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CivicPulse: An AI-Powered Civic Complaint Management and Reward-Based Citizen Engagement System

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Abstract - *Civic issues such as potholes, garbage overflow, water leakage, damaged streetlights, and public safety problems often remain unresolved due to inefficient complaint reporting systems, lack of accountability, poor coordination between citizens and workers, and limited citizen engagement. Traditional complaint systems generally provide limited status tracking and do not motivate users to actively participate in civic improvement. To address these challenges, this paper presents CivicPulse, an AI-powered civic complaint management and reward-based citizen engagement system.*

CivicPulse enables citizens and students to report civic issues with images, descriptions, categories, and geolocation data. The system integrates Google Gemini API for AI-powered image analysis, which automatically suggests complaint titles, descriptions, and categories. The platform supports role-based workflows for citizens, students, workers, and administrators. Workers can view assigned complaints, access complaint locations through maps, update complaint status, and submit resolution updates. Administrators can manage users, complaints, moderation, rewards, analytics, and worker performance through a centralized dashboard. The system also includes JWT-based authentication, bcrypt password hashing, OTP-based two-factor authentication, real-time notifications, multilingual support, and a reward mechanism consisting of points, badges, certificates, coupons, and leaderboard rankings..

The proposed system improves transparency, accountability, and participation in civic issue resolution. By combining AI-based complaint analysis, geolocation mapping, role-based access, and reward-based engagement, CivicPulse provides an efficient and scalable approach for modern civic complaint management.

Key Words: *Civic Complaint Management, Artificial Intelligence, Google Gemini API, Geolocation, Reward System, Citizen Engagement, Role-Based Access Control, Smart Governance, MongoDB, Angular, Node.js.*

1. INTRODUCTION

Urban and semi-urban areas frequently face civic problems such as potholes, garbage accumulation, water supply issues, electricity failures, noise disturbances, damaged public infrastructure, and public safety concerns. These issues directly affect the quality of life of citizens and hinder sustainable urban development. However, many civic problems remain unresolved for extended periods due to the lack of an efficient, transparent, and user-friendly platform for reporting and tracking complaints.

Traditional complaint management systems are often manual, fragmented, and lack real-time tracking capabilities. Citizens typically face difficulties in registering complaints, monitoring their status, and ensuring accountability from concerned authorities. Additionally, the absence of proper communication between citizens, workers, and administrators leads to delays in issue resolution and reduced trust in public services.

With the advancement of digital technologies, there is a growing need for intelligent systems that can streamline civic issue reporting, improve coordination, and enhance citizen participation. Modern solutions can leverage technologies such as web platforms, geolocation mapping, and artificial intelligence to automate complaint categorization, enable real-time updates, and optimize resource allocation.

To address these challenges, this paper proposes CivicPulse, an AI-powered civic complaint management and reward-based citizen engagement system. The platform enables users to report issues with images and location data, automatically analyzes

complaints using AI, and facilitates efficient assignment and tracking of tasks. Additionally, a reward mechanism is integrated to encourage active citizen participation and improve community engagement.

1.1 Key Features

To ensure an efficient, scalable, and secure civic complaint management system, CivicPulse integrates several advanced technical features:

- **AI-Powered Complaint Analysis:** The system utilizes the Google Gemini API to analyze uploaded images and automatically suggest complaint titles, descriptions, and categories. This reduces manual effort and improves classification accuracy.
- **Geolocation and Mapping Integration:** The platform uses Google Maps API to capture and visualize complaint locations. This enables location-based complaint tracking, worker assignment, and heatmap analysis for administrators.
- **Role-Based Access Control (RBAC):** The system The system supports multiple user roles including citizens, students, workers, and administrators. Each role has specific permissions and dashboards to ensure secure and organized operations.
- **Full-Stack Web Architecture:** The application is built using Angular (frontend), Node.js with Express (backend), and MongoDB (database), ensuring a scalable and responsive system.
- **Secure Authentication Mechanism:** Security is implemented using JWT-based authentication, bcrypt password hashing, and OTP-based two-factor authentication (2FA) to protect user data and system access.
- **Real-Time Notifications:** Users receive updates through in-app notifications and email alerts for complaint status changes, assignments, and rewards.
- **Reward and Engagement System:** A gamified system provides points, badges, certificates, and leaderboard rankings to encourage active citizen participation.

1.2 Novelty

The novelty of the proposed system, CivicPulse, lies in its intelligent integration of artificial intelligence, geolocation-based tracking, and reward-driven citizen engagement within a unified civic complaint management platform. Unlike traditional complaint systems, CivicPulse introduces several innovative features:

1. AI-Powered Complaint Analysis

A key novelty of the system is the integration of AI-based image analysis using the Google Gemini API. Instead of relying solely on manual input, the system automatically:

- Analyzes uploaded images
- Suggests complaint titles and descriptions
- Classifies complaint categories

This significantly reduces user effort and improves the accuracy of complaint reporting.

2. Reward-Based Citizen Engagement System

Unlike conventional civic platforms, CivicPulse incorporates a gamified reward mechanism to motivate user participation.

- Users earn points, badges, certificates, and leaderboard rankings
- Encourages active civic responsibility
- Reduces fake or low-quality complaints through incentive design

This transforms passive users into active contributors.

3. Role-Based Multi-User Workflow System

The platform introduces a structured workflow with multiple roles:

- Citizens / Students → Report issues
- Workers → Resolve complaints
- Admins → Monitor, assign, and analyze

This creates a closed-loop system, improving accountability and coordination.

4. Geolocation-Based Complaint Tracking and Assignment

CivicPulse integrates Google Maps API for:

- Accurate complaint geotagging
- Location-based worker assignment
- Visualization using maps and heatmaps

This ensures faster and more efficient issue resolution.

5. Integrated Real-Time Monitoring and Notifications

The system provides:

- Real-time complaint status tracking
- Instant notifications for updates
- Transparent communication between users and authorities

This improves trust and system responsiveness.

