A Project Report on

CITY WASTE MANAGEMENT SYSTEM USING VAN TRACKING

Submitted by

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In partial fulfilment of the award of Bachelor of Technology in

Computer Science and Engineering

MIT
Quest for Excellence

Department of Computer Science and Engineering

Marathwada Institute of Technology, Chh Sambhajinagar
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[2023-24]

DECLARATION

I declare that this written submission represents my ideas in my own words and where others ideas or words have been included; I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Place:Chh. Sambhajinagar

Date: 31/05/2024

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CERTIFICATE

This is to certify that, the project entitled **"City Waste Management System Using Van Tracking"**, which has been submitted herewith in the partial fulfillment for the award of the **'Bachelor of Technology'** in **'Computer Science and Engineering'** of Dr. Babasaheb Ambedkar Technological University, Lonere, Raigad (M.S.). This is the result of the original work and contribution by **Zaka Tabish Shaikh, Faisal Ul Haque Mohammed, Mohammed Abedi** and **Shaikh Mohammed** under my supervision and guidance.

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Thank you.

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Faisal Mohammad

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APPROVAL CERTIFICATE

This project report entitled **"City Waste Management System Using Van Tracking"** by **Zaka Tabish, Mohammed Abedi, Faisal Mohammed, Shaikh Mohammed** is approved for B.Tech Final year in Computer Science and Engineering, Marathwada Institute of Technology under Dr. Babasaheb Ambedkar Technological University, Chh. Sambhajinagar (M.S.).

Place: Chh. Sambhajinagar

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ABSTRACT

The "City Waste Management System Using Van Tracking" project introduces an innovative solution to enhance municipal waste management processes. Employing cutting-edge technology, the system incorporates NodeMCU and a Neo 6M GPS module seamlessly integrated into garbage vans. This facilitates real-time tracking and monitoring of waste collection routes, optimizing efficiency in waste disposal.

The system operates in conjunction with a MERN (MongoDB, Express.js, React.js, Node.js) stack web application, accessible to municipal corporations, citizens, and van drivers. The web app serves as a centralized platform for registering and tracking complaints related to waste management. Citizens can easily report concerns, while van drivers can efficiently manage their routes.

One of the distinctive features of our project is the utilization of React Leaflet for mapping within the MERN web app. This ensures a user-friendly interface for visualizing the geographic distribution of complaints and monitoring van locations in real-time. The incorporation of Tailwind CSS enhances the aesthetics and usability of the web application.

Key functionalities of the system include complaint registration, complaint tracking, and realtime monitoring of van locations. Municipal corporations gain valuable insights into the efficiency of waste collection routes, allowing for data-driven decision-making and resource optimization.

This project not only introduces a robust waste management solution but also promotes citizen engagement by providing an accessible platform for communication and collaboration between stakeholders. The use of advanced technologies combined with a user-friendly interface makes the "City Waste Management System Using Van Tracking" a valuable and impactful contribution to modern waste management practices.

Keywords: City Waste Management, Van Tracking, NodeMCU, GPS Module, MERN Stack, React Leaflet, Tailwind CSS, Citizen Engagement.

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1.INTRODUCTION

1. Introduction.

The advent of smart technologies has revolutionized the landscape of urban services, necessitating a paradigm shift in traditional approaches to city management.

As urbanization accelerates, effective waste management becomes a critical concern for municipal authorities.

This research-oriented project, titled "City Waste Management System Using Van Tracking," emerges as a response to the challenges posed by conventional waste disposal methods.

1.1 Background

Rapid urbanization brings about a surge in waste generation, demanding a sophisticated and datadriven approach to waste management. Traditional methods often fall short in ensuring optimal resource utilization, timely complaint resolution, and real-time monitoring of waste collection processes. Our project addresses these gaps by harnessing the power of emerging technologies.

1.2 Problem Statement

The inefficiencies in current waste management systems include a lack of real-time visibility into van locations, delayed complaint resolution, and sub optimal route planning. These challenges contribute to increased operational costs and environmental concerns. This project aims to bridge these gaps by implementing a comprehensive waste management system that integrates advanced technologies for improved efficiency and responsiveness.

1.3 Objectives of the Project

The primary objective of our research-oriented project is to design and implement a City Waste Management System that utilizes NodeMCU and a Neo 6M GPS module to enable real-time tracking of garbage vans. Additionally, we aim to develop a MERN stack web application for seamless communication between municipal corporations, citizens, and van drivers.

1.4 Scope of the Project

The scope of our project extends to the development of a holistic waste management solution that caters to the needs of municipal corporations, citizens, and waste collection personnel. The system will enable citizens to register and track complaints, while municipal authorities can optimize waste collection routes based on real-time data. Van drivers benefit from improved route management and navigation.

1.5 Significance of the Study

This research holds significance as it addresses critical issues in waste management, offering a technologically advanced solution that aligns with the principles of efficiency, sustainability, and citizen engagement. The outcomes of this study have the potential to influence municipal waste management practices, contributing to a cleaner, more sustainable urban environment.

2. LITERATURE SURVEY

2.1 Introduction.

The literature survey reveals a diverse range of innovative approaches and technologies applied to address the challenges of waste management in various geographical and socio-economic contexts. Several studies, such as "Design and Development of Smart Waste Management System" by **Palak Jain**, **Taneesha Chaudhary**, and **Sachin Gajjar**, leverage Ultrasonic sensors, NodeMCU, and GPS modules to create smart garbage bins, providing real-time tracking capabilities in locations like Mumbai, India. Others, like "Smart Garbage Monitoring and Alert System" by **Dolan Karmaker** and colleagues, focus on the eco-efficient approach of recycling primarily produced objects. The integration of IoT technologies is a common theme, as seen in "Smart City Waste Management System using IoT" by **Malathy Sathyamoorthy** and team, which enhances waste disposal through sensor-equipped garbage bins, toxic gas detection, and real-time notifications.

Notably, "Smart Solid Waste Management System Using Blockchain and IoT for Smart Cities" by **Mohinish Paturi** and colleagues introduces a blockchain-based system with enhanced waste segregation and user rewards, ensuring transparency and scalability. Each study contributes unique insights, showcasing the multifaceted applications of technology to optimize waste management practices globally. From improved route optimization to odor sensing and deep learning forecasting, these projects collectively offer a rich tapestry of solutions for more effective, sustainable, and technologically advanced waste management systems.

2.2 Literature Survey:

(Table 1.1)

Topic Name	Authors	Publisher	Year	Conference	INSPEC Accesion Number	Location	Conclusion:
Design and Development of Smart Waste Management System	Palak Jain; Taneesha Chaudhary; Sachin Gajjar	IEEE	2023	31 March 2023 - 01 April 2023	22964040	Mumbai, India	The system consists of smart garbage bins made using Ultrasonic sensors, NodeMCU, and a Global Positioning System (GPS) module.
Sensor-Based Garbage Monitoring System and Application Development in Magallanes Agusan Del Norte	Sensor-Based Garbage Monitoring System and Application Development in Magallanes Agusan Del Norte	IEEE	2022	01-04 December 2022	23039302	Boracay Island, Philippines	The researchers developed a low-cost hardware prototype to track the trash can's location using GPS technology and the total volume of waste generated in the neighborhood.
Smart Monitoring and Collection of Garbage System Using Internet of Things	C. Abhinav; M. Balaram; A. Sanjana	IEEE	2021	04-06 February 2021	2060774	Tirunelveli, India	The proposed system is more effective than the current system as it simplifies the human effort, saves time and is more costeffective.

Smart Garbage Monitoring and Alert System:An Eco-Efficient Approach towards Environmental Sustainability and Recycling	Dolan Karmaker; Mahjabin Muntaha; Md Sifat Ibn Awlad; Sumaiya Iqbal	IEEE	2021	08-10 December 2021	21692131	Brisbane, Australia	The best way to achieve that is by recycling the primarily produced objects.
Improve Smart Waste Management to Preserve Tourist Attractions Yogyakarta in IoT Environment	Rania Rizki Arinta; Dominikus Boli Watomakin; Suyoto Suyoto	IEEE	2020	20-20 February 2020	19573888	Surabaya, Indonesia	To make it easier to sort out and sensitize the community to be more disciplined, we renew the garbage bin using IoT Environment.
Smart Solid Waste Management System Using Blockchain and IoT for Smart Cities	Mohinish Paturi; Sampath Puvvada; Badhari Sai Ponnuru; Mounika	IEEE	2021	December 2021	21721073	Jaipur, India	This article presents a blockchain-based IoT smart waste management system that enhances waste segregation, provides user rewards, and exhibits superior performance on Matic test network, ensuring transparency, traceability, and scalability.
Smart City Waste Management System using IOT	Malathy Sathyamoorthy; C N Vanitha; S Praveen Raja; Ajeet Kumar	IEEE	2023	03-04 March 2023	23115404	Mathura, India	The "Smart City Waste Management System using IoT" enhances waste disposal by deploying sensors in garbage bins to monitor trash levels, detect toxic gases, and send notifications for prompt cleanup, offering users hygiene and convenience benefits.

