Tribhuvan University

Institute of Science and Technology

WEB APPLICATION FOR CIVIC ISSUE MANAGEMENT USING GEOTAGGED REPORTING, TEMPORAL ANALYSIS, AND RESPONSE PRIORITIZATION

A FINAL PROJECT REPORT

Submitted to

Department of Computer Science and Information Technology

In partial fulfillment of the requirements for the Bachelor's Degree in Computer Science and Information Technology

Submitted by

Sakar Shrestha

TU Roll No: 5-2-1175-28-2020

December 23, 2024

Under the supervision of

Saurav Gautam

DEERWALK INSTITUTE OF TECHNOLOGY

Tribhuvan University

Institute of Science and Technology

SUPERVISOR'S RECOMMENDATION

I hereby recommend that this project prepared under my supervision by SAKAR SHRESTHA entitled **"WEB APPLICATION FOR CIVIC ISSUE MANAGEMENT USING GEOTAGGED REPORTING, TEMPORAL ANALYSIS, AND RESPONSE PRIORITIZATION"** in partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Information Technology be processed for the evaluation.

……

Saurav Gautam

Project Supervisor

DWIT College

Deerwalk Institute of Technology

DWIT College

DEERWALK INSTITUTE OF TECHNOLOGY

STUDENT'S DECLARATION

I hereby declare that I am the only author of this work and that no sources other than that listed here have been used in this work.

……

Sakar Shrestha

December 23, 2024

DWIT College

DEERWALK INSTITUTE OF TECHNOLOGY

LETTER OF APPROVAL

This is to certify that this project prepared by SAKAR SHRESTHA entitled **"WEB APPLICATION FOR CIVIC ISSUE MANAGEMENT USING GEOTAGGED REPORTING, TEMPORAL ANALYSIS, AND RESPONSE PRIORITIZATION"** in partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Information Technology has been well studied. In our opinion it is satisfactory in the scope and quality as a project for the required degree.

……	……
Mr. Saurav Gautam	Mr. Hitesh Karki
Supervisor	Campus Chief
DWIT College	DWIT College
……..	……..
[External Examiner]	Mr. Shyam Sundar Khatiwada
Academic designation	Project Coordinator
IOST, Tribhuvan University	DWIT College

ACKNOWLEDGEMENT

I would like to extend my thanks to Mr. Saurav Gautam for his guidance and assistance. His valuable feedback and encouragement improved the quality of my work. I am also grateful to Deerwalk Institute of Technology for their dedication to advancing technical knowledge by pushing our limits.

I also want to acknowledge the support and understanding of my family and friends who helped me with their valuable expertise and insights to make the project better.

I wish to express my appreciation to all those who contributed to the completion of this project, whether directly or indirectly. Their support, insights, and encouragement have played a significant role in shaping the outcome of this scientific endeavor. I am sincerely grateful for their involvement and recognize their role in the successful completion of this project.

Sakar Shrestha
TU Roll No: 5-2-1175-28-2020
Date: December 23, 2024

ABSTRACT

Managing civic issues is essential for maintaining the quality of urban life. However, challenges such as delayed reporting, inefficient resource allocation, and lack of transparency hinder effective resolution. This project addresses these challenges through the development of the Civic Issue Management System (CIMS), a web application that enables citizens to report issues like potholes, waste management problems, and streetlight outages with geotagged photos and descriptions. The system facilitates city officials in tracking, prioritizing, and resolving issues efficiently. By incorporating features such as real-time status updates, trend analysis, and an interactive dashboard, CIMS provides valuable insights for urban management. Through its streamlined reporting process and automated notifications, the system fosters better communication between citizens and authorities, enhancing overall civic engagement. The project demonstrates a significant improvement in the transparency and efficiency of issue management, contributing to the development of smarter and more responsive cities.

Keywords: *Civic Management; Geotagging; Real-time Updates; Urban Analytics; Resource Optimization.*

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

API	Application Programming Interface
CIMS	Civic Issue Management System
ER	Entity-Relationship
HTML	Hypertext Markup Language
JWT	JSON Web Token

CHAPTER 1: INTRODUCTION

1.1. Introduction

The management of civic issues plays a crucial role in ensuring the quality of urban life. Problems such as potholes, waste mismanagement, and faulty streetlights can significantly impact daily life. However, traditional methods of reporting and addressing these issues are often inefficient, leading to delays and a lack of accountability. With advancements in technology, there is a growing need for digital solutions that streamline issue reporting, provide real-time updates, and offer actionable insights for city officials. The Civic Issue Management System (CIMS) is designed to bridge this gap, enabling citizens and administrators to collaborate effectively in resolving urban challenges.

1.2. Problem Statement

Urban areas face numerous civic issues daily, ranging from infrastructure damage to waste management problems. Existing systems for reporting and managing these issues are often fragmented, resulting in delays and inefficient use of resources. Citizens face difficulties in reporting issues, while city officials lack the tools to prioritize and track them effectively. Additionally, there is limited transparency and communication between citizens and authorities, leading to dissatisfaction and reduced trust in public services. CIMS aims to address these challenges by providing a unified platform for efficient issue reporting, tracking, and resolution.

1.3. Objectives

The primary objectives of this application are:

- Enable citizens to report civic issues with geotagged photos and descriptions.
- Provide real-time status updates on reported issues.
- Offer city officials tools to prioritize and manage issues efficiently.
- Facilitate data-driven decision-making through analytics and visualizations.
- Enhance communication between citizens and authorities through automated notifications.

1.4. Scope and Limitation

The CIMS focuses on improving the reporting and management of civic issues within urban areas. It provides functionalities for citizens to submit reports and for administrators to track and resolve issues. Key features include geolocation-based reporting, trend analysis, and an interactive dashboard.

Limitations:

- Initial deployment is limited to specific urban areas.
- Dependence on internet connectivity for real-time updates.
- Requires user participation for comprehensive data collection.

1.5. Development Methodology

The Waterfall model is used for the development of the system because it gives an easy overview of the system based on the required specifications, and to present the general flow on the development of the system.