6. Secure and Scalable Architecture

The platform is built using a modern full-stack architecture:

- Angular frontend
- Node.js + Express backend
- MongoDB database

Security is enhanced using:

- JWT authentication
- bcrypt password hashing
- OTP-based two-factor authentication

7. Unified Smart Governance Approach

Unlike existing fragmented systems, CivicPulse combines:

- Complaint management
- AI-based automation
- Citizen engagement
- Administrative analytics

into a single scalable platform, supporting smart city initiatives.

2. LITERATRE SURVEY

2.1 Related Work and Field Observation

The rapid growth of smart city initiatives has led to the development of various digital platforms for civic complaint management. These systems aim to improve communication between citizens and municipal authorities by enabling online complaint registration and tracking. However, most existing systems are limited in functionality and lack intelligent automation, user engagement mechanisms, and real-time coordination.

Traditional civic complaint systems are often manual or semi-digital, where users submit complaints through websites or mobile applications. While these systems allow issue reporting, they typically lack transparency, efficient tracking, and timely resolution. Users often face difficulties in monitoring complaint progress, leading to reduced trust in public services.

Several modern systems have introduced geolocation-based complaint tracking, allowing authorities to identify problem areas and assign workers accordingly. However, these systems often depend heavily on manual classification of complaints, which can lead to inconsistencies and delays in processing.

Recent research has explored the use of artificial intelligence in smart governance systems. AI techniques can be used to classify complaints, detect patterns, and automate decision-making processes. However, many existing implementations rely on text-based inputs and do not fully utilize image-based analysis for real-world issue identification.

Another major limitation observed in existing systems is the lack of citizen engagement. Most platforms treat users as passive reporters without providing incentives or feedback mechanisms. This results in low participation rates and incomplete reporting of civic issues.

Furthermore, existing systems often lack a structured workflow between citizens, workers, and administrators. The absence of role-based coordination leads to inefficient task assignment and poor accountability in resolving complaints.

From the field observation, it is evident that current civic complaint platforms suffer from the following limitations:

- Lack of AI-based complaint classification
- Limited use of image analysis for issue identification
- Absence of reward-based engagement systems
- Poor transparency in complaint tracking
- Weak coordination between stakeholders
- Limited use of geolocation for efficient task assignment

To overcome these limitations, there is a need for an integrated system that combines AI-based automation, geolocation tracking, role-based workflows, and citizen engagement mechanisms.

The proposed system, CivicPulse, addresses these gaps by providing an AI-powered civic complaint management platform with real-time tracking, reward-based participation, and efficient coordination between users, workers, and administrators.

Identified Problems and Proposed Solutions

Identified Problem	Proposed Technical Solution
Lack of Efficient Complaint Reporting Systems: Citizens often face difficulty in reporting civic issues due to complex or outdated systems.	**User-Friendly Web Platform:** CivicPulse provides a simple interface for reporting issues with images, descriptions, and geolocation data.
Manual Complaint Classification: Traditional systems rely on manual categorization, leading to delays and errors.	**AI-Powered Analysis:** Integration of Google Gemini API automatically analyzes images and suggests complaint categories and descriptions.
Poor Transparency in Complaint Tracking: Users cannot easily track the progress of their complaints.	**Real-Time Status Tracking:** The system provides live updates from "Pending" to "Closed" stages with notifications.
Low Citizen Engagement: Lack of motivation leads to fewer reported issues and reduced participation.	**Reward-Based Engagement System:** Users earn points, badges, certificates, and leaderboard rankings for active participation.
Inefficient Worker Assignment: Complaints are not assigned based on location or priority.	**Geolocation-Based Assignment:** Google Maps integration enables location-based task allocation and efficient routing.
Lack of Coordination Between Stakeholders: Poor communication between citizens, workers, and administrators.	**Role-Based Workflow System:** Separate dashboards and permissions for citizens, workers, and admins ensure smooth coordination.
Limited Administrative Insights: Authorities lack proper tools for monitoring and analysis.	**Admin Dashboard with Analytics:** Provides performance metrics, complaint trends, and heatmaps for better decision-making.
Security and Data Integrity Issues: Weak authentication mechanisms can lead to unauthorized access.	**Secure Authentication System:** Uses JWT, bcrypt, and OTP-based two-factor authentication for enhanced security.

2.2: AI-Based Complaint Classification Systems

Recent advancements in artificial intelligence have enabled the development of intelligent systems for automated classification and analysis of user-generated data. In the context of civic complaint management, AI techniques can be used to classify complaints based on text and images, improving efficiency and reducing manual workload.

Several studies have explored the use of machine learning and deep learning models for classification tasks. Natural Language Processing (NLP) techniques are commonly used to analyze textual complaints, while computer vision models are used to analyze images of real-world issues such as potholes, garbage, and infrastructure damage.

However, many existing systems rely primarily on text-based inputs and require users to manually describe issues in detail. This approach can lead to inconsistent categorization and increased processing time. Image-based analysis, combined with AI, provides a more accurate and efficient way to identify and classify real-world problems.

In addition, recent AI models have demonstrated strong performance in understanding contextual information from images and generating meaningful descriptions. These capabilities can be leveraged to automatically suggest complaint categories, titles, and descriptions, thereby improving user experience and system efficiency.

Despite these advancements, the integration of AI-based image analysis into civic complaint platforms is still limited. The proposed system, CivicPulse, addresses this gap by incorporating AI-powered image analysis to assist users in reporting issues more accurately and efficiently.

2.3: Geolocation-Based Civic Management Systems

Approximately Geolocation-based systems have become an important component in modern smart city applications. These systems use location data to identify, monitor, and manage civic issues more effectively. In the context of complaint management, geolocation enables accurate mapping of reported issues such as potholes, garbage dumps, and infrastructure damage.

