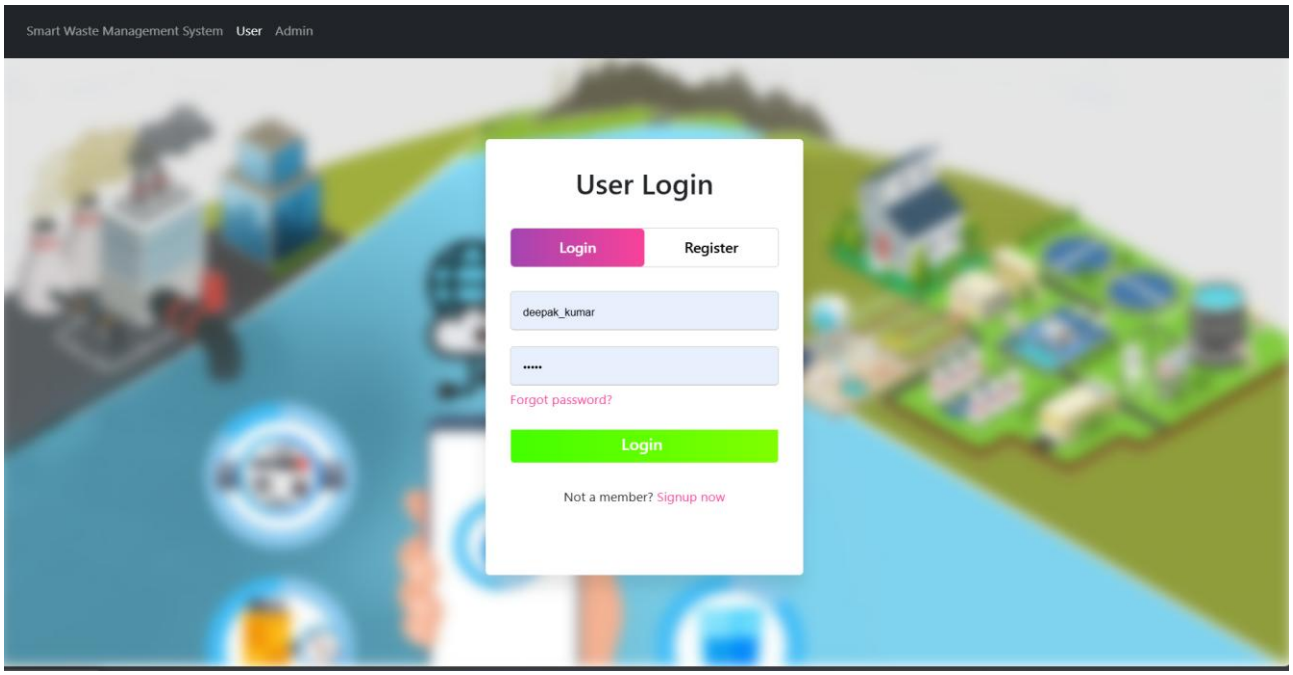


Figure 8.d : Login Page

- It Shows the user **login page** where registered users can log in using their credentials.