Trucks: An IoT-based Novel Approach for Smart and Effective Waste Management System	Singh; Anurag Bajpai		2	23 December 2022	3	India	IoT-based waste management system, promoting waste segregation, recycling, and efficient collection through smart trucks, with potential to enhance city cleanliness, disease prevention, and environmental preservation.
nnovative Waste Management Solutions For Smart Cities Using IoT & NodeMCU	Suresh V Kumar; Sree Rethanya K; Shameer Hussain S; Siva Sankar S; Sriram	IEEE	2023	19-21 April 2023	2320228 7	Chennai, India	This paper introduces a WiFi-connected smart garbage bin system with real-time status monitoring, route optimization, and userfriendly features, aimed at enhancing efficiency and cleanliness in waste collection, with potential future integration of AI algorithms for optimization.
A Smell Sensor based Improved Waste Management System for Green and Smart Cities	Hadiba Saud; Sameena Naaz; Anam Saiyeda	IEEE	2022	10-12 November 2022	2244589 3	Dharan, Nepal	This paper presents an IoTenabled smart waste management system for smart cities, utilizing sensors to monitor trash bins, with a goal to enhance efficiency and cleanliness.
Smart Solid Waste management system using blockchain and IoT	Sampath Puvvada,Mohinish Paturi	IEEE	2021 IEEE Ises	18-22 December 2021	2172107 3	Jaipur,India	Proposed solution ensures system transparency, traceability, and scalability, as well as eliminating single points of failure (SPoF)

Solid waste management system for urban Sri Lanka using Iot and ML	Tharuni Baddegama, Hashini Ariya	IEEE	2022 ICACC	09-10 December 2022	22571518	Colombo ,Sri Lanka	a web application has been designed and developed with all the necessary features. The project's end goal is to manage disposal methodically before the problem becomes worse and to appraise trash collectors for their service
Design and Development of Smart Waste	Palak Jain ,Tanees ha Chaudhary	IEEE	2023 CSCITA	31 March -1 April	22964040	Mumbai, India	A mobile application is created using the Massachusetts Institute of Technology app inventor
management				2023			where the authorities can see the status of the dustbin and an optimized shortest route to be followed by the garbage collector truck for garbage collection and disposal.
GIS basedWaste to energy and improved Solid Waste Management System	Abdul Zafar,Iftikhar Ahmad	IEEE	2021 ICREGA	02-04 February 2021	20607651	Al Ain,Uae	the purpose of the study is to propose a solution for the issues, i.e., to improve the municipal solid waste disposal system by digitizing through GIS, to recommend an appropriate point of WTE plant, to suggest a suitable rerouting network through state-ofart sensors for accessible data collection online
A new smart waste management system	Hassan Jabar,Rosilah Hassan	IEEE	2020 CSASE	16-18 April 2020	19807595	Duhok,Iraq	The proposed solution provides a web-based system and a mobile application to manage the organization of these wastes and facilitate the garbage collection by the drivers. The proposed solution provides an 80% faster convergence system in comparison with traditional garbage collecting method.

2.3 Literature Survey summary

In conclusion, the literature survey provides a comprehensive overview of the innovative and diverse approaches undertaken globally to address the challenges in waste management. The studies discussed showcase a common thread of utilizing advanced technologies such as IoT, GPS, and blockchain to enhance the efficiency, sustainability, and responsiveness of waste management systems. From smart garbage bins in Mumbai to low-cost hardware prototypes in the Philippines and real-time monitoring systems in Tirunelveli, the studies underscore the global nature of the issue and the need for context-specific solutions.

The integration of blockchain in waste management, as demonstrated in projects from Jaipur and Brisbane, introduces novel concepts such as user rewards and system transparency, contributing to the ongoing discourse on sustainable waste management practices. Collectively, these research initiatives offer a rich source of inspiration for the development and implementation of technologically advanced, environmentally conscious waste management systems in diverse settings worldwide.

3. SYSTEM DESIGN

3.1 System Design Details:

The City Waste Management System using Van Tracking is a comprehensive solution designed to enhance the efficiency of waste collection processes. The system utilizes advanced technologies, including NodeMCU with Neo 6m GPS modules installed in garbage vans, along with a MERN (MongoDB, Express.js, React.js, Node.js) stack web application accessible to municipal corporations, citizens, and van drivers.

A)Components:

a. NodeMCU with Neo 6m GPS Module:

- The core hardware component fitted within garbage vans.
- Enables real-time tracking of van locations using GPS technology.
- Sends location data to the central server for effective monitoring.

b. MERN Stack Web Application:

- **MongoDB:** Database for storing van locations, user data, and complaint records.
- **Express.js:** Facilitates seamless communication between the front-end and back-end components.
- **React.js:** User-friendly interface for municipal corporations, citizens, and van drivers to access and interact with the system.
- **Node.js:** Server-side scripting for managing requests and responses.

B)Functionalities:

- **Municipal Corporation Portal:**

  Allows municipal corporations to register vans, view real-time van locations, and manage waste collection routes.

  Provides a platform to address and resolve citizen complaints related to waste management.

- **Citizen Portal**:

  Enables citizens to register complaints regarding waste collection issues.

  Allows citizens to track the status and location of registered complaints in real-time.

- **Van Driver Portal:**

  Allows van drivers to view assigned routes and real-time locations.

  Facilitates communication with municipal corporations for route optimization and issue

C) Workflow:

- **Data Collection:**

  Van GPS modules collect real-time location data.

  Complaints and registration information are stored in the MongoDB database.

- **Server-side Processing:**

  Node.js server processes requests and communicates with the MongoDB database.

- **User Interaction:**

  React.js provides a dynamic and interactive interface for municipal corporations, citizens, and van drivers.

- **Mapping and Visualization:**

  React Leaflet integrates mapping features, allowing users to visualize van locations, routes, and complaint data.

- **Responsive Design:**

  Tailwind CSS ensures a visually appealing and responsive design for a seamless user experience.

  The City Waste Management System offers a holistic approach, enhancing communication and transparency among municipal corporations, citizens, and van drivers for effective waste management.

Algorithm for City Waste Management System using Van Tracking

1.Initialization:

- Start the system by initializing the NodeMCU with the Neo 6m GPS module installed in the garbage van.
- Initialize the MERN stack (MongoDB, Express.js, React, Node.js) web application for municipal corporation, citizens, and van drivers.

2. Data Collection:

- NodeMCU collects real-time GPS data from the Neo 6m GPS module in the garbage van.
- Send GPS data to the server through the Express.js API.

3. Database Management:

- Store GPS data in the MongoDB database for historical tracking and analysis.
- Maintain separate collections for van routes, citizen complaints, and municipal corporation information.

4. Van Tracking:

- Van driver can log in to the system using the web app.
- Display real-time location of the garbage van on the map using React Leaflet.
- Periodically update the van's location using WebSocket communication.

5. **Citizen Interaction:**

- Citizens can register and log in to the web app.
- Report waste-related issues or complaints with location details.
- Display reported complaints on the map for municipal corporation and citizens.

6. **Municipal Corporation Access:**

- Municipal corporation officials can log in to the system through the web app.
- View real-time location of garbage vans on the map.
- Access a dashboard displaying statistical information about waste collection efficiency.

7. **Complaint Handling:**

- Van drivers can view and acknowledge citizen complaints assigned to their route.
- Update the status of each complaint (e.g., resolved, in progress) in real-time. • Municipal corporation officials can assign and monitor complaint resolution progress.

8. **Map Visualization:**

- Use React Leaflet to render an interactive map in the web app.
- Customize map markers to differentiate between garbage van locations and citizenreported complaints.
- Implement zoom and pan functionalities for better map navigation.

9. **User Interface Styling:**

- Utilize Tailwind CSS for consistent and responsive styling across the MERN stack web app.
- Design a user-friendly interface for citizens, van drivers, and municipal corporation officials.

10. **Error Handling and Logging:**

- Implement error handling mechanisms at every stage of data processing.
- Log errors and exceptions for debugging and system improvement.

11. **Security Measures:**

- Implement user authentication and authorization for secure access.
- Encrypt sensitive information during data transmission.

Summary of Section:

The City Waste Management System using Van Tracking is designed to optimize waste collection processes within urban areas. The system employs a robust architecture, combining hardware and software components to streamline operations. A NodeMCU, integrated with a Neo 6m GPS module, is strategically placed within each garbage van, providing real-time location tracking. This hardware solution ensures accurate and efficient monitoring of van movements, allowing for effective waste management.

On the software front, the system features a MERN stack web application accessible to municipal corporations, citizens, and van drivers. This comprehensive platform serves as a centralized hub for registering and tracking complaints related to waste management. Municipal authorities can seamlessly manage and monitor these complaints through the web app. The inclusion of React Leaflet for mapping enhances the user experience, offering an intuitive visual representation of complaint locations.

The MERN web app integrates seamlessly with the hardware, allowing van drivers to update their current location, facilitating a synchronized and optimized waste collection process. Citizens can register complaints through the user-friendly interface, while also monitoring the status and location of their registered complaints in real-time.

System Development:

The City Waste Management System using Van Tracking is a forward-thinking project that integrates NodeMCU and the Neo 6m GPS module within garbage vans, enabling real-time tracking for optimized waste collection routes. Our MERN stack web app, adorned with React Leaflet maps and styled with Tailwind CSS, serves as a unified platform for municipal corporations, citizens, and van drivers. Citizens can seamlessly register and monitor complaints, visualizing their locations on an interactive map, while municipal corporations gain valuable insights for strategic planning.