Several existing platforms use GPS and map-based visualization to assist authorities in identifying high-density problem areas. This helps in prioritizing complaints and allocating resources efficiently. Additionally, location-based worker assignment ensures that complaints are handled by nearby personnel, reducing response time.

However, many existing systems provide only basic mapping functionality and lack advanced features such as real-time tracking, heatmap visualization, and integration with intelligent decision-making systems. Furthermore, they often do not combine geolocation with user engagement or AI-based automation.

The proposed system, CivicPulse, enhances geolocation-based complaint management by integrating Google Maps API for complaint tracking, worker assignment, and administrative analytics. It also supports visualization tools such as heatmaps and clustering to identify frequently affected areas, enabling better planning and faster resolution of civic issues.

2.4: Citizen Engagement and Smart Governance Systems

Citizen engagement plays a crucial role in the success of smart city initiatives and digital governance platforms. Modern civic systems aim not only to provide complaint registration but also to actively involve citizens in improving urban infrastructure and public services.

Several existing platforms allow users to report civic issues; however, they often lack mechanisms to motivate continuous participation. Without incentives or feedback systems, users tend to lose interest after submitting complaints, resulting in low engagement and incomplete reporting.

Recent studies highlight the importance of incorporating gamification techniques such as reward points, badges, and leaderboards to encourage user participation. These techniques have been successfully applied in various domains to increase user activity and improve system interaction.

Additionally, feedback systems such as ratings and comments help improve transparency and accountability in complaint resolution. When users can rate the quality of resolution and track their contributions, it builds trust and encourages consistent engagement.

However, most existing civic platforms do not integrate engagement mechanisms with complaint management systems in a structured way. There is a need for a unified system that combines complaint reporting, tracking, and user motivation.

The proposed system, CivicPulse, addresses this gap by incorporating a reward-based engagement system along with real-time tracking and feedback mechanisms. This approach not only improves citizen participation but also enhances the overall efficiency and transparency of civic issue resolution.

2.5: Smart Governance and Digital Complaint Platforms

Smart governance systems aim to improve the efficiency, transparency, and responsiveness of public services through the use of digital technologies. In recent years, many governments and municipalities have adopted online platforms to manage civic complaints and public grievances.

These platforms enable citizens to report issues such as road damage, waste management problems, and infrastructure failures. However, many existing systems suffer from limitations such as delayed responses, lack of transparency, and minimal user interaction.

Research in smart governance highlights the importance of integrating modern technologies such as artificial intelligence, cloud computing, and data analytics to improve service delivery. AI can assist in automating complaint classification, prioritizing issues, and identifying recurring patterns. Data analytics can help administrators understand trends and allocate resources more effectively.

Despite these advancements, many existing systems lack integration between complaint reporting, real-time tracking, and user engagement. Additionally, most platforms do not provide incentives for citizen participation, leading to reduced reporting of issues.

The proposed system, CivicPulse, addresses these challenges by combining AI-based automation, real-time tracking, geolocation services, and reward-based engagement into a unified platform. This approach enhances transparency, improves response time, and encourages active participation from citizens.

2.6: Role-Based Workflow and Complaint Management Systems

Efficient complaint management systems require structured workflows to ensure proper coordination between different stakeholders such as citizens, field workers, and administrative authorities. Traditional systems often lack clearly defined roles, leading to delays, miscommunication, and poor accountability.

Modern systems are increasingly adopting role-based access control (RBAC) to organize operations. In such systems, users are assigned specific roles with predefined permissions. For example, citizens can report issues, workers can handle assigned complaints, and administrators can monitor and manage the overall system.

Role-based systems improve efficiency by:

- Ensuring proper task assignment
- Reducing unauthorized access
- Streamlining communication between stakeholders
- Enhancing accountability in complaint resolution

However, many existing platforms still lack fully integrated workflows that connect all stakeholders in a closed-loop system. This results in gaps between complaint reporting, assignment, and resolution.

The proposed system, CivicPulse, implements a structured role-based workflow that connects citizens, workers, and administrators within a single platform. This ensures seamless communication, efficient task management, and improved transparency throughout the complaint lifecycle.

