Final Project Report for Bachelor in Computer Engineering

Mobile Road Maintenance Complaint System

Submitted By:

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United Technical College

Faculty of Science and Technology

Affiliated to Pokhara University, Nepal

September, 2024

Minor Project Report for the Degree of Bachelor of Computer Engineering

Mobile Road Maintenance Complaint System

Supervised By: Er. Sahit Baral

A third-year project report submitted in partial fulfillment of the requirements for the degree of Bachelor of Computer Engineering.

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Dedication

This project is dedicated to all those who travel the roads each day, navigating through challenges and obstacles. A special dedication to the teacher who provided invaluable guidance and to our department for assigning such a humble and supportive supervisor, enabling us to complete this project work. To all the individuals who have worked tirelessly to support and guide us in completing this project. This project is a tribute to your collective efforts and a commitment to a safer and smoother road ahead.

Declaration

We hereby affirm that this research study, titled "Mobile Road Maintenance Complaint System" represents the culmination of our original work. Any relevant prior research conducted by other scholars has been duly acknowledged.

We assume full responsibility for the precision and authenticity of all data and information contained within this study.

Names of the Students:

Aashutosh Sapkota

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Abhishek Sharma

Rajeev Paudel

Date: September 12, 2024

Recommendation

This is to certify that the project work titled “Mobile Road Maintenance Complaint System” prepared and submitted by Aashutosh Sapkota, Hom Bdr. Pathak Kshetri, Abhishek Sharma, and Rajeev Paudel in partial fulfillment of the requirements for the degree of Bachelor of Engineering (BE) in Computer Science, awarded by Pokhara University, has been conducted under the supervision of Er. Sahit Baral.

We recommend the acceptance of this project by Pokhara University based on its comprehensive research, innovative approach, and successful execution.

Signature: _____

Name of the Supervisor: Er. Sahit Baral

Designation: Head of Department (HoD)

Organization: United Technical College

Date: September, 2024

Certificate

This project entitled “Mobile Road Maintenance Complaint System” was prepared and submitted by Aashutosh Sapkota, Hom Bdr. Pathak Kshetri, Abhishek Sharma, and Rajeev Paudel have been examined by us and are accepted for the award of the degree of Bachelor Engineering in Computer by Pokhara University.

Signature: _____

Name of External:

Designation:

Organization:

Signature: _____

Name of Supervisor: Er. Sahit Baral

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Name of Principal: Prof. Keshab Datt Awasthi (PhD)

Organization: United Technical College

Date: September, 2024

Abstract

Road accidents are incidents that occur on roads involving vehicles, resulting in damage to property, injuries, or even loss of life. Increasing road accidents, often linked to bad roads, require innovative solutions for better safety. In response to this pressing issue, we introduce the Mobile Road Maintenance Complaint System, a dynamic application designed to empower citizens to actively contribute to road safety improvements. The Mobile Road Maintenance Complaint System empowers citizens to report road issues directly to government authorities, fostering collaboration for safer roads. Built with Flutter, it ensures a seamless experience across platforms. With geolocation precision, photo uploads, and push notifications, users can actively engage in improving road safety. The application is built using Flutter, Dart, and Firebase ensuring a user-friendly interface and efficient data Management.

KEYWORDS: *Road accidents, Solution, Empowerment, Report, Geolocation, Photo Uploads, Flutter, Dart, Firebase, etc.*

Acknowledgement

We would like to express our heartfelt gratitude to all those who have contributed to the successful completion of this project.

First and foremost, we are deeply thankful to our project advisor, Er. Sahit Baral, Er. Sudeep Thapaliya for their unwavering guidance, invaluable insights, and constant encouragement throughout this journey. Their expertise and mentorship played a pivotal role in shaping the direction and quality of this project.

We extend our appreciation to the faculty members of the United Technical College Department of Computer Engineering for their dedication to imparting knowledge and for providing us with a conducive learning environment.

We are also indebted to our teammates who worked tirelessly, sharing their knowledge and experiences. Our collaborative efforts were instrumental in achieving the project's goals.

We extend our gratitude to our family for their unwavering support and understanding during the demanding phases of this project.

Lastly, we would like to express our thanks to all the resources, books, and online materials that were instrumental in enhancing our understanding and knowledge in the field of computer engineering. This project would not have been possible without the collective efforts and support of all these individuals and resources. We are truly grateful for their contributions.