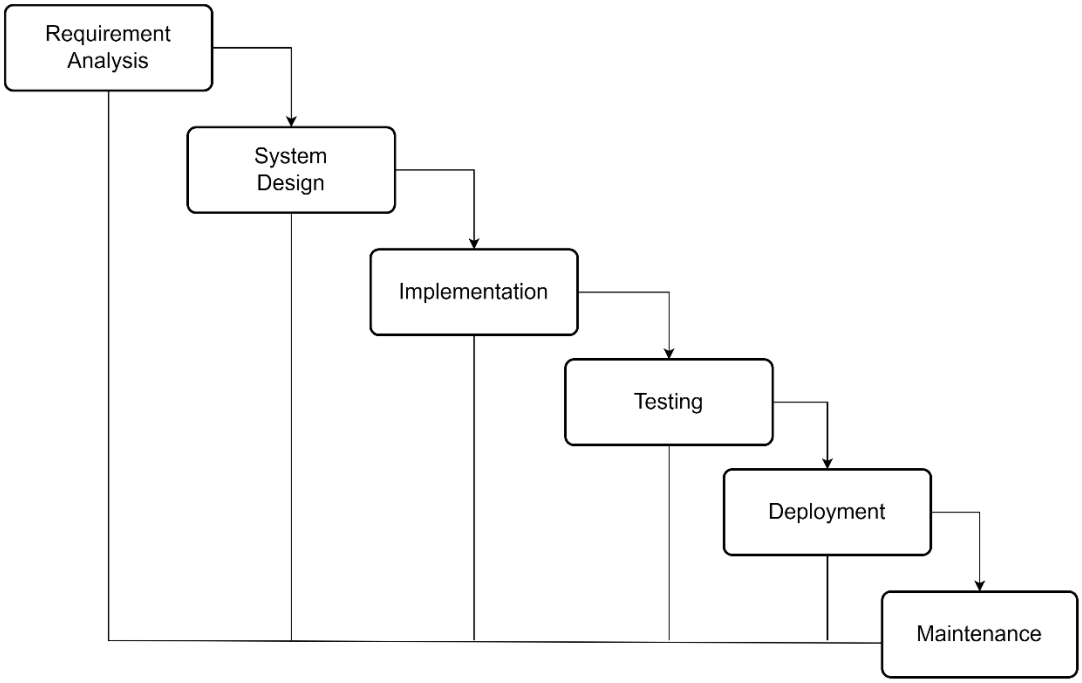

Figure 1: Waterfall model

The project makes use of the Waterfall model. The Waterfall model is a structured and linear approach that follows a sequence of phases, including requirements gathering, system design, implementation, testing, and maintenance. This model is suitable for our

project as it allows for thorough planning and documentation, ensuring a systematic and well-organized development process.

1.6. Report Organization

This report is organized as follows:

Chapter 1 introduces the project, outlining its background, problem statement, objectives, scope, and methodology.

Chapter 2 provides a background study and literature review, highlighting related works and existing systems.

Chapter 3 details the system analysis, including requirement analysis and feasibility studies.

Chapter 4 covers the system design, including architecture, database schema, and algorithms.

Chapter 5 focuses on the implementation and testing phases, discussing tools, modules, and test results.

Chapter 6 concludes the report, summarizing findings and offering future recommendations.

CHAPTER 2: BACKGROUND STUDY AND LITERATURE REVIEW

2.1. Background Study

Urban management is a complex process that involves addressing various civic issues to improve the quality of life for residents. Traditionally, citizens report issues through physical visits or phone calls, which are time-consuming and inefficient. With the rise of digital platforms, there is a significant opportunity to streamline these processes. Systems like CIMS aim to leverage technology to simplify issue reporting, provide real-time updates, and enhance decision-making through data analytics. These advancements not only improve efficiency but also foster greater transparency and citizen engagement.

2.2. Literature Review

The integration of technology into civic issue management has been a subject of growing interest. Several systems have been developed to enhance urban management and community engagement:

- H. G. S. & Y. K. Li (2019) explored a location-based service system for smart urban management. Their research highlights how geotagging can improve the accuracy and timeliness of issue reporting, a key feature of CIMS(CIMS) [1].
- S. S. R. & S. A. Manandhar (2022) focused on mobile-based applications for municipal solid waste management. They emphasized the importance of real-time updates and user feedback in enhancing service delivery, which aligns with CIMS's objectives(CIMS) [2].
- E. I. K. M. G. & G. J. C. Vlahogianni (2021) proposed the use of neural networks for short-term traffic flow prediction. This study underscores the potential of data-driven decision-making in urban management, an approach incorporated into the CIMS analytics dashboard(CIMS) [3].

These studies provide valuable insights into the benefits of integrating real-time data and geolocation technology into civic systems. However, existing solutions often lack comprehensive analytics and user-friendly dashboards, limiting their effectiveness. CIMS

addresses these gaps by providing a centralized platform that combines geotagged issue reporting, trend analysis, and resource optimization.

2.3. Current System

In the realm of civic issue management, several systems have been developed to facilitate the reporting and resolution of community concerns. Notable among these are:

- FixMyStreet: Developed by mySociety, FixMyStreet is a UK-based platform that enables citizens to report local problems such as potholes and broken streetlights. It utilizes geolocation to direct reports to the appropriate local authority, streamlining the resolution process.
- SeeClickFix: Originating in the United States, SeeClickFix allows users to report non-emergency issues to local governments. The platform offers a mobile app and website where users can submit reports, track their status, and view other community-reported issues.
- Snap Send Solve: This application serves Australia and New Zealand, enabling residents to report civic issues directly to the responsible authorities. Users can capture photos, provide descriptions, and send reports, which are then routed to the appropriate council or service provider.

While these systems have improved civic engagement and streamlined issue reporting, they often face challenges such as limited integration with municipal workflows, lack of real-time updates, and insufficient analytics for trend identification. The Civic Issue Management System (CIMS) aims to address these limitations by offering a comprehensive platform that not only facilitates issue reporting but also provides real-time status updates, trend analysis, and optimized resource allocation for city officials.

2.4. The problem with Current System

The primary challenges in current systems include:

- Fragmented Processes: Issue reporting, tracking, and resolution often occur on separate platforms, leading to delays and data inconsistencies.
- Limited Prioritization Tools: There is no efficient mechanism to prioritize issues based on urgency or impact.
- Lack of Transparency: Citizens rarely receive updates on the status of their reports, reducing trust and engagement.
- Inadequate Data Analysis: Without trend analysis and dashboards, city officials struggle to identify recurring issues or allocate resources effectively.

CHAPTER 3: SYSTEM ANALYSIS

3.1. Requirement Analysis

3.1.1. Functional Requirement

The primary challenges in current systems include:

- Fragmented Processes: Issue reporting, tracking, and resolution often occur on separate platforms, leading to delays and data inconsistencies.
- Limited Prioritization Tools: There is no efficient mechanism to prioritize issues based on urgency or impact.
- Lack of Transparency: Citizens rarely receive updates on the status of their reports, reducing trust and engagement.
- Inadequate Data Analysis: Without trend analysis and dashboards, city officials struggle to identify recurring issues or allocate resources effectively.