3. DESIGN AND ARCHITECTURE

3.1 Block Diagram

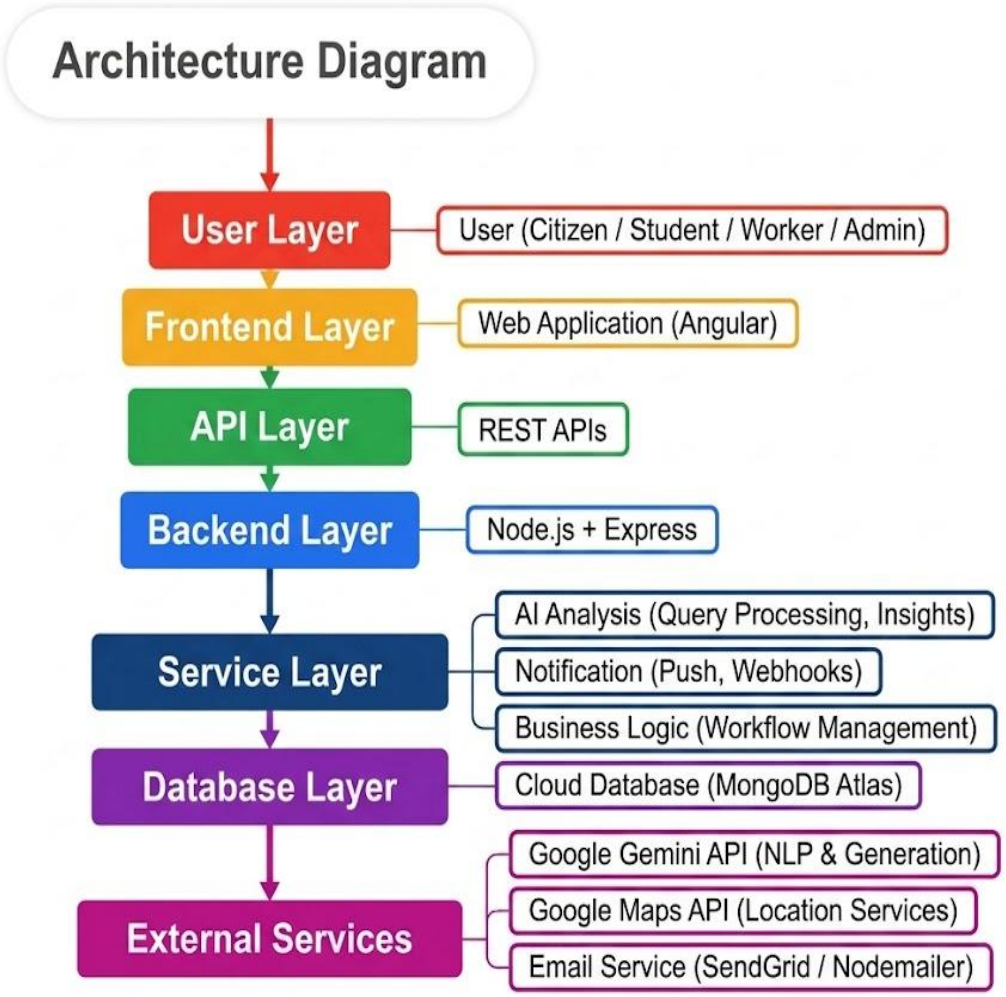

Figure 3.1 Block diagram of system.

3.2 Level 0 Data Flow Diagram (DFD)

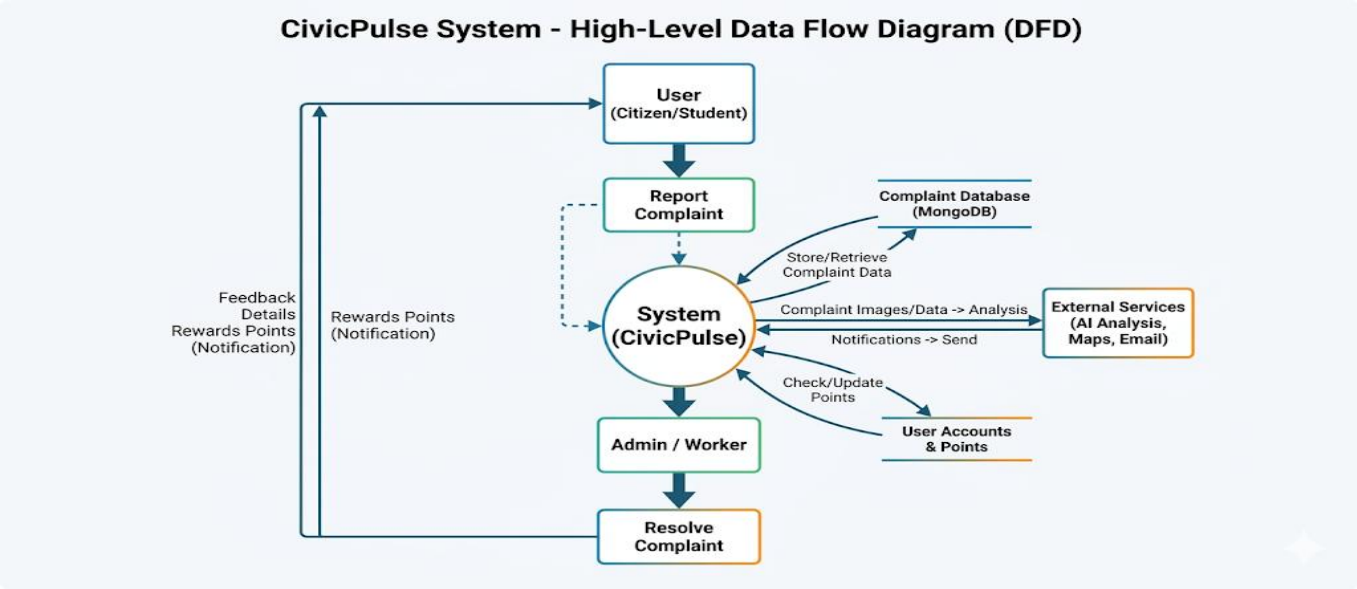

Figure 3.2 Level 0 Data Flow Diagram.