AKAR

United Technical College

September, 2024

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Acronyms and Abbreviations

DFD	:	Data Flow Diagram
ERD	:	Entity Relationship Diagram
GB	:	Gigabytes
GDP	:	Gross Domestic Product
HTTP	:	Hypertext Transfer Protocol
MB	:	Mega-Bytes
RAM	:	Random Access Memory
RDBMS	:	Relational Database Maintenance System
SDK	:	Software Development Kit
VS Code	:	Visual Studio Code

Chapter 1: Introduction

1.1 Background

Roads play a crucial role in the transportation system of Nepal, serving as the primary mode of transport. In the past, roads were constructed without adequate consideration for future maintenance needs, resulting in a significant loss of road assets. On average, 5 km of road per year per 100 km of roads built were being lost. Even higher-standard roads, supported by donors, experienced a similar rate of decline. From 1988 to 1992, the length of roads in "poor condition" nearly doubled, and the overall condition of the major road network deteriorated rapidly, with approximately 180 km of good road being lost annually [1].

Unfortunately, the situation is further aggravated by the increasing number of road accidents and fatalities. The declining road quality, coupled with the growing volume of vehicles on the roads, has led to a surge in fatal accidents nationwide. According to the World Health Organization (WHO) report of 2013, more than three thousand people lose their lives daily due to road traffic accidents globally, with approximately 1.3 million annual fatalities. The alarming combination of poor road conditions and rising accident rates emphasizes the urgent need for research to address these critical issues [2].

By investigating the factors contributing to road deterioration, exploring effective road maintenance strategies, and examining measures to enhance road safety, this proposed research aims to make significant contributions toward improving Nepal's road infrastructure and reducing the number of road accidents and fatalities. The deteriorating road conditions have contributed to an increase in accidents. Factors such as potholes, inadequate signage, poor road markings, and lack of maintenance have created hazardous conditions for drivers, pedestrians, and other road users. The combination of substandard road infrastructure and unsafe driving behaviors has resulted in a high number of road accidents, injuries, and fatalities in Nepal [3].

To address these challenges, the proposed solution of the Mobile Road Complaint Maintenance System offers an application to tackle the problem of poor road conditions. The system aims to empower citizens by providing them with a platform to actively participate in improving road safety. Through this application, individuals can report road conditions and maintenance requirements to the government, ensuring that concerns regarding road quality and safety are promptly addressed [3].

The key objective of the Mobile Road Complaint Maintenance System is to establish a transparent and efficient collaboration between the public and government organizations. By leveraging the power of citizen engagement, the system aims to enhance the quality of roads and prevent accidents. It provides a mechanism for citizens to report issues such as potholes, damaged signage, inadequate lighting, or any other factors that contribute to unsafe road conditions. These reports can then be reviewed and addressed by the relevant authorities responsible for road maintenance [4].

Mobile Road Complain Maintenance System offers a promising solution to the challenges faced in road Maintenance and the escalating accident rates in Nepal. By facilitating citizen engagement, promoting transparency, and enabling efficient collaboration between the public and government organizations, the system has the potential to significantly improve road conditions and enhance road safety. Through its implementation, Nepal can work towards achieving a safer and more sustainable road network [5].

1.2 Problem Statement

The roads in Nepal are currently plagued by several issues, including poor maintenance, inadequate infrastructure, and lack of timely repairs. However, one of the significant challenges exacerbating these problems is the absence of a dedicated governing body or mechanism to effectively listen to public concerns and address the road-related issues reported by citizens. The limited government budget allocations and historical negligence of future maintenance needs during road construction have resulted in deteriorating road conditions. The road network is facing a rapid decline, with an increasing length of roads

falling into the category of "poor condition." These substandard road conditions pose significant risks to road users, leading to a surge in accidents, injuries, and fatalities [6].

The lack of a system for public involvement in road maintenance makes the problem worse. Without a way for people to report road issues, concerns are often ignored. This lowers public trust and keeps road conditions unsafe [6].

We would solve this problem by implementing a user-friendly road Maintenance system which can help to address the challenges in road Maintenance. This system enables real-time monitoring, public reporting of road issues, streamlined maintenance processes, and improved communication between the government and the public.

1.3 Objectives

The objectives of the proposed system are as follows:

1. To facilitate identifying areas requiring maintenance, repairs, or infrastructure upgrades for safer and more reliable road networks.
2. To develop a mobile application for reporting road maintenance issues using Flutter.
3. To empower citizens by providing them with a platform to actively participate in road improvement.