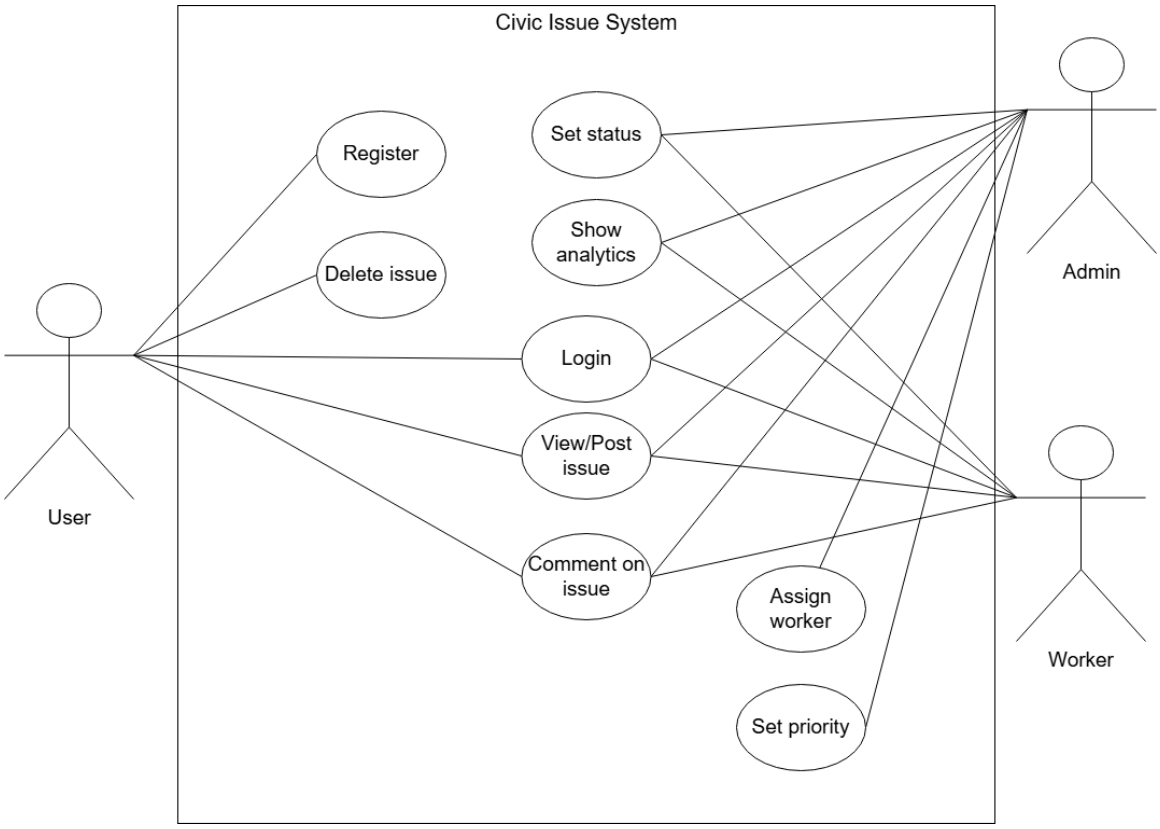

Figure 2: Use case diagram for CIMS

3.1.2. Non-Functional Requirement

Key non-functional requirements are:

- Scalability: The system must handle a growing number of users and reports.
- Reliability: Ensure minimal downtime and accurate issue reporting.

- Security: Use secure authentication (JWT) and data encryption.
- Usability: Maintain an intuitive and user-friendly interface.
- Performance: Provide real-time responses for critical actions.

3.2. Feasibility Analysis

3.2.1. Technical Feasibility

The system uses proven technologies such as React.js for the frontend, Node.js for the backend, and PostgreSQL for the database. The integration of libraries like React-Leaflet for mapping ensures that technical needs are met effectively.

3.2.2. Operational Feasibility

CIMS is designed to be user-friendly for both citizens and city officials. Training for city officials will ensure they can fully utilize the system's features.

3.2.3. Economic Feasibility

The use of open-source tools and frameworks minimizes costs. Hosting services like Neon for PostgreSQL offer cost-effective scalability.

3.2.4. Schedule Feasibility

The project development follows a structured timeline based on the Waterfall model. Each phase, from requirement analysis to deployment, has been allocated sufficient time to meet the deadlines.

Table 1: Time Schedule for System Development

Task	Duration
Research and Planning	3 weeks
System Design	2 weeks
Frontend Development	4 weeks
Backend Development	6 weeks