3.3 Level 1 Data Flow Diagram (DFD)

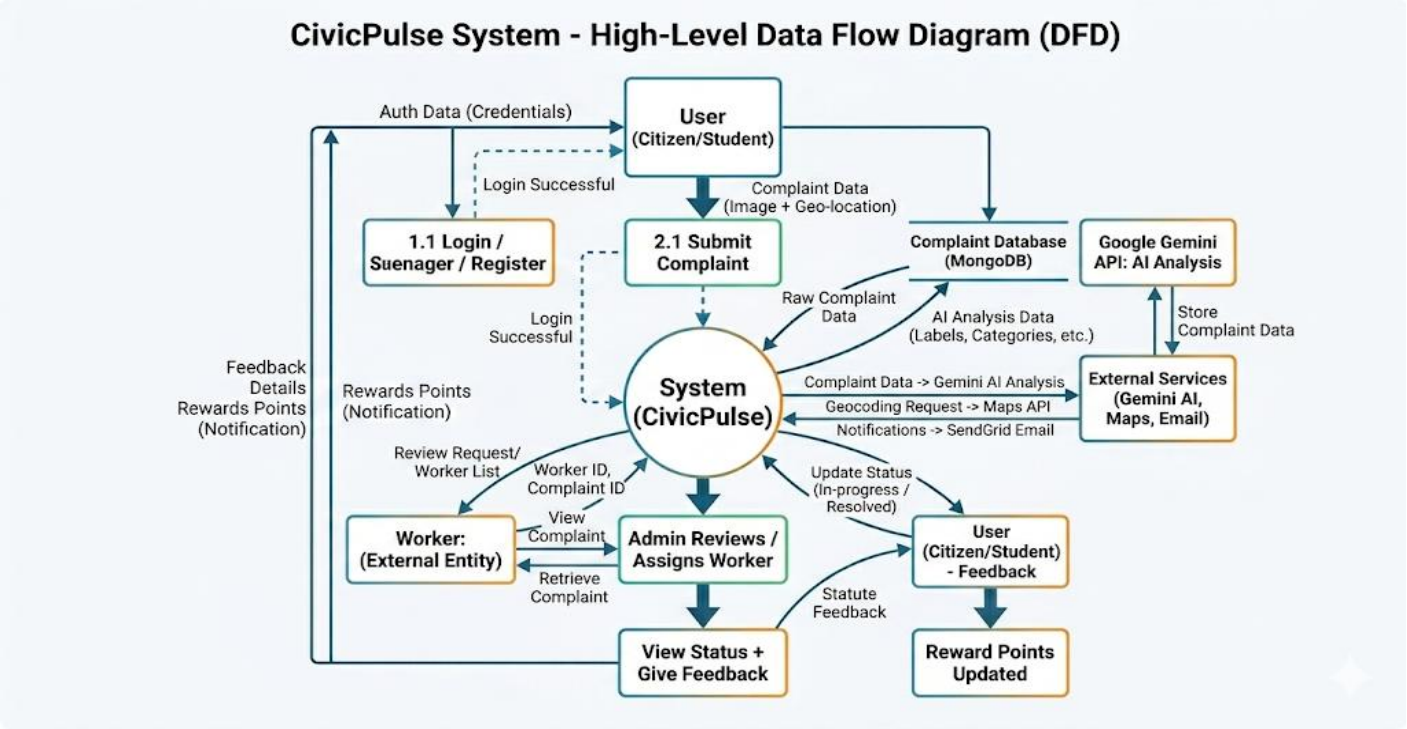

Figure 3.3 Level 1 Data Flow Diagram

4. SYSTEM IMPLEMENTATION AND RESULT

4.1 Home Dashboard

The home page provides an overview of the CivicPulse platform, allowing users to navigate, register, or report issues easily. It highlights the system's goal of enabling citizens to report and track civic problems efficiently through a user-friendly interface.

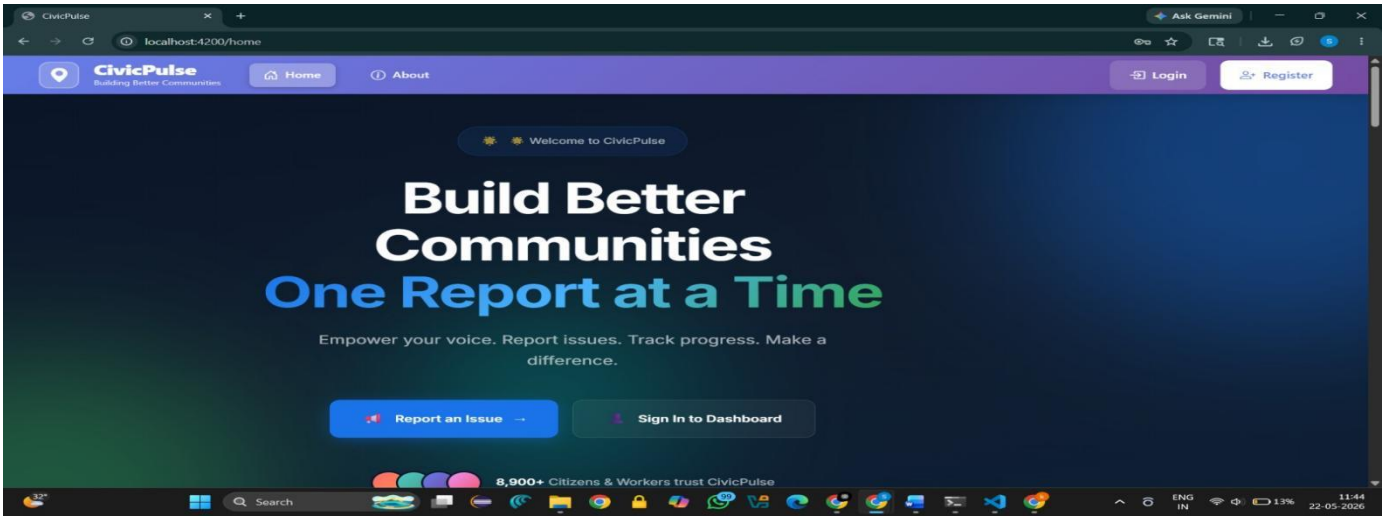

Figure 4.1 Home dashboard.

4.2 CivicPulse Login Page

The login page allows users to securely access their accounts by entering their email and password. It provides quick access to the system and enables users to report and track civic issue.