1.4 Scopes

1. **Complaint submission:** Users can report road complaints through the application.
2. **Government collaboration:** Facilitating collaboration between users and government agencies.
3. **Scalability:** Capable of handling a large volume of complaints and future growth.
4. **Public participation:** Encouraging citizen involvement in road improvement.

5. **Road network improvement:** Contributing to safer and more reliable road networks.

1.5 Limitation

1. **Reliability of user-generated data:** User-generated data may vary in accuracy and reliability, necessitating validation and verification mechanisms.
2. **Connectivity and access:** A stable internet connection and access to smartphones or internet-enabled devices are necessary for system usage, potentially limiting its effectiveness in areas with connectivity issues.

1.6 Application

The main concept of this application is to establish a platform that empowers citizens to actively participate in enhancing road safety and infrastructure. Through this platform, individuals can report road complaints, such as poor road conditions, inadequate signage, or other hazards. Also, to improve the overall quality and safety of the road network.

1.7 Feasibility Analysis

Feasibility analysis is a process of evaluating the practicality and likelihood of success of a proposed project or venture. It involves assessing the economic, technical, and operational feasibility of the project.

1.7.1 Economic Feasibility

The economic feasibility of a road maintenance complaint management system (RMCMS) can be assessed by comparing the costs and benefits of the system.

- **Development Costs:** The estimated cost of developing the RMCS includes expenses for software development, server infrastructure, and initial setup. This cost is considered feasible as it falls within the allocated budget. By leveraging open-source tools and efficient project management, the development costs are kept under control.
- **Implementation Costs:** These costs encompass the expenses associated with training government staff and deploying the system across various regions. The implementation costs are justified by the long-term benefits of streamlined road maintenance processes and improved public satisfaction. The cost of training is a one-time investment that will enable staff to effectively use the system, ensuring smooth operation from the outset.
- **Maintenance Costs:** Ongoing maintenance costs include bug fixes, software updates, and server upkeep. These costs are essential to ensure the system remains functional and up-to-date with technological advancements. The maintenance costs are projected to be minimal compared to the savings generated by the system's efficiency in addressing road maintenance issues promptly.

1.7.2 Technical Feasibility

The technical feasibility analysis demonstrates that the development and implementation of the "Mobile Road Maintenance Complaint Management System" is both practical and attainable.

Technology Assessment: The required technology components, including hardware and software, are readily available and well-established in the market. There are no significant technological barriers that would impede the project's progress.

Skills and Expertise: Our project team possesses the necessary technical skills and expertise to design, develop, and maintain the system. In cases where specialized knowledge is required, we have identified potential team members or external consultants with the requisite skills.

1.7.3 Operational Feasibility

The operational feasibility analysis affirms that the "Mobile Road Maintenance Complaint Management System" can be smoothly integrated into existing operations and effectively used by all stakeholders.

User Acceptance: Extensive user feedback and input from road maintenance personnel, citizens, and other relevant stakeholders have been gathered and incorporated into the system's design.

Operational Processes: The system seamlessly integrates with existing operational processes and workflows. It streamlines the management of road maintenance complaints, optimizes resource allocation, and enhances communication between various departments and stakeholders.

1.8 System Requirements

For our Road Complaint Maintenance System project, the hardware and software requirements are as follows:

1.8.1 Software Requirements

1. **Operating System:** Compatible with various operating systems, including Windows, macOS, Android, and iOS.
2. **Web Browsers:** Support for popular web browsers such as Google Chrome, Mozilla Firefox, Microsoft Edge, and Safari.
3. **Responsive Design:** The system should be designed and developed using responsive web design principles to ensure optimal user experience across different devices and screen sizes.
4. **Cross-Browser Compatibility:** The system should be compatible with multiple web browsers to ensure consistent functionality and appearance.

1.8.2 Hardware Requirements

1. **Mobile Devices:** Any smartphone or tablet with an internet connection and a modern web browser.
2. **Computers:** Any desktop or laptop computer with an internet connection and a modern web browser. The system should be compatible with both Windows and macOS operating systems.

By ensuring compatibility with a wide range of devices and operating systems, our Road Complaint Maintenance System can be accessed and used seamlessly by users on their smartphones, computers, and other devices.

Chapter 2: Literature Review

The use of mobile-based solutions for road management and public complaint registries has become increasingly popular in recent years.