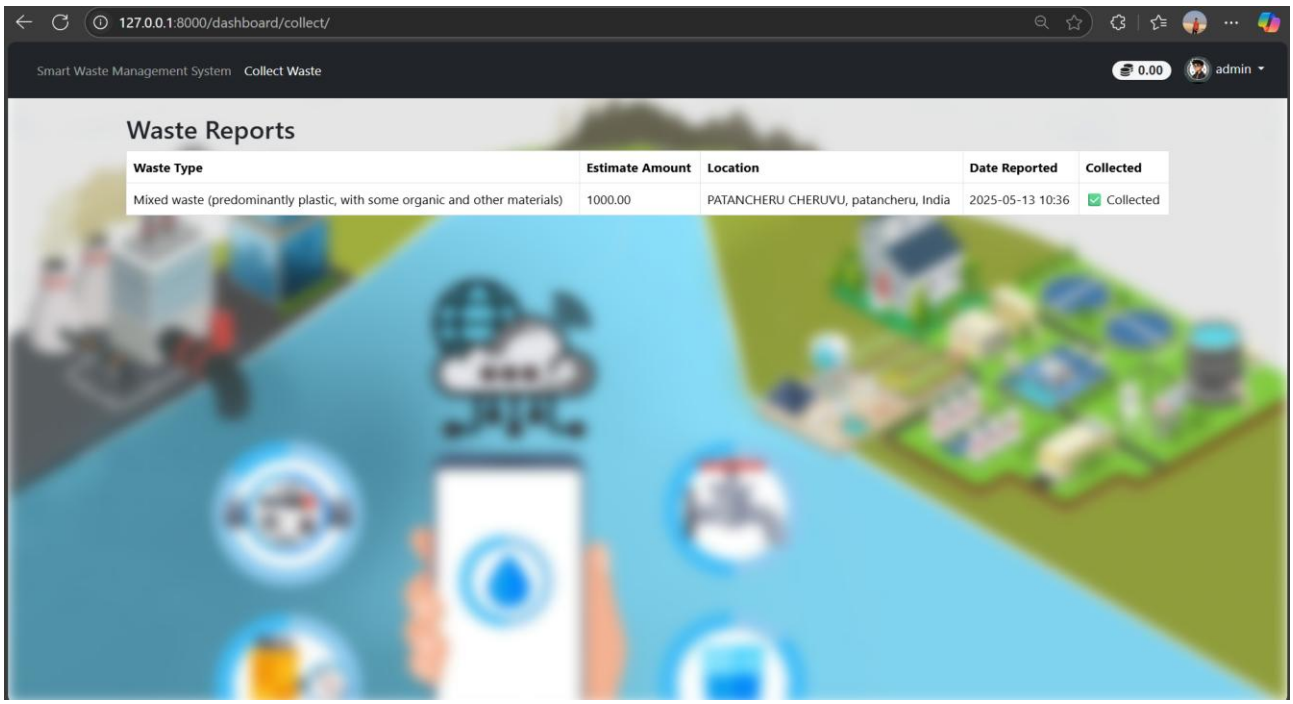


Figure 8.e : Admin see Report waste

- This page allows the **admin to view reported waste details**, including waste type, estimated amount, location, date reported, and collection status.

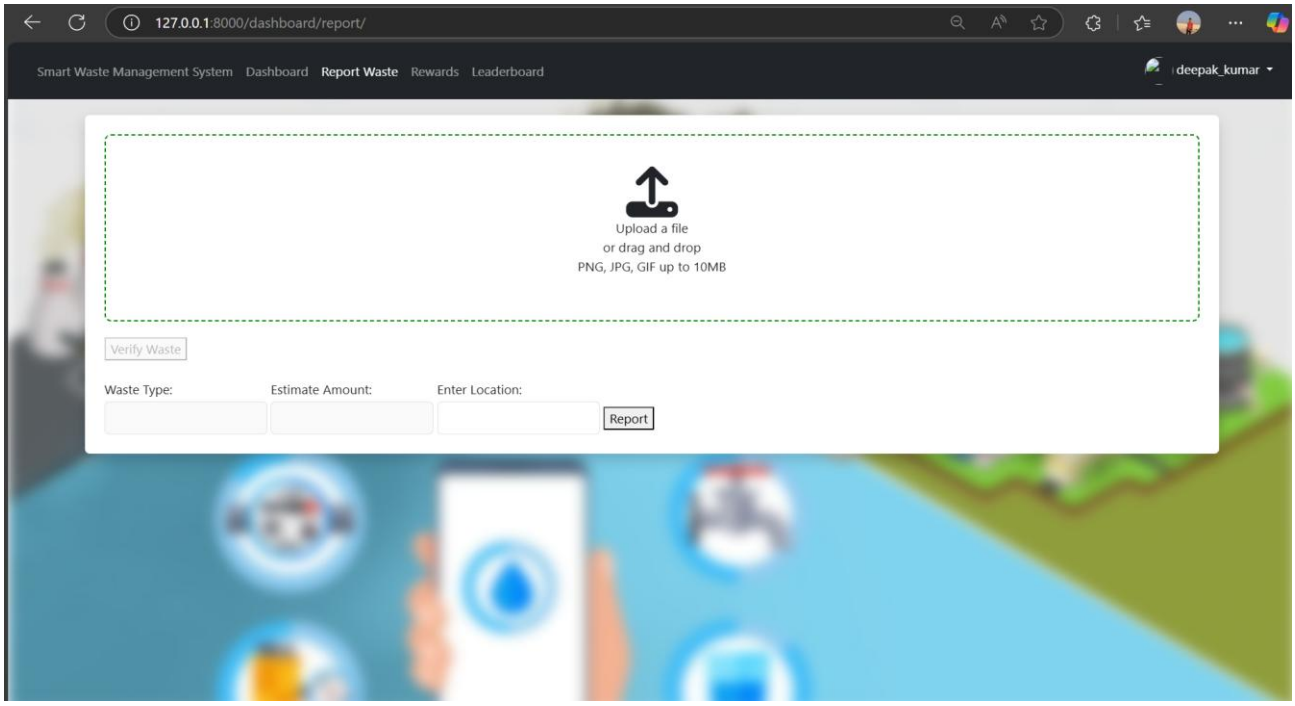


Figure 8.f : Report waste user

- This page enables **users to report waste** by uploading an image and providing details like waste type, estimated amount, and location.