3.1 Architectural Diagram

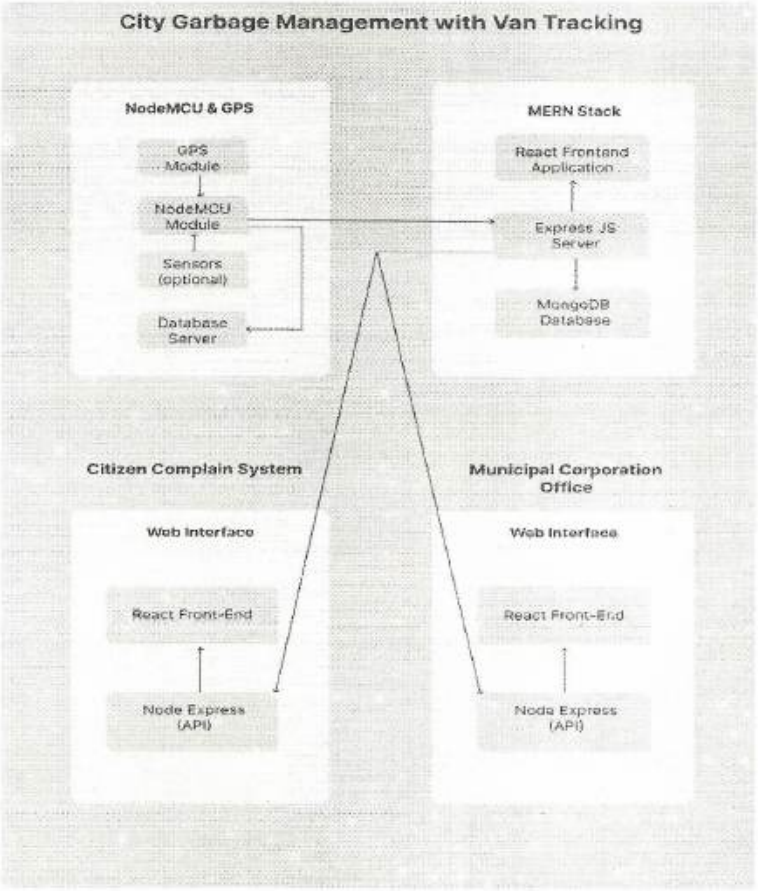


Fig: 3.1 System Architecture Diagram.

NodeMCU with GPS: These devices are deployed in waste collection vehicles or bins to track their real-time location using GPS technology. NodeMCU, equipped with GPS modules, communicates location data to the central system.

MERN Stack: The MERN (MongoDB, Express.js, React.js, Node.js) stack is used for developing the web application. MongoDB serves as the database to store various data such as user information, complaint details, waste collection schedules, etc. Express.js is employed as the backend framework to handle server-side logic and API requests. React.js is utilized for building the frontend user interface, providing a responsive and interactive experience. Node.js serves as the runtime environment for executing server-side JavaScript code.

Citizen Complaint System: This component allows citizens to register complaints related to waste management issues. It includes a user-friendly interface for submitting complaints, tracking their status, and providing feedback.

3.2 Data Flow Diagram:

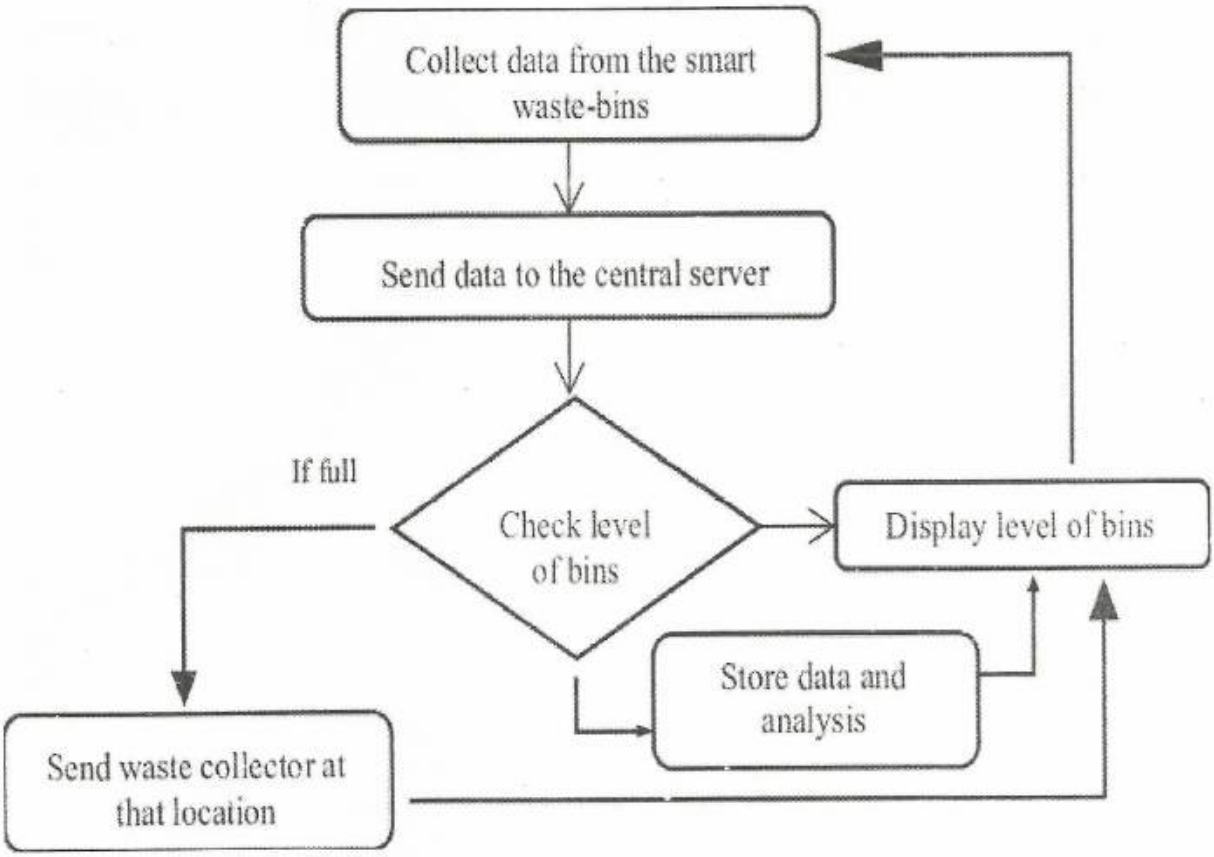


Fig:3.2: DFD

The data flow in the "City Waste Management System Using Van Tracking" project is orchestrated seamlessly, commencing with the continuous transmission of GPS data from garbage vans equipped with NodeMCU and Neo 6m GPS modules.

This data is directed to the central server, built on Node.js and Express.js, where it undergoes processing before updating the MongoDB database with real-time van locations and pertinent details. Subsequently, the MERN stack web application, developed with React.js and Leaflet, interacts with the MongoDB database.

3.3 Use Case Diagram:

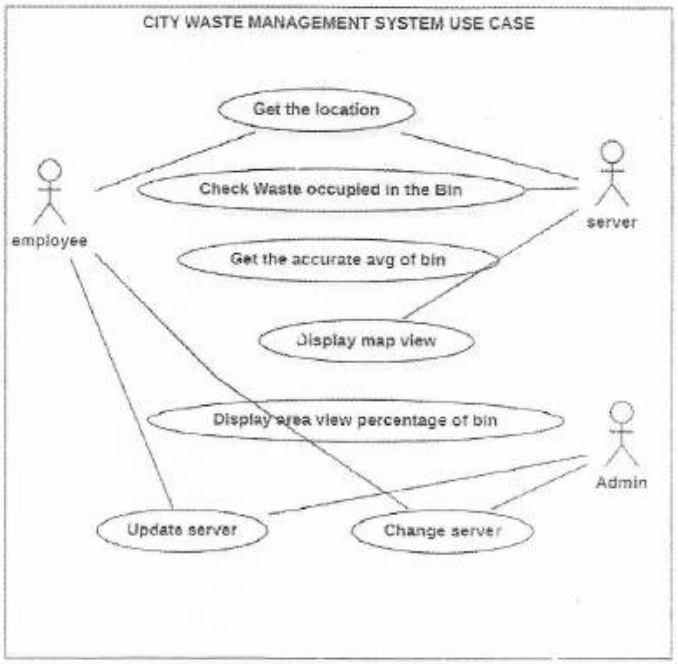


Fig 3.3: Use Case Diagram

A use case diagram for a city waste management system using van tracking could summarize the main functionalities and interactions within the system. Here's a brief summary:

[A] Actors:

- Waste Management Staff: Individuals responsible for managing waste collection operations.
- Van Tracking System: Technology that tracks the location and status of waste collection vans.
- City Residents: Individuals who generate waste and interact with the waste management system indirectly.

[B] Use Cases:

- Track Van: Waste management staff can track the location of collection vans in real-time using the van tracking system.
- Update Van Status: The van tracking system updates the status of vans (e.g., idle, en route, collecting) as they progress through their assigned routes.