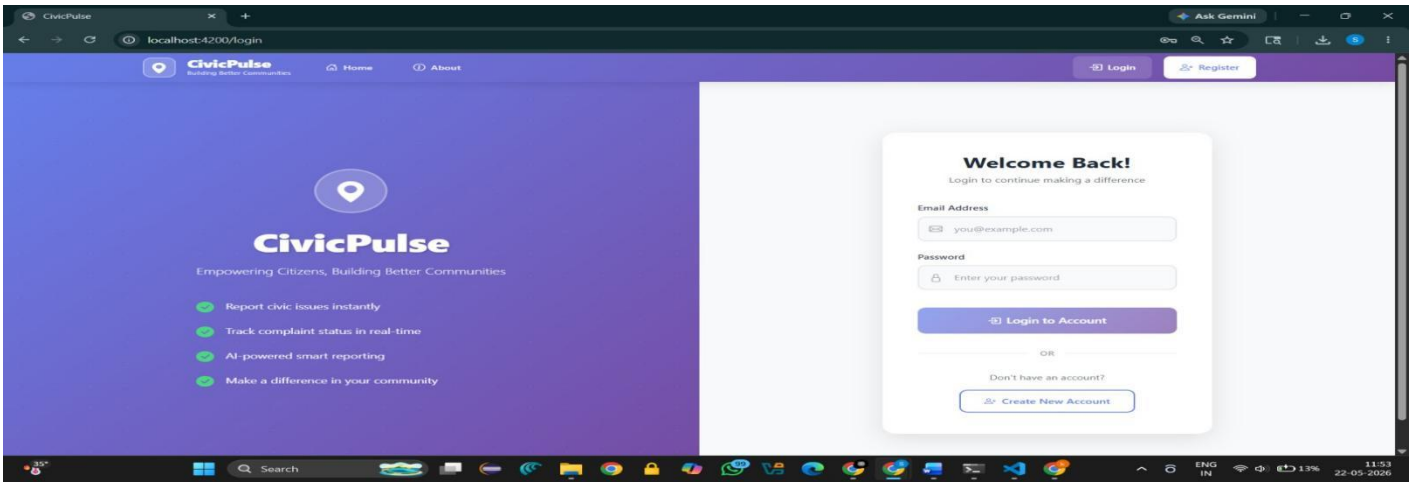

Figure 4.2 Login Page.

4.2 CivicPulse Registration Page

The registration page allows new users to create an account by entering personal details such as name, email, and password. It enables users to join the platform and start reporting and tracking civic issues.

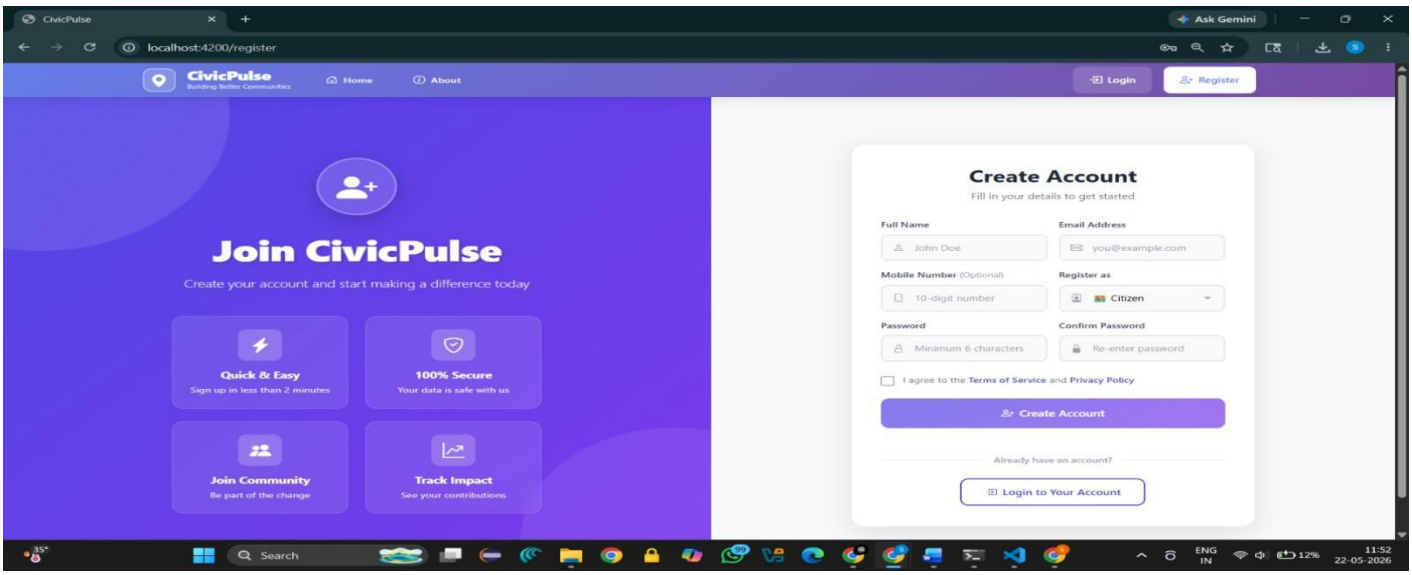

Figure 4.3 Registration Page.

4.3 CivicPulse Citizen Dashboard

The citizen dashboard provides an overview of user activity, allowing users to report issues, track complaints, and view leader-board rankings through quick action options.