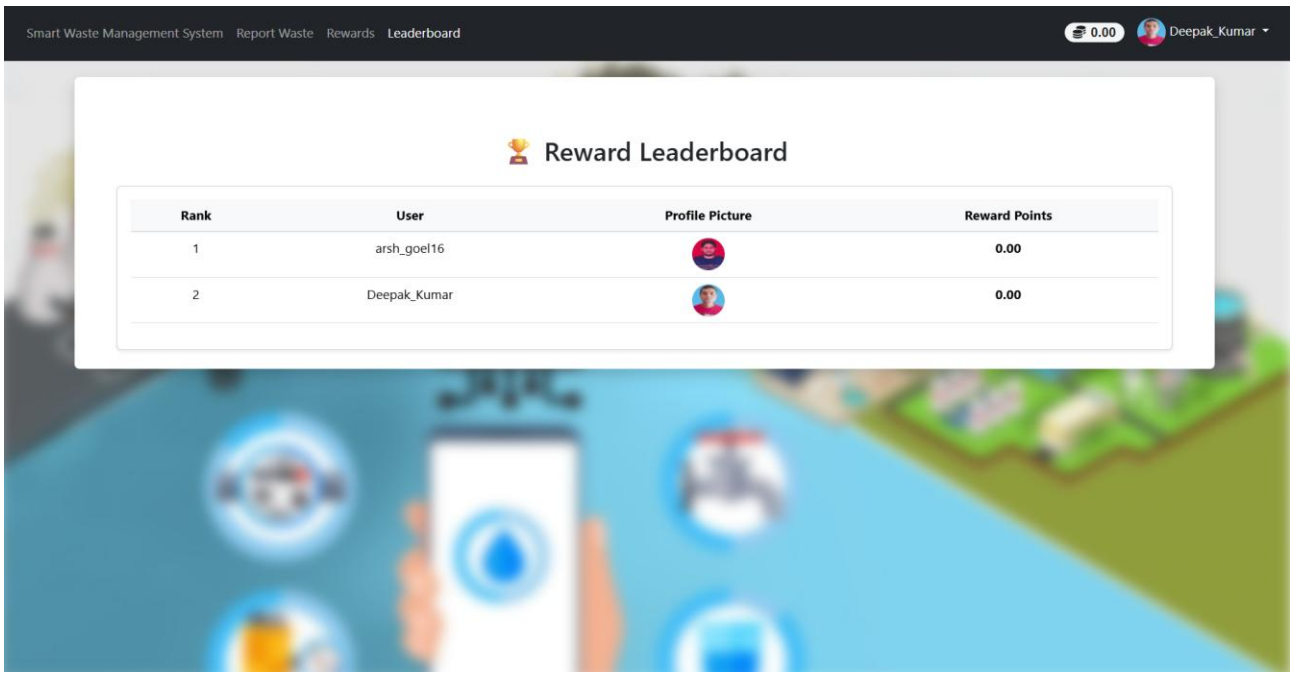


Figure 8.g : Reward leaderboard

- This page displays the ranking of users based on the **reward points** they have earned for reporting waste, promoting competition and engagement.