3.4: Sequence Diagram of user interaction:

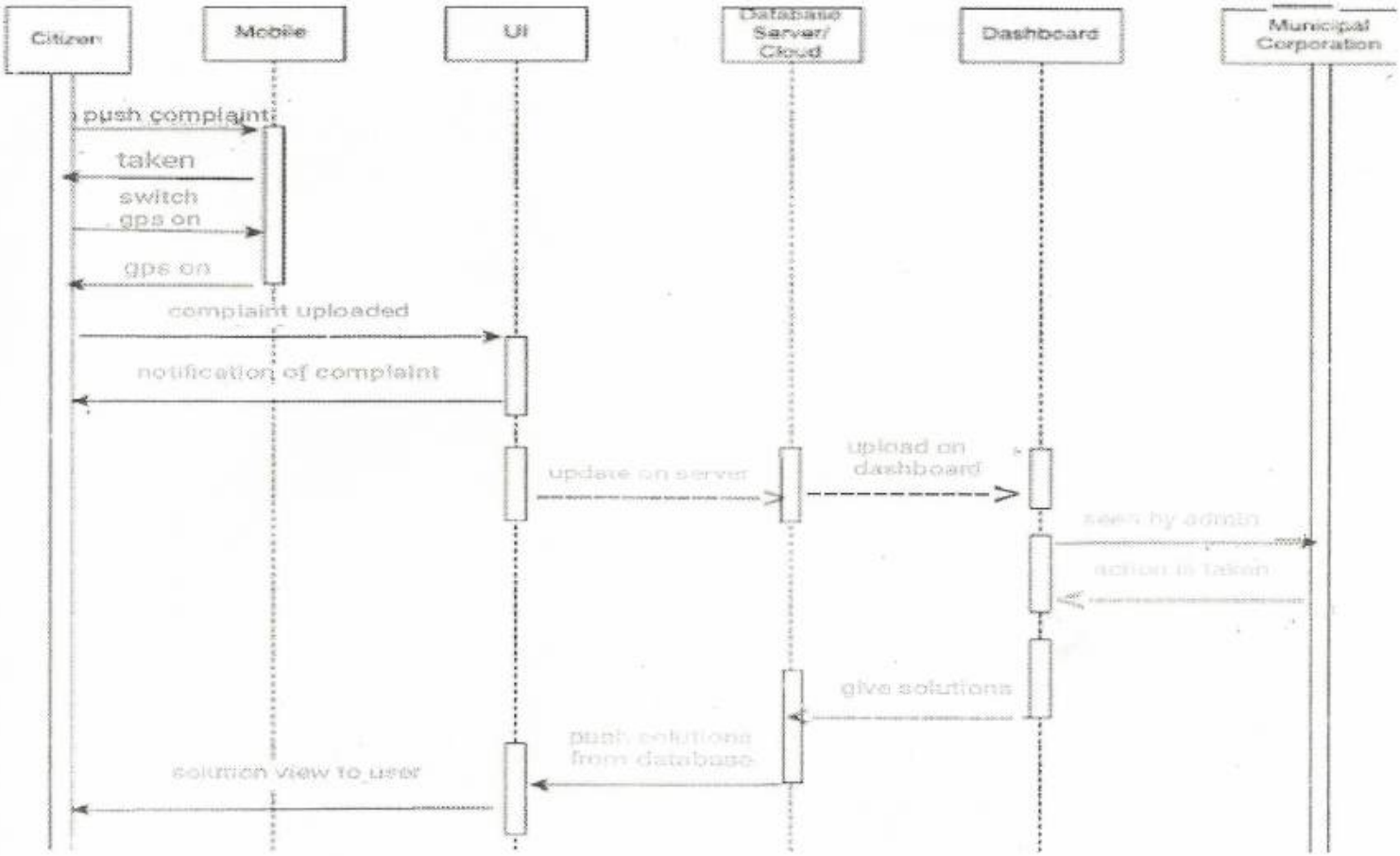


Fig 3.4: Sequence Diagram

In a sequence diagram for a city waste management system, you'd illustrate the interactions between different components or actors in a chronological sequence.

Initiation: The process begins with the initiation of waste collection activities, triggered by scheduling algorithms or manual input from staff and citizens.

Van Dispatch: Waste management staff dispatch collection vans to designated routes based on scheduling and optimization criteria.

Van Tracking: Vans communicate their location and status updates to the tracking system periodically as they move through their assigned routes. It is done by the municipal coroperation.

3.5 Deployment Diagram:

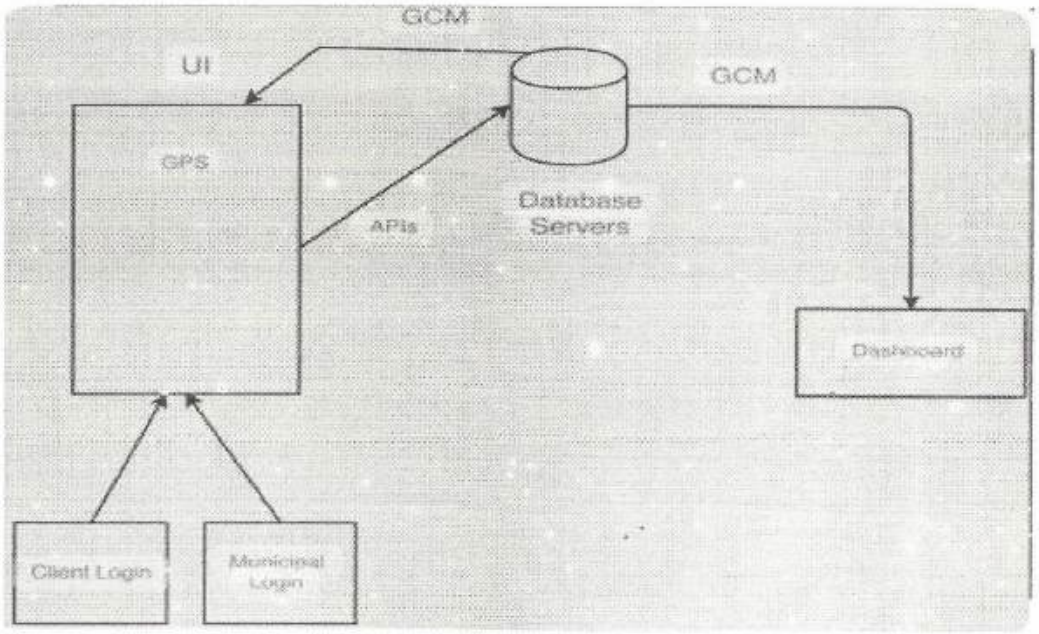


Fig 3.5: Deployment Diagram

A deployment diagram for a city waste management system illustrates how various components of the system are distributed across different servers or nodes.

- GPS UI Client: This component represents the user interface accessible by waste management personnel or citizens. It provides functionalities related to location tracking and user interaction.
- Municipal Login: This is the authentication and access point for municipal employees or administrators. It allows them to access privileged features and data within the system.
- Dashboard: The dashboard component aggregates and displays essential information and statistics regarding waste management operations. It provides a comprehensive overview for decision-making and monitoring purposes.
- GCM (Google Cloud Messaging) Server: This server facilitates communication between the system and mobile devices, such as push notifications for updates or alerts related to waste management activities.
- Database Server: The database server stores all relevant data pertaining to waste management, including user information, waste collection schedules, GPS coordinates, and historical records.
- It serves as the central repository for the system's data management needs.

3.6 ER Diagram

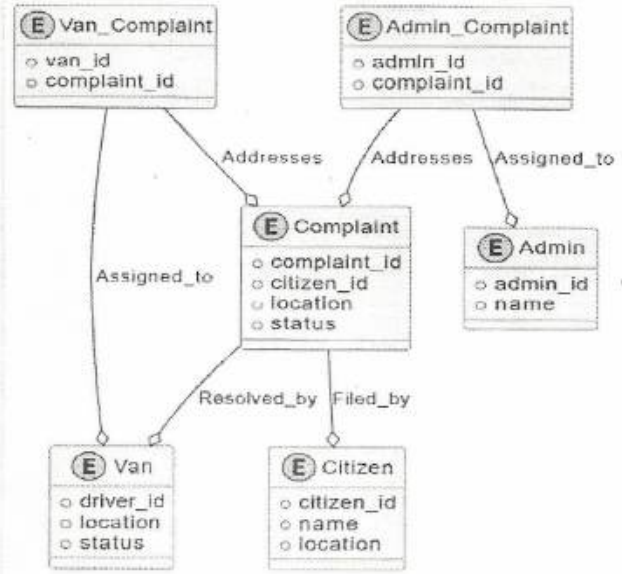


Fig 3.6: ER Diagram

[A] Entities:

- Admin: Represents administrative personnel responsible for system management.
- Driver: Represents the personnel responsible for waste collection activities.
- User Complaints: Represents the complaints raised by users regarding waste management issues.

[B] Attributes:

- Admin: ID, email, password
- Garbage: ID, location, Bin, Best route, Cleaning cycle, mobile no, Address.
- Driver: Bin ID, Area, Status Update.
- User Complaints: ID, description, status,complaint,Name,Mobile.

[C] Relationships:

Admin manages Garbage and Drivers. Drivers are associated with Garbage bins for waste collection. Users can submit complaints related to Garbage bins, which are managed by Admins and Driver

4. IMPLEMENTATION

4.1: Implementation Details

1] Van Tracking Hardware: Install GPS tracking devices in waste collection vans. These devices could be based on GPS modules integrated with microcontrollers like Arduino or ESP32/NodeMCU. These devices will continuously transmit the van's location data to the central server.

2] Central Server Setup Database: Set up a database (e.g., MongoDB, PostgreSQL) to store van location data, user information, garbage bin locations, and other relevant data.

Backend: Develop a backend server using Node.js, Python (with frameworks like Flask or Django), or any other suitable technology. The backend will receive and process location data from vans, manage user requests, handle authentication, and interact with the database.