CPOT - Construction App for Road Maintenance (Nordics)

Streamline the reporting and repair of road damage. CPOT mobile app allows users to photograph damage, pinpoint location, categorize issues, and order materials directly. Reduced reporting and repair time by 15 times, simplified communication, and improved efficiency [7].

Perup - Road Inspection and Management System Roadai (Argentina)

Improve data collection and analysis for informed maintenance decisions. Perup app enables inspectors to record road conditions, defects, and repair needs using smartphones and tablets. Data is then analyzed for prioritization and resource allocation. Enhanced data accuracy and accessibility, optimized maintenance planning, and reduced costs [8].

IM Road Repair System (India)

Bridge the gap between citizens, authorities, and contractors for efficient road repairs. IM Road Repair app allows users to report potholes, track repairs, and receive updates. Authorities manage repair projects and contractors use the app for scheduling and documentation. Increased citizen participation, improved communication and collaboration, and enhanced accountability in road maintenance [9].

Rajmarg Yatra (India)

Rajmarg Yatra is an initiative by the National Highways Authority of India (NHAI) that provides travellers with real-time information regarding Indian national highways. It includes features like toll plaza information, highway route details, amenities available along the highways, and more, aimed at enhancing the road travel experience for users across India [10].

2.1 Case Study

2.1.1.1 FixMyStreet

FixMyStreet is an online platform that has revolutionized the way citizens engage with their local communities to address infrastructure problems. Launched in 2007, FixMyStreet provides a user-friendly website and mobile application that enables citizens to report various issues, such as potholes, broken streetlights, and graffiti, by pinpointing the problem's location on a map [11].

The primary objective of FixMyStreet is to empower citizens and establish a direct and efficient channel of communication with local government authorities. By utilizing the platform, citizens can actively participate in improving their community's infrastructure and contribute to the prompt resolution of reported issues. One of the key features of FixMyStreet is its user-friendly interface, making it easy for individuals to report problems seamlessly. Through the website or mobile app, users can accurately pinpoint the location of the issue on a map, facilitating swift identification and resolution. FixMyStreet promotes transparency and collaboration by providing real-time updates to users. Citizens can track the progress of their reported issues and receive updates on their resolution status, fostering a sense of engagement and accountability [12].

FixMyStreet's data collection and analysis have also proven valuable. By analyzing the reported issues, local authorities can gain insights into patterns, prioritize repairs based on severity, and allocate resources efficiently. This data-driven approach enables evidence-based decision-making and enhances resource utilization. FixMyStreet has transformed the way citizens engage with local authorities, fostering transparency, accountability, and collaborative problem-solving [13].

2.1.1.2 Roadify

Roadify is an innovative application that has revolutionized the way road user access and share real-time information about road conditions, traffic congestion, and incidents.

This mobile app provides a platform for users to report and communicate road-related updates, contributing to a collective pool of data that enhances awareness and assists drivers in making informed decisions [14].

The main concept behind Roadify is to create a community-driven network where users actively participate in sharing real-time road information. By utilizing the app, users can report road hazards, accidents, or road closures, providing valuable insights to other road users and relevant authorities. The success of Roadify can be attributed to several factors. The app harnesses the collective power of its user base, creating a vast network of real-time road information. This network effect enhances the accuracy and reliability of the reported information, benefiting all users who rely on the app for road updates [15].

Additionally, Roadify leverages data-driven insights to enhance the overall road experience. The app collects and analyzes user-generated data, enabling authorities to identify traffic patterns, areas prone to accidents, and infrastructure improvements. This data-driven approach supports evidence-based decision-making for road planning and Maintenance. Roadify enhances road safety and empowers individuals to make informed decisions while traveling [14].

2.1.1.3 Street Bump

Street Bump is an innovative case study that focuses on leveraging technology to improve road conditions. Developed by the City of Boston, Street Bump is a smartphone application that allows citizens to contribute to the identification of potholes and other road defects. The app uses the accelerometer and GPS sensors in smartphones to detect and record road irregularities as users drive along city streets. When a bump or pothole is detected, the app automatically sends the data, including the location and severity of the road issue, to the city's Department of Public Works [16].

The case study of Street Bump highlights the power of citizen engagement and crowdsourcing in gathering valuable data for road maintenance and repairs. By involving the community in reporting road defects, the city can prioritize, and address maintenance needs more efficiently. This innovative approach not only improves the overall condition

of the road network but also enhances transparency and accountability in government operations [15].