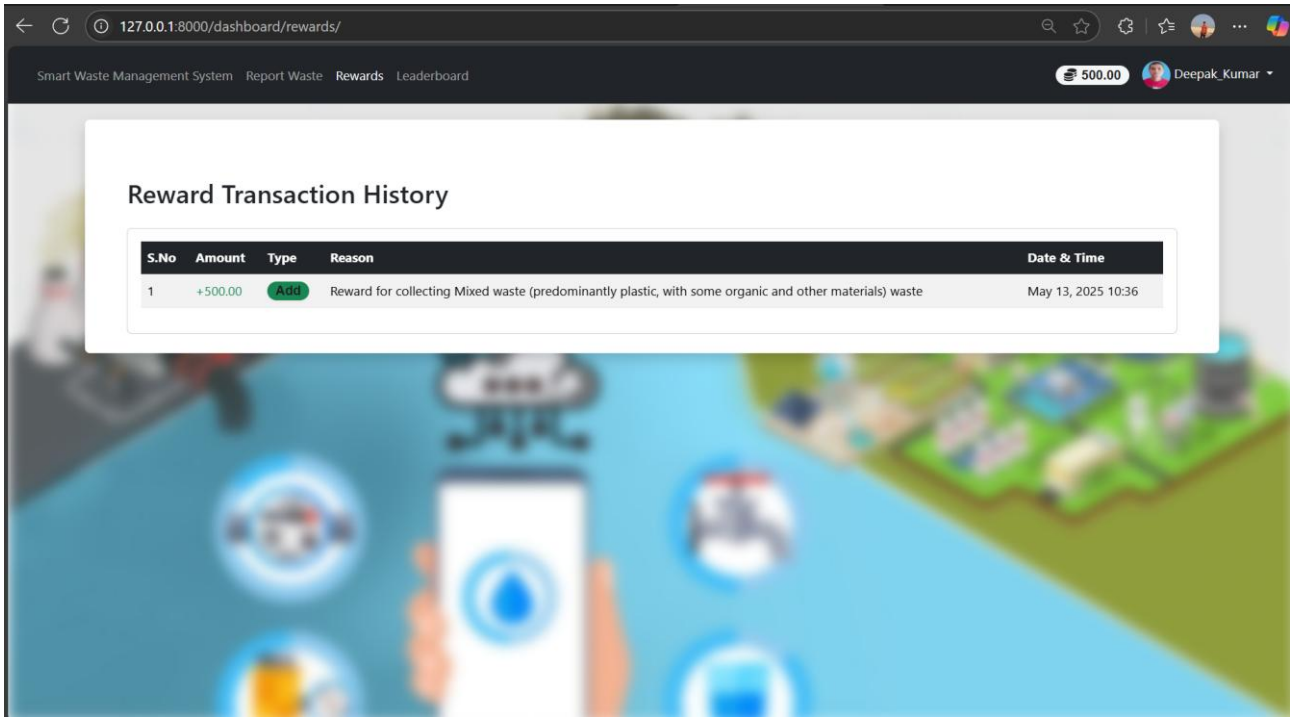


Figure 8.h : Reward Transaction History user

- This page shows a **detailed history of rewards** earned by the user, including the amount, type, reason for reward, and the date/time of the transaction.

CHAPTER - 9

CONCLUSION

9. CONCLUSION

The Smart Waste Management System (SWMS) is a comprehensive and intelligent solution developed to address the pressing challenges of urban waste accumulation, inefficient waste collection, and lack of public awareness about sustainable waste disposal. Traditional waste management techniques often fail to provide timely collection, efficient route planning, and proper segregation, leading to serious health and environmental hazards. This project aims to offer a structured, data-driven, and user-friendly approach by digitizing the process of waste monitoring, collection, and management.

By leveraging modern technologies such as web-based platforms (HTML, CSS, JavaScript), Django (Python-based framework), and PostgreSQL for database management, this system provides a centralized platform that connects waste generators (users), waste collectors, and administrators. The system allows users to report waste status, request pickups, and track the service. Meanwhile, administrators and waste collection personnel can manage routes, monitor requests, and analyze reports to enhance operational efficiency. The modular structure of the application ensures scalability, allowing future integration of more advanced tools such as AI-based waste classification or smart bin integration.

One of the significant achievements of the Smart Waste Management System is the automation of key processes that previously relied heavily on manual intervention. Users can easily interact with the platform to report filled bins or request waste collection, reducing delays and miscommunication. The system also enables route planning based on reported data, ensuring that collection vehicles operate on optimized paths, saving time, fuel, and labor. Additionally, the inclusion of user authentication and profile management fosters a sense of responsibility and traceability in waste handling activities.

CHAPTER – 10

FUTURE ENHANCEMENT

10. FUTURE ENHANCEMENT

1. Integration of AI-based waste classification using image recognition to automatically identify and sort different types of waste.
2. Use of smart bins equipped with IoT sensors to monitor waste levels in real time for more efficient collection.
3. Implementation of route optimization algorithms to minimize fuel consumption and time during waste collection.
4. Addition of a mobile app for users and collectors to track waste pickup schedules and status updates.
5. Real-time notifications for missed pickups, overfilled bins, or improper waste disposal.
6. Introduction of a user reward system based on consistent participation and responsible waste disposal habits.
7. Integration with GIS for dynamic mapping of waste generation hotspots to plan better service coverage.
8. Predictive analytics to forecast waste generation trends for proactive resource allocation.
9. Collaboration with recycling companies to automate the transfer of segregated waste.
10. Support for multi-language interfaces to cater to diverse user groups.
11. Blockchain implementation to ensure transparency and traceability in waste handling and recycling.
12. Automated maintenance alerts for malfunctioning bins and collection vehicles.
13. Expansion to support industrial and hazardous waste management modules.

11. REFERENCES

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11.1 TEXTBOOKS

1. Internet of Things: Architecture and Applications – Rajkumar Buyya
2. Web Development with Django – Nigel George
3. Database System Concepts – Abraham Silberschatz, Henry Korth
4. Artificial Intelligence: A Modern Approach – Stuart Russell, Peter Norvig
5. Learning JavaScript Design Patterns – Addy Osmani

11.2 WEBSITES

1. Django Project – https://www.djangoproject.com (Framework used for web development)
2. Leaflet Maps – https://leafletjs.com (Used for map integration and geolocation)
3. PostgreSQL – https://www.postgresql.org (Database used for backend)
4. W3Schools – https://www.w3schools.com (Frontend and web design references)
5. OpenStreetMap – https://www.openstreetmap.org (Map data for waste pickup and tracking)