APIs: Implement RESTful APIs to facilitate communication between the frontend and backend components.

3] Frontend Development: Web Application: Develop a web-based dashboard using technologies like React.js, Angular, or Vue.js. The dashboard will display real-time van locations, garbage collection schedules, statistics, and allow administrative actions.

4] Van Tracking Algorithm: Implement algorithms to optimize van routes for efficient garbage collection. This may involve using techniques like the traveling salesman problem (TSP) or vehicle routing algorithms.

Integrate real-time van tracking data with the route optimization algorithm to dynamically adjust routes based on factors like traffic conditions and bin fill levels.

5] User Interaction: Allow citizens to report garbage-related issues through a web or mobile interface. Develop features for users to submit complaints, view collection schedules, and receive updates on the status of their complaints.

4.2: Code Details:

```
You, 3 days ago | 1 author (You)
import React, { useState } from "react";
import {
  MapContainer,
  TileLayer,
  Marker,
  Popup,
  useMapEvents,
} from "react-leaflet";
import "./MyMap.css"; // Import your CSS file

export default function MyMap({ setCordinates }) {
  const [markerPosition, setMarkerPosition] = useState(null);

  const handleMapClick = (event) => {
    const { lat, lng } = event.latlng;
    setMarkerPosition([lat, lng]);
    setCordinates([lat, lng]);
    console.log(`Marker dropped at: Lat ${lat}, Lng ${lng}`);
  };

  return (
    <MapContainer
      center={[19.87393439059482, 75.34561157226564]}
      zoom={12}
      className="map-container"
      style={{ height: "400px" }}
    >
      <TileLayer
        url="https://{s}.tile.openstreetmap.org/{z}/{x}/{y}.png"
        attribution='&copy; <a href="https://www.openstreetmap.org/copyright">OpenStreetMap</a> contributors'
      />

      {/* User-dropped Marker with Popup */}
      {markerPosition && (
        <Marker
          position={markerPosition}
          draggable={true}
          eventHandlers={{ dragend: handleMapClick }}
        >
          <Popup>A marker dropped by the user.</Popup>
        </Marker>
      )}

      {/* Event listener for map click */}
      <MapClickHandler onMapClick={handleMapClick} />
    </MapContainer>
  );
}

function MapClickHandler({ onMapClick }) {
```

Using react leaflet an open source solution to render maps.

```
function ComplainsComp() {
  let [options, changeOption] = useState(0);
  let HandleChange = (val) => {
    changeOption(val);
  };
  function FileComplain() {
    const [selectedLocation, setSelectedLocation] = useState([0, 0]);
    useEffect(() => {
      console.log(selectedLocation);
    });
    let phone = JSON.parse(sessionStorage.user).phone;
    const handleSubmit = async (e) => {
      e.preventDefault();
      console.log("submitted", {
        name: e.target.name.value,
        location: selectedLocation,
        complaint: e.target.complaint.value,
      });

      // Logic to send the complaint data to your server
      try {
        const response = await axios.post('http://localhost:3001/complaints', {
          name: e.target.name.value,
          location: selectedLocation,
          complaint: e.target.complaint.value,
        });
        e.target.reset();
        console.log('Complaint submitted successfully:', response.data);
    } catch (error) {
        console.error('Error submitting complaint:', error);
    }


    };
```

Using axios a modern solution for handling XML HTTP requests.

```
function App() {
  // State to track user session
  const [user, setUser] = useState(null);

  useEffect(() => {
    // Check if the user is in the session
    const storedUser = JSON.parse(sessionStorage.getItem("user"));
    // Update the user state
    setUser(storedUser);
  }, []);
  console.log(JSON.parse(sessionStorage.getItem("user")));
  return (
    <>
      <Router>
        <Routes>
          {/* Redirect to WelcomePage if no user in session */}
          <Route
            path="/"
            element={
              user ? (
                // Render the appropriate dashboard based on user role
                user.title === "admin" ? (
                  <Navigate to="/admin-dashboard" />
                ) : user.title === "citizen" ? (
                  <Navigate to="/citizen-dashboard" />
                ) : user.title === "van" ? (
                  <Navigate to="/van-dashboard" />
                ) : (
                  // Default redirect if user has a session but no recognized role
                  <Navigate to="/welcome" />
                )
              ) : (
                // Redirect to WelcomePage if no user in session
                <Navigate to="/welcome" />
              )
            }
          />

          <Route path="/citizen-dashboard" element={<CitizenDashBoard />} />
          <Route path="/van-dashboard" element={<VanDashBoard />} />
          <Route path="/admin-dashboard" element={<AdminDashBoard />} />
          <Route path="/welcome" element={<WelcomePage />} />
        </Routes>
      </Router>
    </>
  );
}
```

Using react-router-dom for managing routes in the single page application

```
// Connect to MongoDB
mongoose.connect('mongodb://localhost:27017/projectdb', { useNewUrlParser: true, useUnifiedTopology: true });

// Create a user schema
const userSchema = new mongoose.Schema({
  phone: { type: String, unique: true, required: true },
  password: { type: String, required: true },
  title: { type: String, required: true }, // Add title field to user schema
});

// Create a user model
const User = mongoose.model('User', userSchema);

// Middleware to parse JSON
app.use(bodyParser.json());

// Register endpoint
app.post('/register', async (req, res) => {
  try {
    const { phone, password, repeatPassword, title } = req.body;

    // Check if passwords match
    if (password !== repeatPassword) {
      return res.status(400).json({ error: 'Passwords do not match' });
    }

    // Hash the password
    const hashedPassword = await bcrypt.hash(password, 10);

    // Create a new user
    const newUser = new User({ phone, password: hashedPassword, title });

    // Save the user to the database
    await newUser.save();

   res.json({ message: 'Register successful', title: title, phone:phone });
  } catch (error) {
    res.status(500).json({ error: 'Internal Server Error' });
  }
});
```

Managing mongodb using mongoose and XHR using Axios

```
const express = require('express');
const mongoose = require('mongoose');
const bodyParser = require('body-parser');
const bcrypt = require('bcrypt');
const app = express();
const PORT = process.env.PORT || 3001;
const cors = require('cors');

const http = require('http');
const socketIo = require('socket.io');
app.use(cors());
const server = http.createServer(app);
const io = socketIo(server, {
  cors: {
      origin: "http://localhost:5173",
      methods: ["GET", "POST"]
  }
});
```

Using 'cors' to solve cross origin resource sharing problem also making it full proof of cross site resource forgery and other security vulnerabilities

Select Board

sketch_may17a.ino

```
#include <SoftwareSerial.h>
#include <TinyGPS++.h>
#include <ESP8266WiFi.h>
#include <WebSocketsClient.h>

// Replace with your network credentials
const char* ssid = "wifi";
const char* password = "password";

// Replace with your server details
const char* serverHost = "192.168.0.104"; // e.g., "192.168.0.10"
const uint16_t serverPort = 3001;

TinyGPSPlus gps;
SoftwareSerial ss(4, 5); // RX, TX
WebSocketsClient webSocket;

void setup() {
  Serial.begin(9600);
  ss.begin(9600);

  WiFi.begin(ssid, password);
  while (WiFi.status() != WL_CONNECTED) {
    delay(1000);
    Serial.println("Connecting to WiFi...");
  }
  Serial.println("Connected to WiFi");

  webSocket.begin(serverHost, serverPort, "/");
  webSocket.onEvent(webSocketEvent);
}

void loop() {
  webSocket.loop();

  while (ss.available() > 0) {
    if (gps.encode(ss.read())) {
      if (gps.location.isUpdated()) {
        String locationData = String(gps.location.lat(), 6) + "," + String(gps.location.lng(), 6);
        webSocket.sendTXT(locationData);
        Serial.println("Sent: " + locationData);
        Serial.println("Latitude: " + String(gps.location.lat(), 6));
        Serial.println("Longitude: " + String(gps.location.lng(), 6));
      }
    }
  }
}

void webSocketEvent(WStype_t type, uint8_t * payload, size_t length) {
  switch (type) {
    case WStype_DISCONNECTED:
      Serial.println("WebSocket Disconnected!");
      break;
    case WStype_CONNECTED:
      Serial.println("WebSocket Connected to server");
      break;
    case WStype_TEXT:
      Serial.printf("WebSocket Received: %s\n", payload);
      break;
  }
}
```

Implementing WebSocket connection between nodeMCU + neo 6M gps module and express server using WebSocketClient.h library in Arduino and broadcasting it from express server using socket.io-server library. Also using TinyGPS++ in Arduino to connect gps module.