Testing	2 weeks
Implementation	1 week

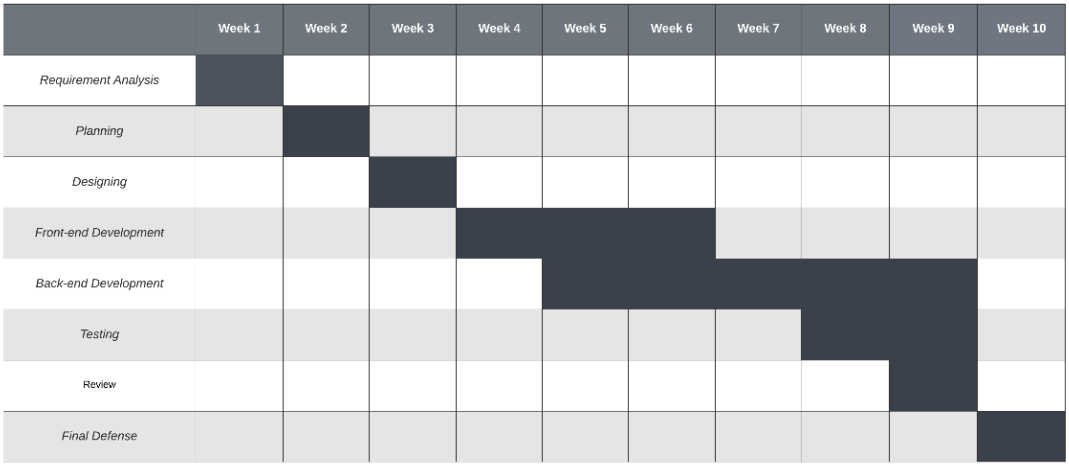

Figure 3: Gantt Chart for CIMS

3.3. Analysis

3.1.1 ER Diagram

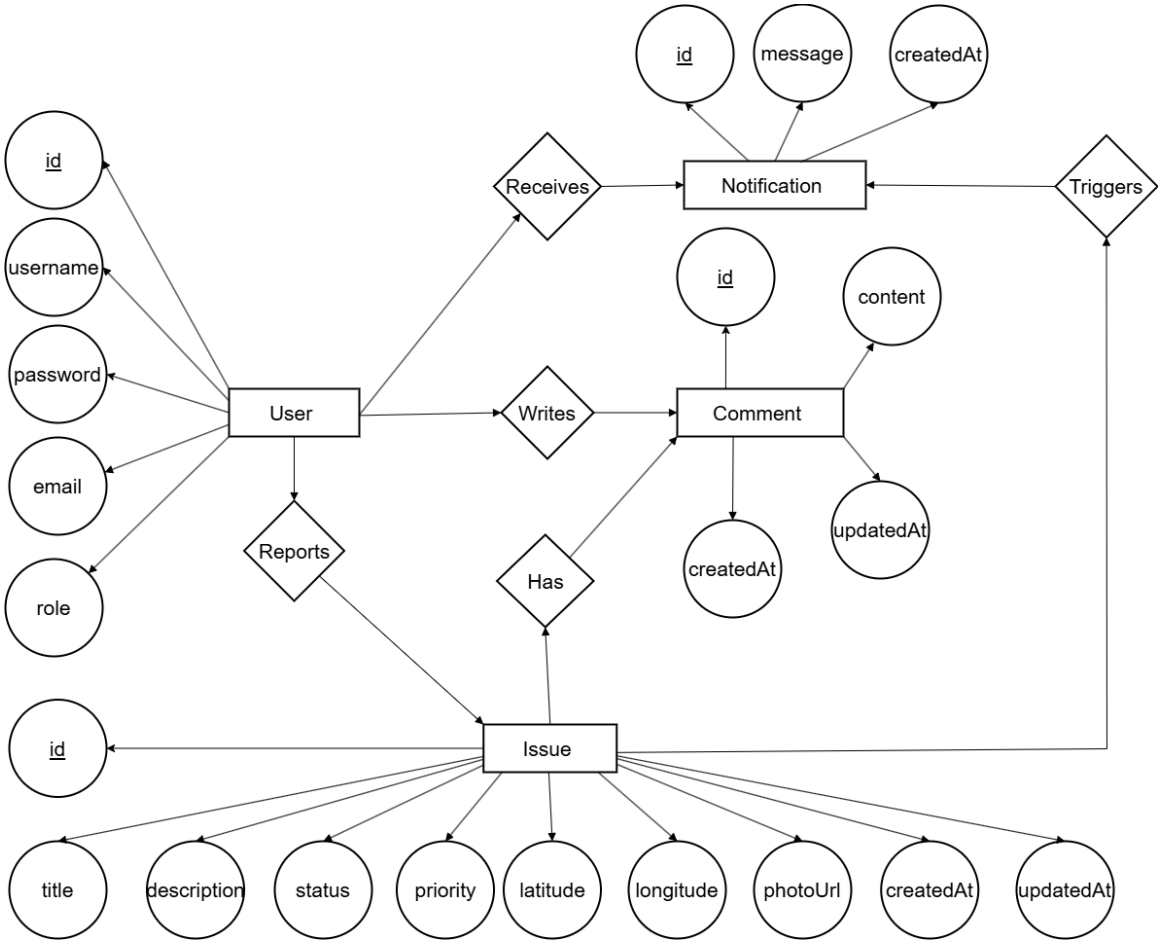

Figure 4: ER diagram of CIMS

The ER diagram outlines the relationships between core entities such as Users, Issues, Comments and Notifications.