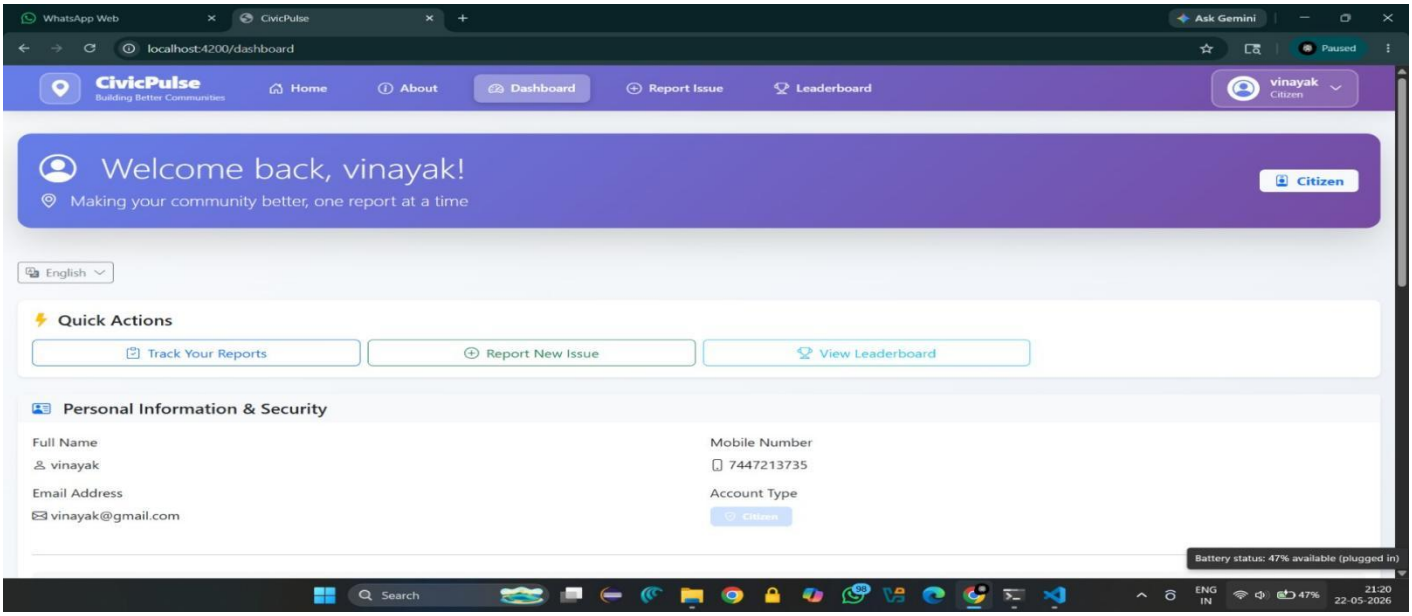

Figure 4.4 Citizen Dashboard.

4.4 CivicPulse Report Issue Page

The report issue page allows users to submit complaints by entering location details, selecting priority, and providing relevant information. It also supports GPS-based location detection for accurate issue reporting.

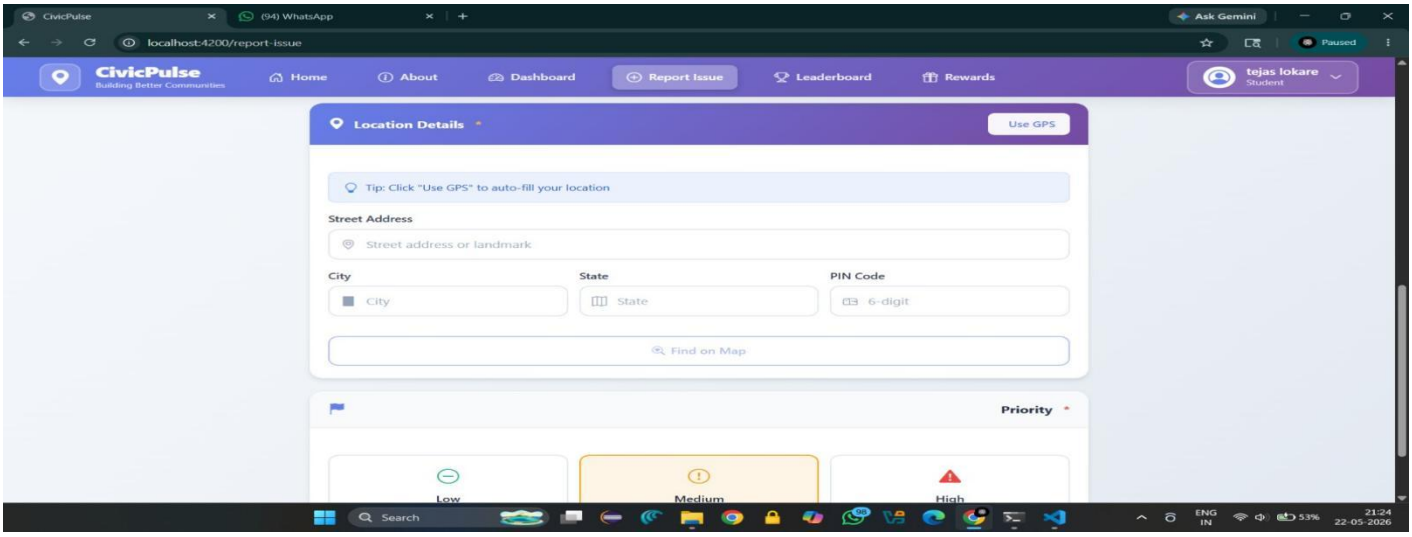

Figure 4.5 Report Issue Page.

4.5 CivicPulse Worker Dashboard

The worker dashboard provides an overview of assigned complaints, including status such as pending, in-progress, and resolved issues, along with performance metrics and completion rate.