4.3: Front End:

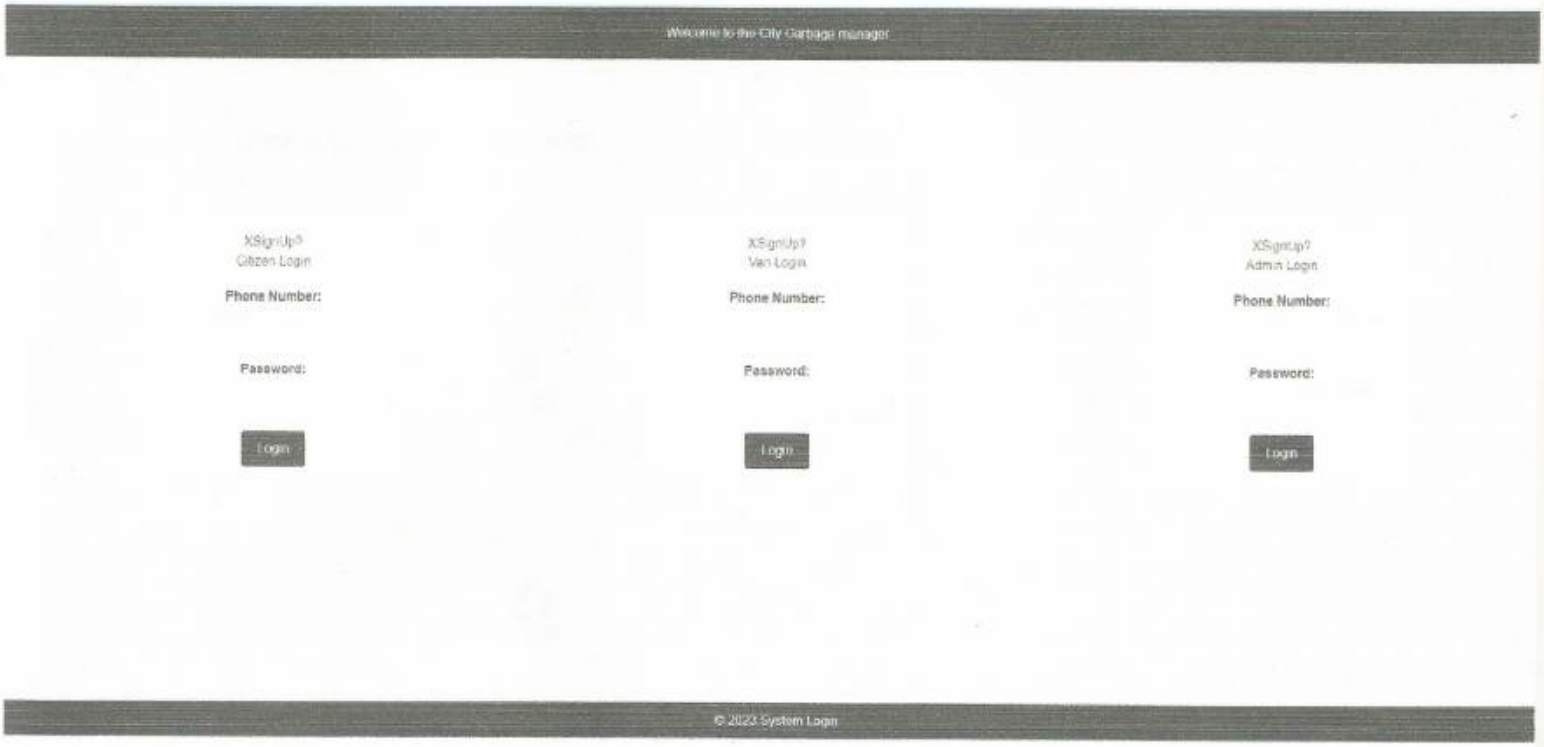


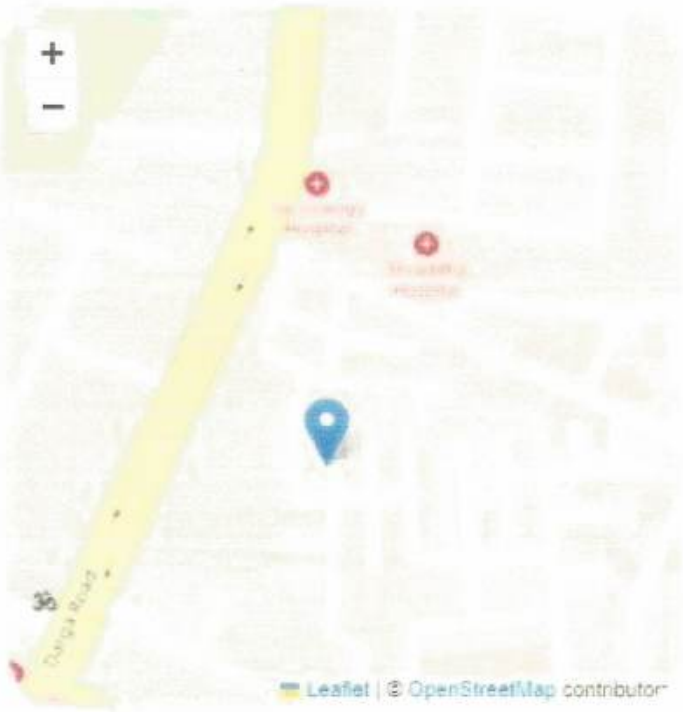
Fig 4.3.1: Login Page

Fig:4.3.2: Citizen Dashboard Profile Page

Your Phone:

1231231235

Pick a location on the map :



GPS co-ordinates: 19.86988165003945,75.3522807379856

Complaint Details:

Garbage problem in this location. Please solve it.

Submit Complaint

Fig 4.3.3: History Page

Fig: 4.3.4: Citizen Complaint History

Fig 4.3.5: Garbage Van location with Vehicle number

Fig 4.3.6 : Van Dashboard

Fig 4.3.7 Admin Dashboard

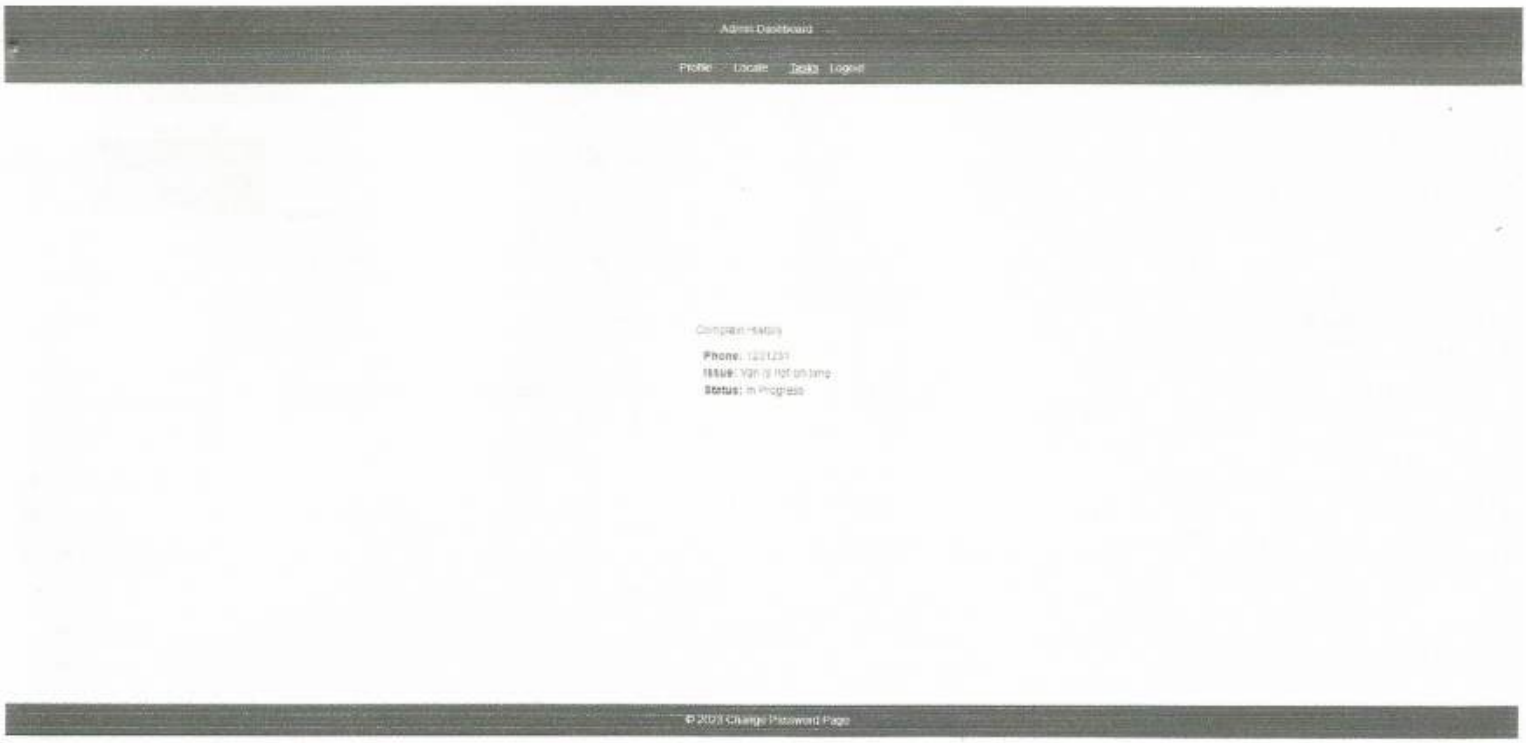


Fig 4.3.8 Admin Complaint History

4.4: Backend Details:

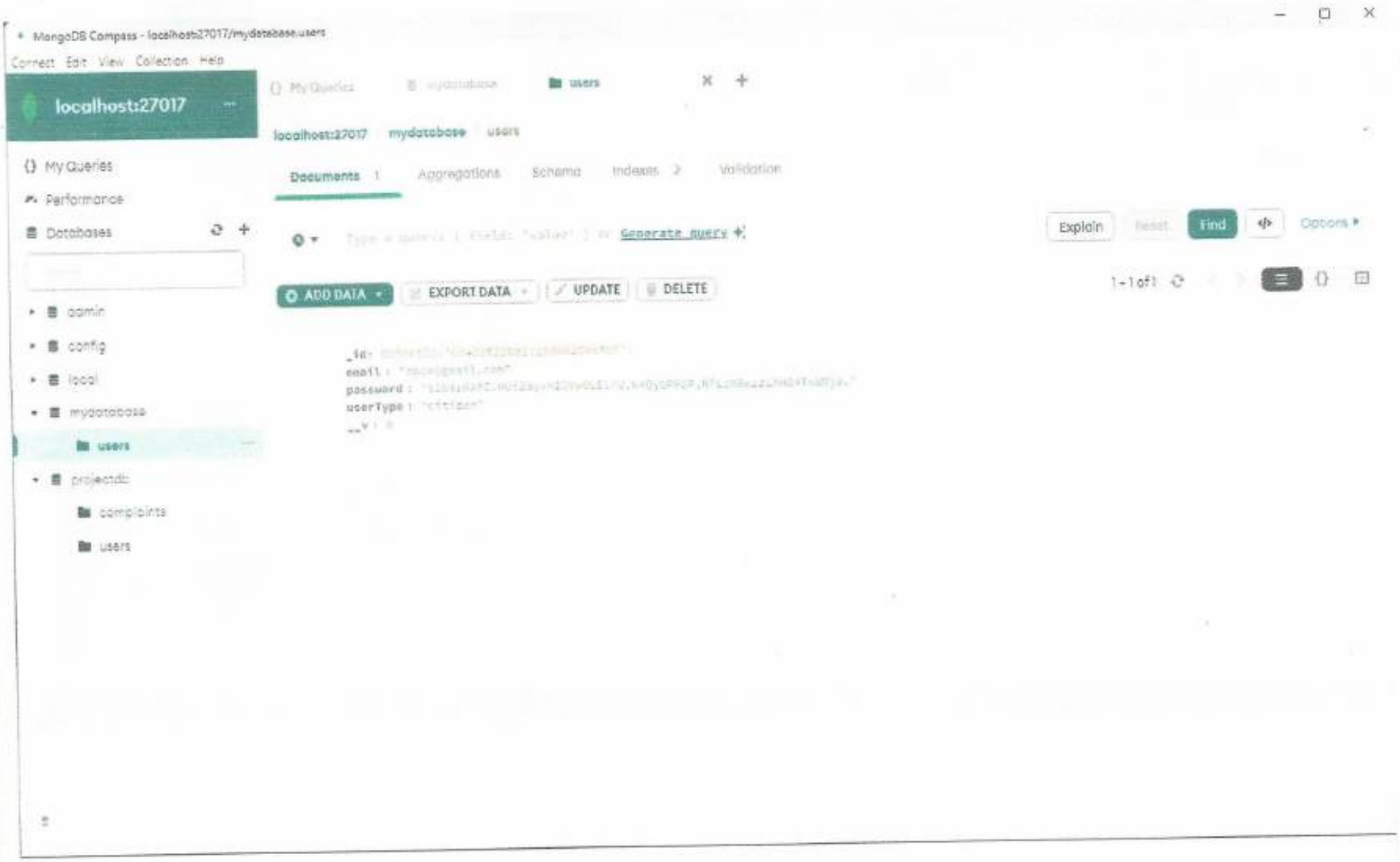


Fig 4.4.1: MongoDB stored data and encrypted password

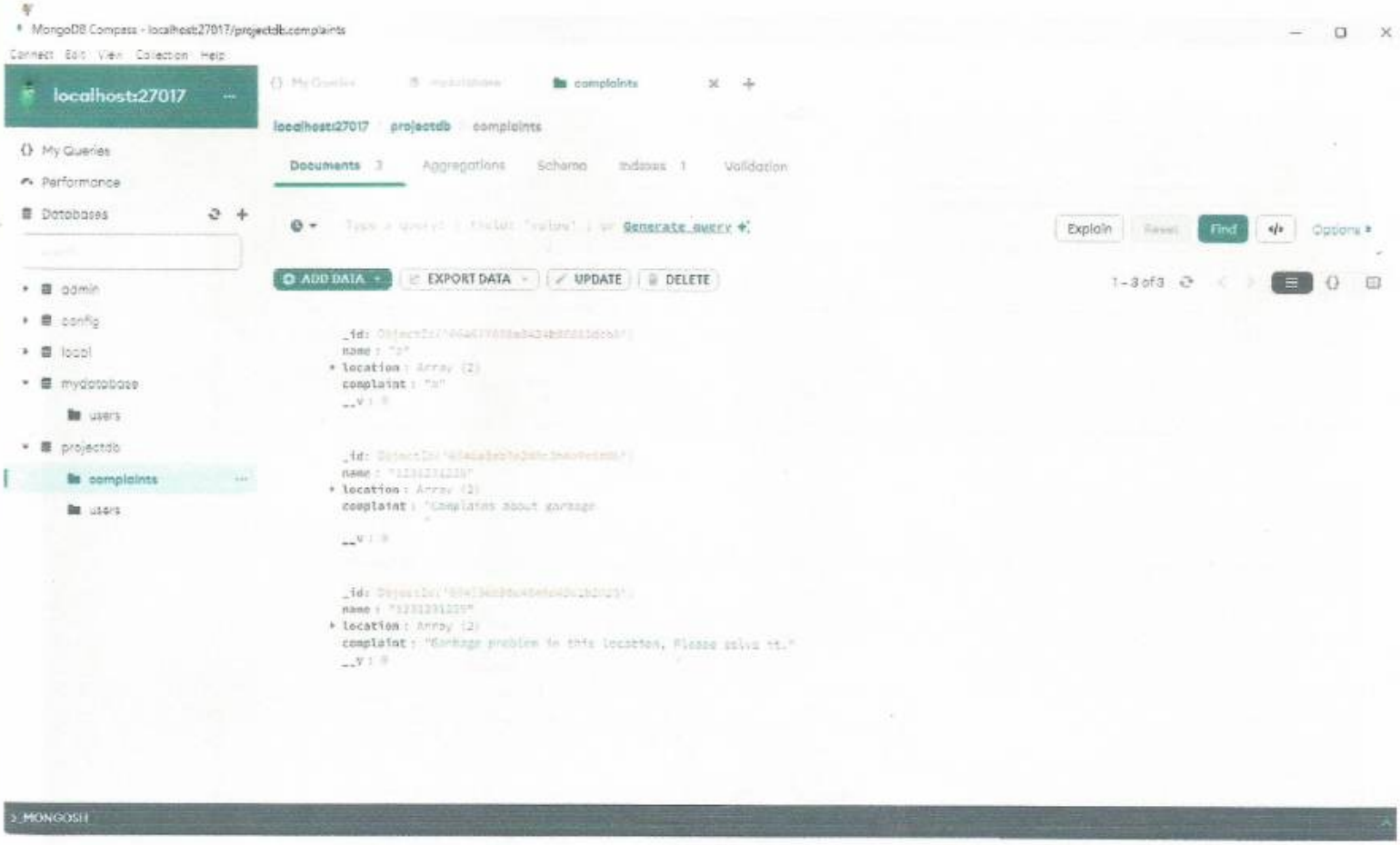


Fig: 4.4.2: All complaints are registered and can only be revoked by user.