3.1.2 DFD Diagram

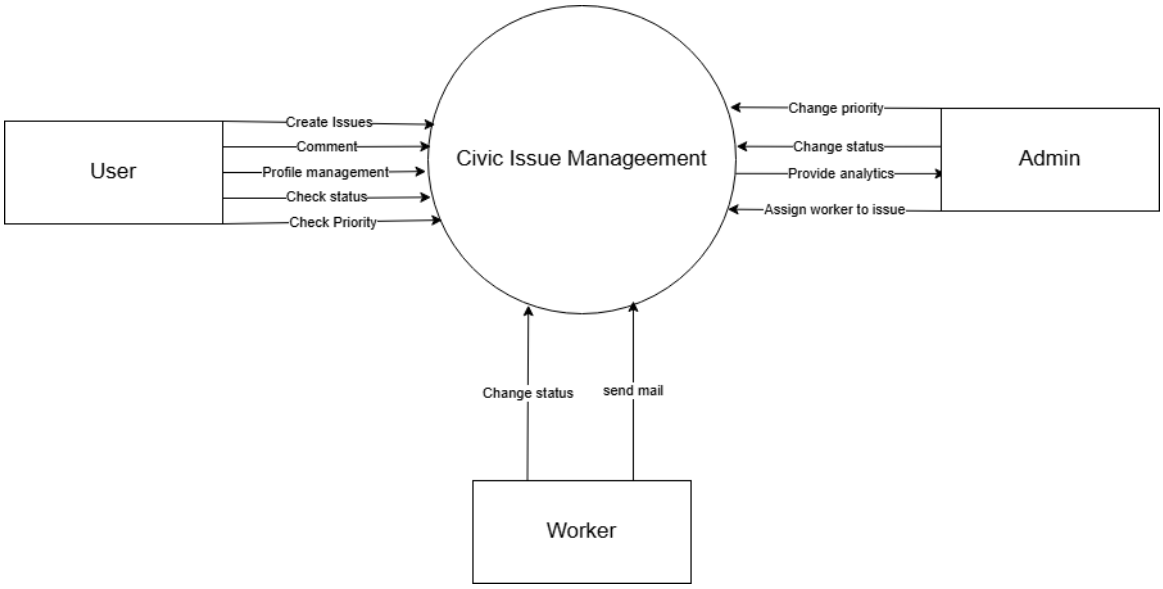

Figure 5: DFD level 0 for CIMS

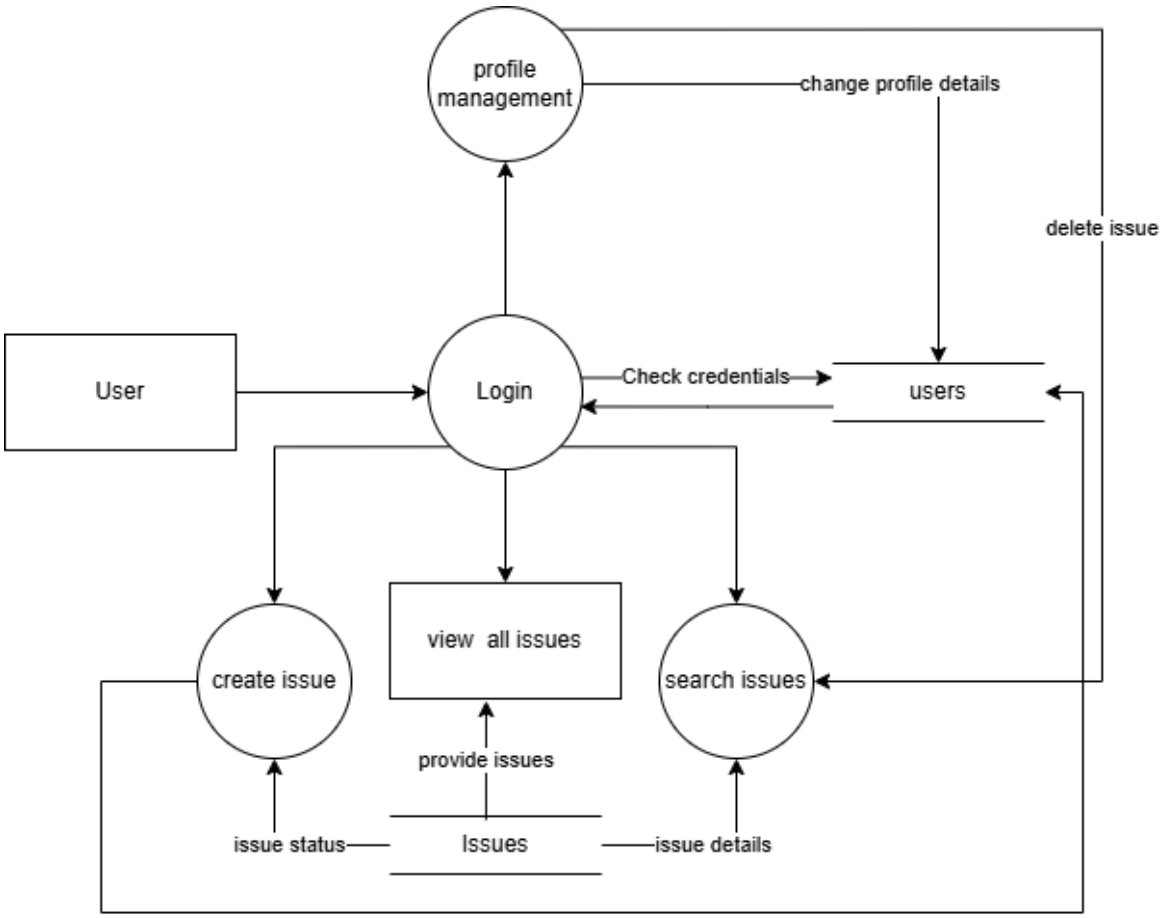

Figure 6: DFD level 1 for User of CIMS

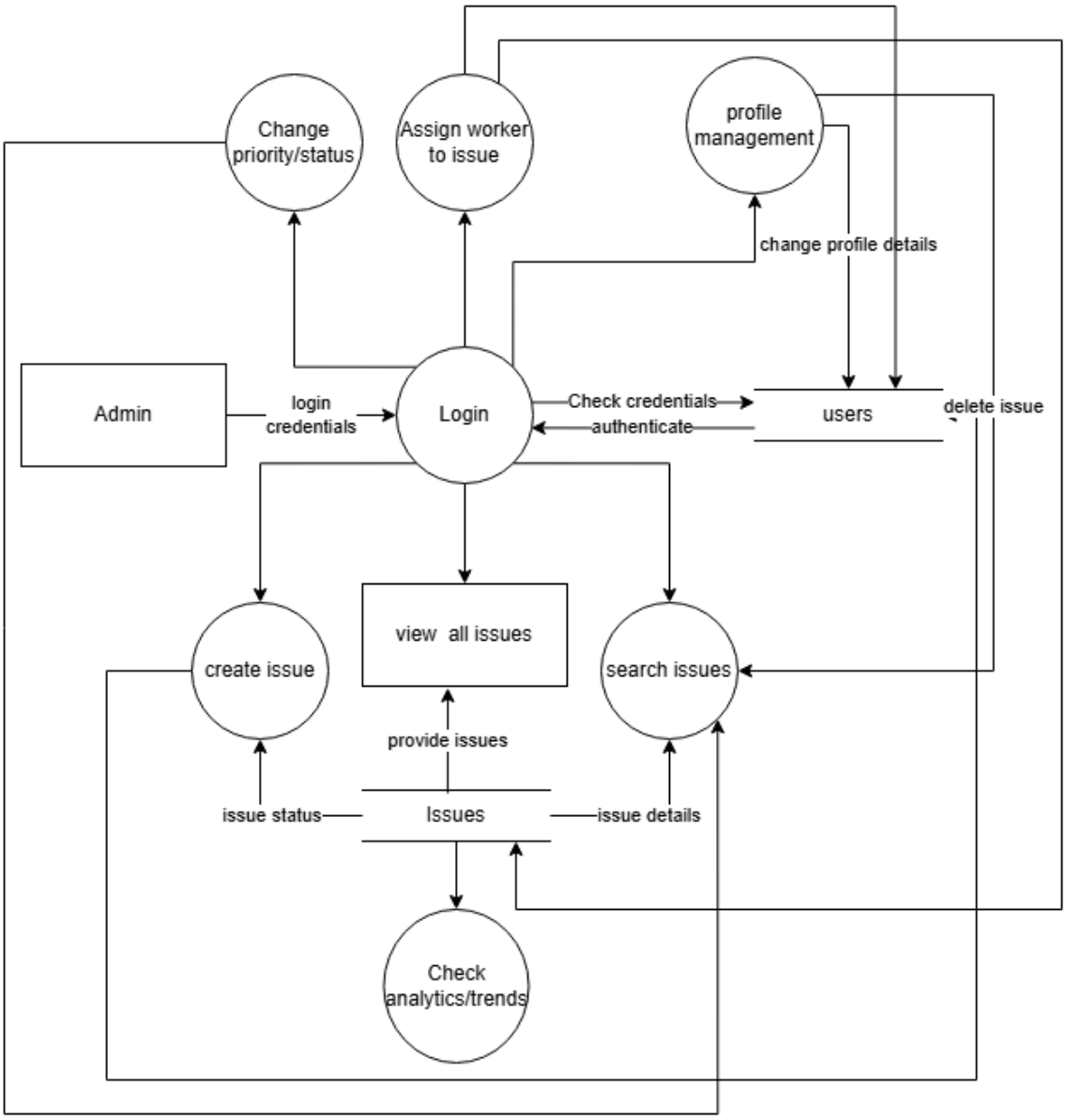

Figure 7: DFD level 1 for Admin of CIMS

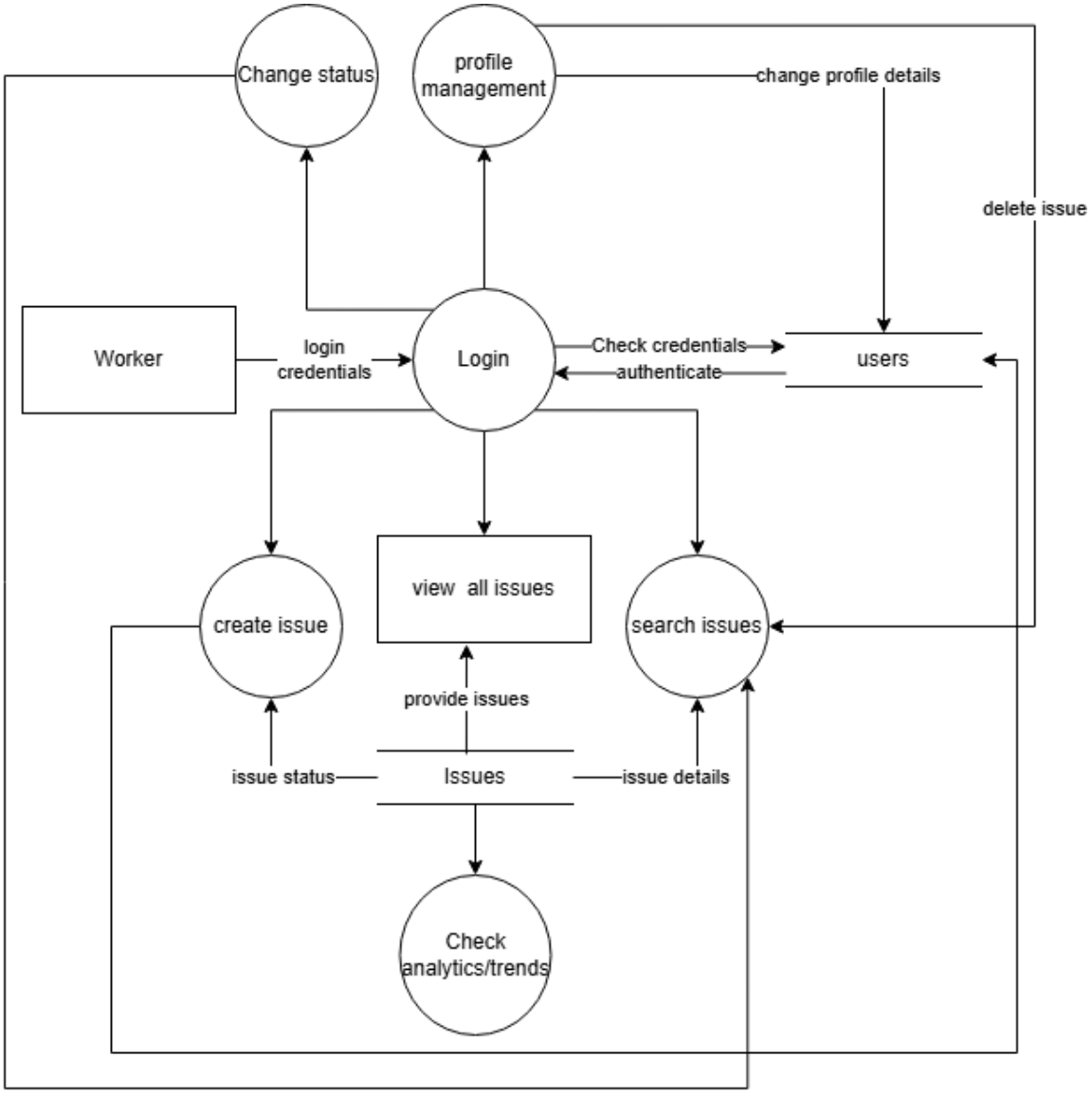

Figure 8: DFD level 1 for Worker of CIMS

The above Data Flow Diagrams collectively illustrate the structure and functionality of CIMS, which facilitates interactions between the users. The first level 0 DFD shows the core system. The DFD level 1 for User depicts the User's ability to view issues, create them, while the admin can create, update, and delete issues and their priority as well as status, as well as view issue details, and the worker can update the status of the issue per procedure. The DFD level 1 for admin and worker focuses on the their perspective, highlighting their access to view and manage issues, create issues, view analytics, and other issue-related data. Together, these DFDs provide a comprehensive overview of the Civic Issue Management System architecture.