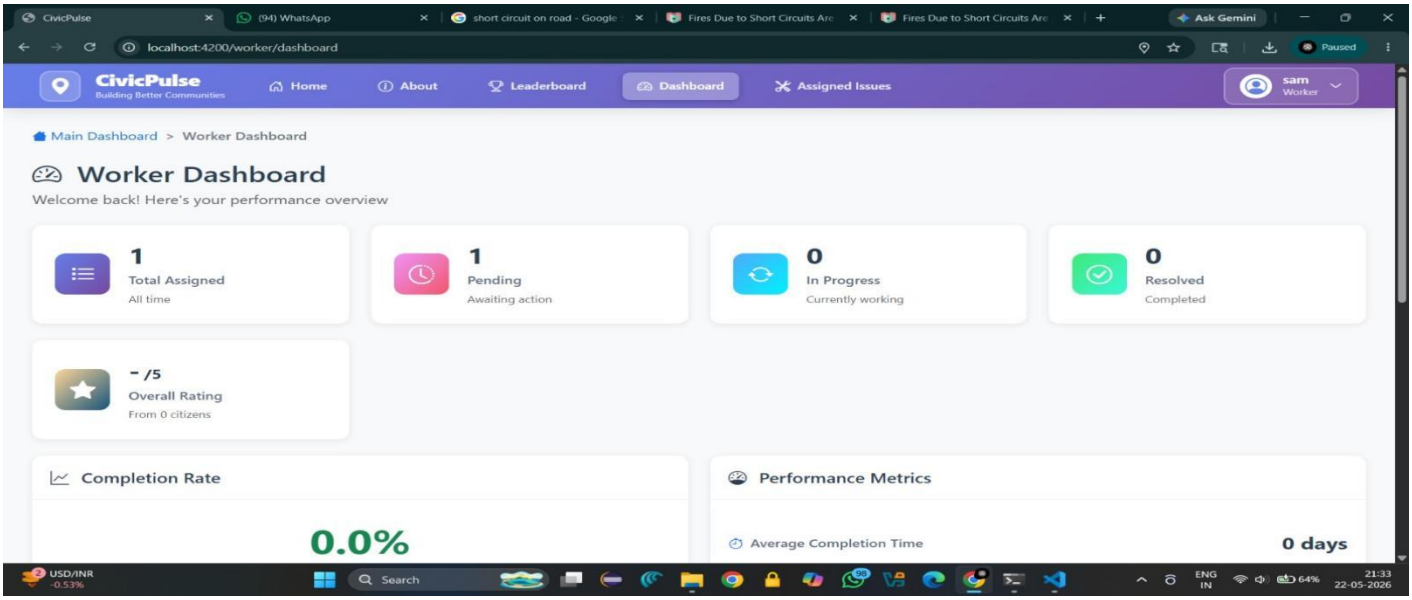

Figure 4.6 Report Issue Page

4.6 CivicPulse Admin Dashboard

The admin dashboard provides an overview of system performance, including total users, complaints, resolution rate, and worker activity. It also displays analytics and trends to help administrators monitor and manage the system efficiently.

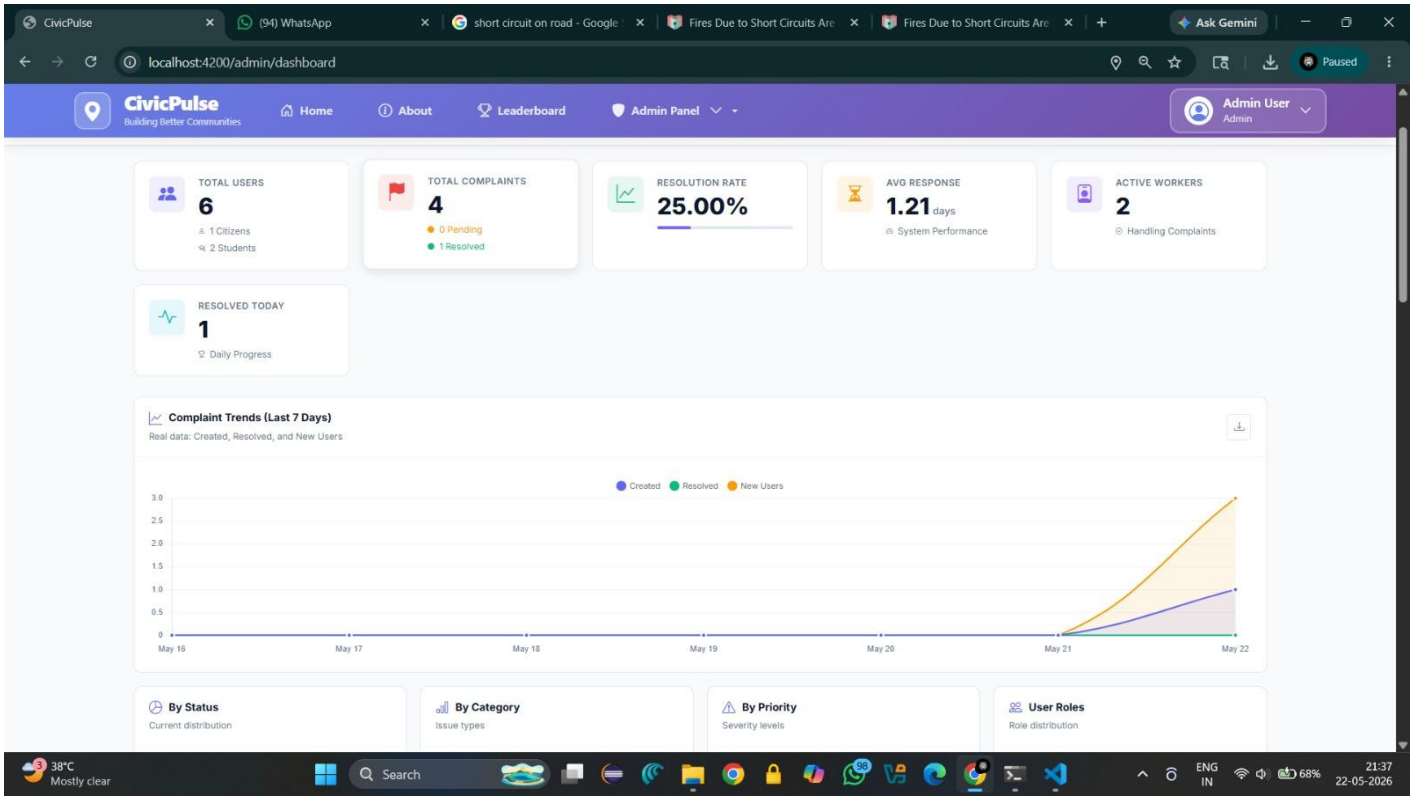

Figure 4.7 CivicPulse Admin Dashboard

5. CONCLUSIONS

The CivicPulse application is designed to simplify and enhance civic issue reporting and management by integrating multiple functionalities into a unified platform. The system enables citizens to report issues, track complaint status, and engage with community-driven solutions efficiently. By incorporating features such as AI-based complaint analysis, geolocation tracking, role-based workflows, and reward mechanisms, the platform improves transparency, accountability, and user participation. The application leverages modern web technologies such as Angular, Node.js, and MongoDB, along with external services like Google Gemini API and Google Maps, to ensure a scalable, responsive, and efficient system for smart civic governance.

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