4.5 Hardware Details:

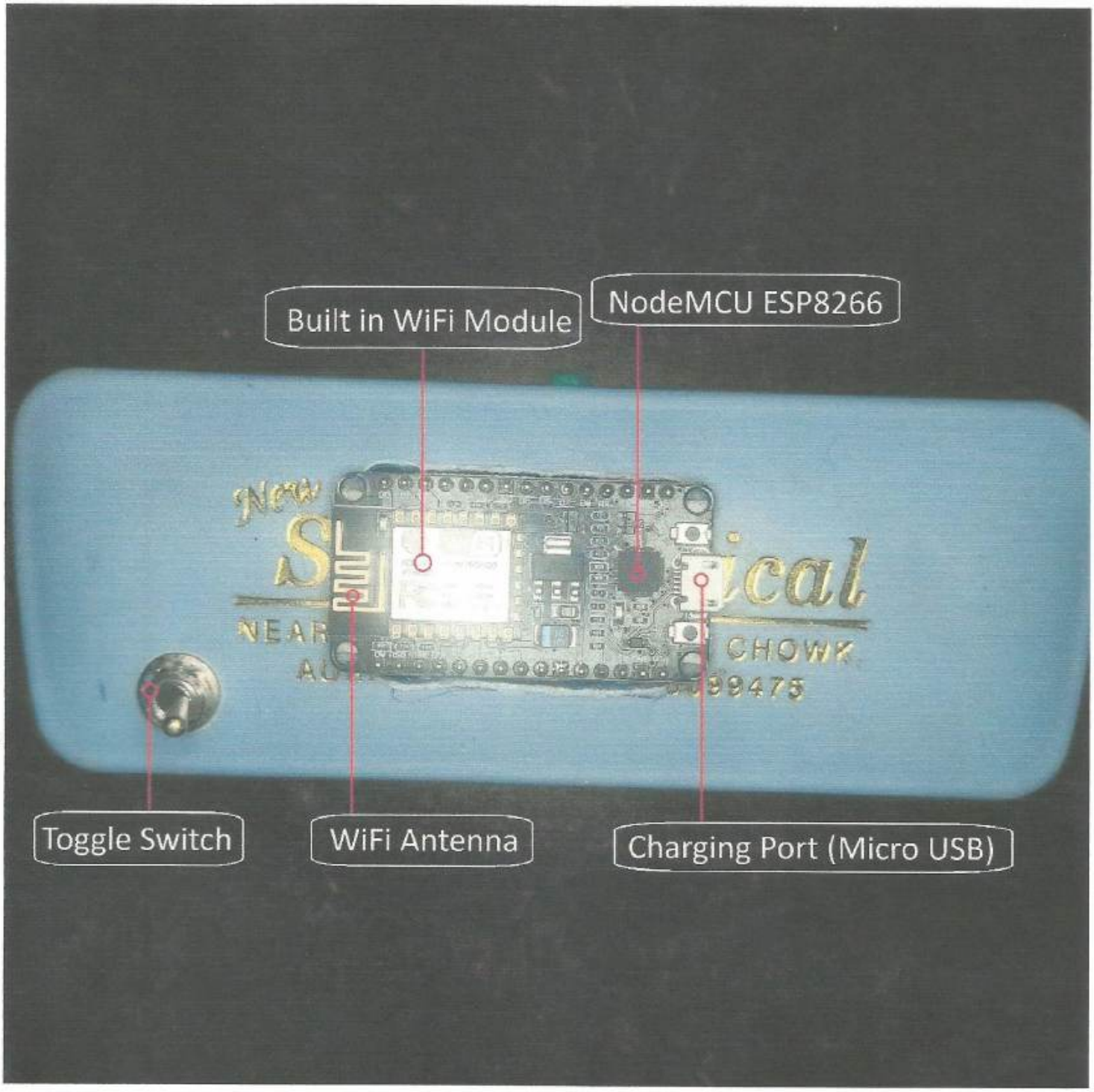


Fig:4.5.1: Outside View(Built in WiFi Module, NodeMCU ESP8266 ,Toggle switch, Wifi Antenna, Charging port)

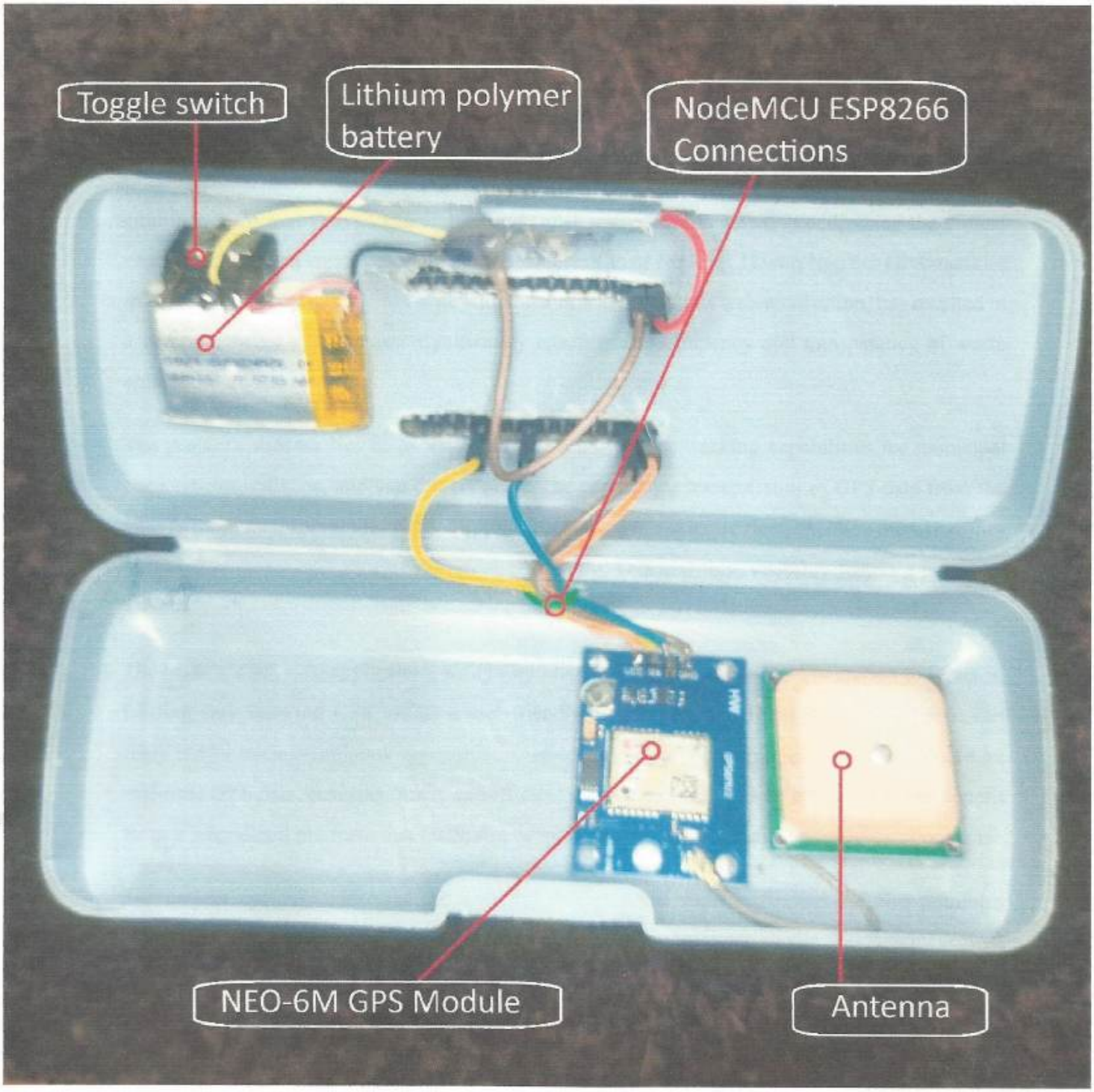


Fig:4.5.2:Inside View (Toggle Switch, Litium Polymer battery, NodeMCU Connections, NEO-6M GPSModule, Antenna.)

5. CONCLUSION

5.1: Conclusion

In conclusion, the "City Waste Management System Using Van Tracking" project has been a culmination of innovative technologies and collaborative efforts aimed at addressing the critical challenges in urban waste management. The integration of NodeMCU with Neo 6m GPS modules in garbage vans, coupled with the development of a MERN stack web application, has resulted in a comprehensive solution that significantly enhances the efficiency and transparency of waste collection processes.

The project's success lies in its ability to provide real-time tracking capabilities for municipal corporations, citizens, and van drivers alike. The continuous transmission of GPS data from the vans to the central server allows for dynamic monitoring of the entire fleet, enabling municipalities to optimize routes and allocate resources effectively. This real-time visibility fosters a proactive approach to waste management, enhancing overall operational efficiency.

The MERN stack web application, with its intuitive interface and seamless integration of React.js, Leaflet, and Tailwind CSS, offers a user-friendly experience for all stakeholders. Citizens can register and track complaints transparently, while van drivers receive optimized routes based on real-time GPS data, ensuring timely and efficient waste collection. Municipal corporations benefit from a centralized platform that facilitates data-driven decision-making and resource allocation.

The project not only addresses the logistical challenges of waste collection but also promotes community engagement by allowing citizens to actively participate in the waste management process. The transparency provided by the MERN application fosters a sense of responsibility and collaboration among citizens, contributing to the larger goal of sustainable and responsible waste disposal practices.

In essence, the "City Waste Management System Using Van Tracking" project exemplifies the successful convergence of hardware and software solutions to tackle a pressing urban challenge. It stands as a testament to the potential of technology-driven initiatives in creating smart and sustainable solutions for the benefit of communities. As we conclude this endeavor, we recognize the potential for future enhancements and the scalability of this model to address waste management challenges in diverse urban settings.

5.2: Future Scope:

The future scope of city waste management systems utilizing van tracking technology is quite promising. Here are some potential developments and benefits:

Efficient Routing: Van tracking can optimize waste collection routes, reducing fuel consumption and emissions while ensuring timely pickup. Advanced algorithms can analyze real-time data to dynamically adjust routes based on factors like traffic conditions and the volume of waste at collection points.

Resource Optimization: By tracking the movement of waste collection vans, authorities can optimize the allocation of resources such as personnel and equipment. This ensures that the right amount of resources is deployed to areas with higher waste generation, improving overall efficiency and cost-effectiveness.

Data-Driven Decision Making: Van tracking generates a wealth of data that can be analyzed to gain insights into waste generation patterns, collection efficiency, and areas requiring intervention. This data-driven approach enables informed decision-making for future waste management strategies and infrastructure planning.

Enhanced Service Quality: With van tracking, authorities can monitor the performance of waste collection contractors more effectively, ensuring compliance with service level agreements and standards. This leads to improved service quality and customer satisfaction.

Environmental Benefits: By optimizing waste collection routes and reducing unnecessary trips, van tracking contributes to lower fuel consumption and greenhouse gas emissions. Additionally, efficient waste management practices can minimize the environmental impact of landfills and promote recycling and composting initiatives.

Public Engagement and Transparency: Transparency in waste management operations, enabled by van tracking technology, fosters public trust and engagement. Citizens can track the movement of waste collection vans in real time, providing visibility into the city's efforts to manage waste effectively.

Overall, the future of city waste management systems using van tracking technology holds great promise for enhancing efficiency, sustainability, and quality of life in urban environment.

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