CHAPTER 4: SYSTEM DESIGN

4.1. Database Design

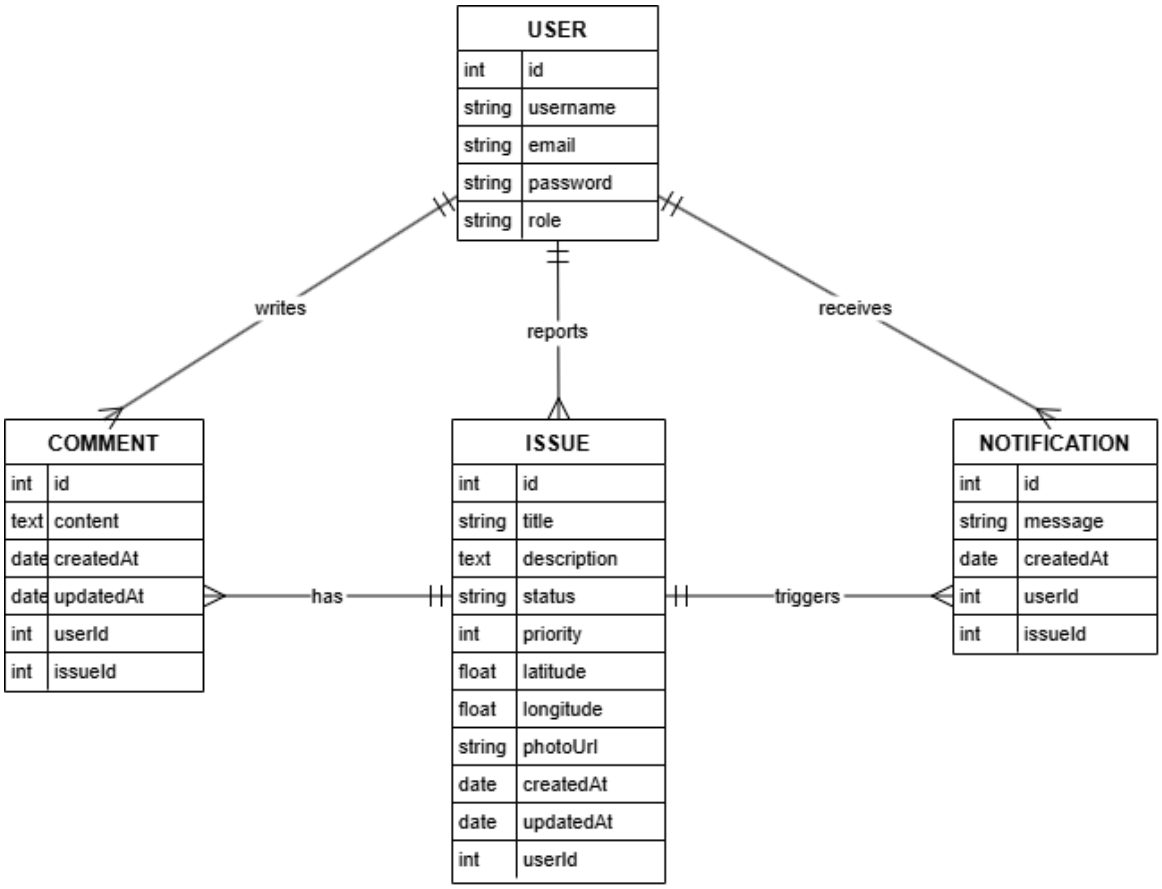

Figure 9: Database Schema of CIMS

The database schema is designed to support the core functionality of the CIMS, including the management of issues, comments, notifications and administrative tasks.

4.2. Flowchart

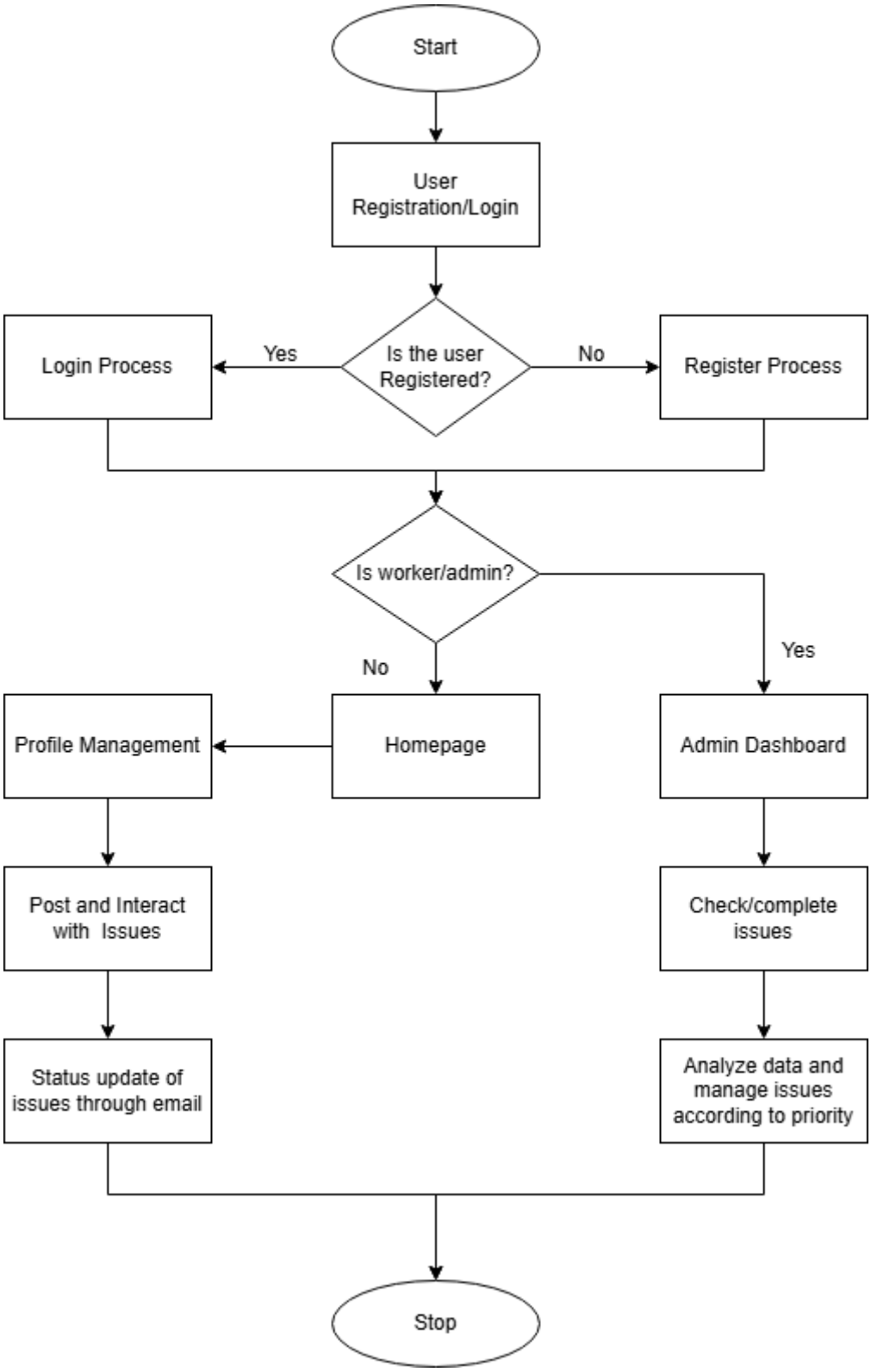

Figure 10: Flowchart for CIMS

The flowchart depicts a complete civic issue management system workflow starting from the home page. Users begin by either registering or logging in, after which they're directed

to different functionalities based on their role (Regular User or Admin). Regular users can search issues, view details, create issues. Admins have additional capabilities to create and manage issues, set priorities and status, and view analytics. Administrators possess the highest level of access, including issue management, user management, and viewing issue details.

4.4. Algorithm Details

Priority-Based Issue Management

The system implements a Time-Weighted Priority Queue algorithm to dynamically adjust and prioritize issues based on two primary factors:

• Initial Priority: Administrator-assigned value (scale of 1-7, where 1 is highest priority)

• Time Aging: Automatic priority adjustment based on issue age

Algorithm Parameters:

1. Base Priority (P): Integer value from 1-7 assigned by administrators.
2. Time Factor (T): Number of days since issue creation
3. Aging Interval (I): Fixed at 2 days - the period after which priority increases.
4. Status Weight (S): Binary factor (0 for completed, 1 for active issues)

Algorithm Steps:

1) Input Collection:
   - Retrieve base priority (P)
   - Calculate days since creation (T)
   - Check issue status (S)
2) Priority Adjustment:
   - Age Priority Factor = floor(T / I)
   - Adjusted Priority = max(1, min(7, P - (Age Priority Factor * S)))
3) Time Weight Calculation:
   - Time Weight = T * 0.1
   - Final Sort Weight = Adjusted Priority + Time Weight
4) Output:
   - Adjusted Priority (1-7 scale)• Sort Weight (for final ordering)

- Original creation timestamp (for tiebreaking)

Sorting Logic:

1) Primary Sort: By Adjusted Priority (ascending)
2) Secondary Sort: By Creation Date (oldest first)

Key Features:

- Automatic Priority Escalation: Issues gain priority every 2 days if unresolved.
- Priority Bounds: Maintains 1-7 scale regardless of age.
- Status-Based Adjustment: Only active issues receive priority adjustments.
- Time-Weight Hybrid: Combines discrete priority levels with continuous time-based weighting.

This algorithm ensures that:

1) Critical issues (priority 1) remain at top priority.
2) Older issues gradually gain prominence in the queue.
3) Completed issues maintain their original priority.
4) Similar-priority issues are ordered by age.

The TWPQ algorithm provides a balanced approach between administrative priority assignments and automatic time-based adjustments, ensuring that no reported issues are left unattended for extended periods while maintaining the significance of administrator-assigned priority levels.

CHAPTER 5: IMPLEMENTATION AND TESTING

5.1. Implementation

5.1.1. Tools Used

The implementation of CIMS leveraged the following tools and technologies:

- Frontend: React.js for dynamic user interfaces, React-Leaflet for interactive maps.
- Backend: Node.js with Express.js for RESTful APIs.
- Database: PostgreSQL managed using Sequelize ORM.
- Data Visualization: Chart.js for graphical representations in the admin dashboard.
- Authentication: JWT for secure user authentication.

5.1.2. Implementation Details of Modules

The system is modular, with each module designed to handle specific tasks. Key modules include:

- User Module: Handles user registration, login, and profile management.
- Issue Reporting Module: Enables users to report issues with geotagged photos.
- Admin Module: Allows administrators to manage reported issues, update their statuses, and analyze trends through the dashboard.
- Notification Module: Sends automated email notifications to users regarding issue status changes.

System Workflow:

1. Users submit reports via the frontend.
2. Reports are processed and stored in the PostgreSQL database through the backend API.
3. Admins access the analytics dashboard to prioritize and manage issues.
4. Real-time updates and notifications are sent to users.

5.2. Testing

5.2.1. Test Cases for Unit testing

Table 2: Test Case for Unit Testing of CIMS

TID	Test Case	Data Input	Expected Outcome	Actual Output	Result
1.	Verify the login functionality.	Username: admin@gmail.com Password: Admin#123	Successful Login and Redirect to the Admin Page	Successful Login with Redirection to the Home Page	Pass
2	Verify if login attempt is failed when wrong credentials are entered	Username: fake@email.com Password: 12345567	Login Error	Login Error with Wrong Credentials Message	Pass
3.	Check if users can upload issues with location, pictures and required details	Issue location, picture, and details	Successfully created issue	Issue created successfully	Pass
4.	Check if the issue status is updated on the user side after admin side updates it	Admin or worker updates issue status	Issue status reflected in citizen side	Successful update of issue status on citizen side	Pass
5.	Check if email notification is sent to user after admin assigns worker to the issue	Admin assigns a worker to an issue	Email successfully delivered to user email	Email is delivered successfully	Pass
6.	Check if users can delete their issues	Click in the delete button of the user profile of the respective issue	Issue should be deleted successfully	Issue is deleted successfully	Pass

5.2.2. Test Cases for System Testing

Table 3: Test Cases for System Testing of CIMS

TID	Test Case	Data Input	Expected Outcome	Actual Output	Result
1.	Check if the page of certain role can be accessed by users logged in through another role	Visit Admin url: localhost:3001/admin	Redirection to normal page or error page	403 Unauthorized Page Shown	Pass
2.	Check if user can post issues without sufficient details	Post an issue with incomplete details	Failure in accepting the issue creation	Issue creation fail	Pass
3.	Check if worker can update the priority	View issue details and attempt to change issue priority	Failure to change priority	Failure to change priority	Pass
4.	Check if all Issue details and comments get deleted	Delete button on issue	Issue completely deleted along with comments	Issue and all its constituents deleted	Pass

CHAPTER 6: CONCLUSION AND FUTURE RECOMMENDATION

6.1. Conclusion

The Civic Issue Management System (CIMS) successfully addresses the core challenges of urban issue management by providing a centralized platform for reporting, tracking, and resolving civic problems. Through features like geotagged reporting, real-time status updates, and an interactive analytics dashboard, the system enhances communication between citizens and administrators.

Testing and evaluation demonstrated that CIMS improves response times, optimizes resource allocation, and fosters greater transparency in urban governance. By leveraging modern web technologies and data analytics, the project offers a scalable and efficient solution for managing civic issues, contributing to smarter urban management and higher citizen satisfaction.

6.2. Future Recommendation

While CIMS meets its primary objectives, there are several areas for future enhancement:

1. Zone-Based Filtering for Admins:

Enable administrators to filter and manage issues based on specific geographic zones or districts, improving localized management.

2. Enhanced Security Features:

Implement multi-factor authentication (MFA) and advanced encryption protocols to further secure user data.

3. Community Engagement Features:

Introduce a voting system where citizens can upvote critical issues, helping administrators prioritize tasks based on community consensus.

REFERENCES

[1] H. G. S. &. Y. K. Li, Development of a location-based service system for smart urban management. Journal of Urban Technology, 2019.

[2] S. S. R. &. S. A. Manandhar, Developing a mobile-based application for the management of municipal solid waste. Journal of Environmental Management, 2022.

[3] E. I. K. M. G. &. G. J. C. Vlahogianni, Optimized and meta-optimized neural networks for short-term traffic flow prediction: A genetic approach. Transportation Research Part C: Emerging Technologies, 2021.

[4] "ResearchGate," 2022. [Online]. Available: https://www.researchgate.net/figure/Diagram-of-MVC-Architecture-applied-as-a-pattern-to-the-system_fig2_288318654. [Accessed 2024].