The success of Street Bump lies in its ability to harness the ubiquity of smartphones and engage citizens as active participants in the maintenance and improvement of city infrastructure. The data collected through the app helps the city identify areas in need of repair, allocate resources effectively, and provide a safer and smoother driving experience for residents and visitors. Moreover, the case study demonstrates the potential of technology-driven solutions in solving real-world challenges, transforming the way governments and communities collaborate for the benefit of all [16].

Conclusion:

FixMyStreet is an online platform that empowers citizens to report local infrastructure issues. Users can pinpoint problems on a map, enabling swift identification and resolution by authorities. The platform promotes transparency and data-driven decision-making, revolutionizing citizen engagement with local governments. Roadify is a mobile app that lets users report and access real-time road conditions, traffic, and incidents. By crowdsourcing data, it provides a reliable network to improve road safety and inform infrastructure decisions. Roadify leverages the network effect and data insights to support evidence-based planning and maintenance. Street Bump, a Boston app, uses smartphone sensors to detect and report potholes. The crowdsourced data helps the city prioritize and address road maintenance needs efficiently, improving infrastructure. The case showcases the power of citizen engagement and ubiquitous tech in enhancing government transparency and accountability, demonstrating the potential of technology-driven solutions.

2.2 Status of Road Maintenance in Nepal

There is little doubt that roads are arteries of development and can add to the overall quality of citizens' lives. Sadly, if you talk about public roads in Nepal, national highways, strategic road networks, city roads, feeder roads, district roads, or rural roads—most of them have

been clogged and turned into perils. Further, countless potholes, poor drainage systems, yawning ditches, several mismanaged manholes and sinkholes as well as other road-related infrastructural breakdowns have perennially added to the public woes [1].

At the eleventh hour of every fiscal year, the government speeds up various developmental projects at the cost of sustainable infrastructures. Our contractors can be seen carrying out many developmental activities–digging ditches, laying sewerage pipelines, constructing and blacktopping roads, and setting up other road-related critical infrastructures, among others. Hence, the under-utilization of the budget for the substantial part of the fiscal year and gush in expenditure towards the end only makes matters worse, thus leading to rickety, shoddy, and substandard road-related infrastructures [1].

The Department of Road (DoR) and the Department of Local Infrastructure Development and Agricultural Roads (DoLIDAR) are government agencies responsible for the planning, construction, maintenance, and improvement of public roads and related infrastructure. They have the necessary institutional support, policies, legal frameworks, technical expertise, and human resources to carry out these responsibilities effectively [2].

Therefore, such perilous roads and road-related infrastructures require the serious attention of the concerned agencies of the government to identify the root causes and mitigate their potential costs.

Chapter 3: Methodology

It provides a structured framework for executing and completing a project. In the context of this project, the methodology outlines the step-by-step process that will be followed to design, develop, and deploy the Mobile Road Maintenance Complaint System. The methodology encompasses various stages, each stage involves specific tasks and activities that contribute to the successful implementation of the project. The methodology ensures a systematic and organized approach, allowing for efficient project Maintenance and the achievement of project objectives [15].

The purpose of the project methodology is to allow for controlling the entire Maintenance process through effective decision-making and problem-solving while ensuring the success of specific processes, approaches, techniques, methods, and technologies.

In the proposed methodology there are 4 different stages which are the flow of the project, system design, software and hardware requirements and testing and maintenance.

3.1 Development and Planning

3.1.1 Concept and Initiation

Before starting any project, it's important to gather and assess the feasibility of the requirements. The project could proceed if the requirements were viable. In this phase, all stakeholders, including citizens and government officials, collaborated to collect all essential information required for the project's creation and development. It was akin to assembling all the puzzle pieces to ensure we had everything necessary. This approach enabled developers and designers to comprehend the tasks at hand and develop a system that addresses road-related issues.

3.1.2 Definition and planning

In this project, we developed a mobile application that facilitated the maintenance of road complaints. The key components of the system included features for complaint submission

by users, services for addressing the complaints, efficient administration and maintenance of the system, and comprehensive tracking and resolution of reported road issues.

3.1.3 Software Used

1. **Flutter:** Flutter is an open-source UI toolkit by Google for building natively compiled applications across mobile, web, and desktop from a single codebase. Its standout features include "Hot Reload" for rapid development, expressive UI elements for visually appealing designs, and high-performance output on both iOS and Android devices. Flutter's adoption by major companies and a supportive community makes it an increasingly popular choice for efficient and cross-platform app development [17].
2. **Visual Studio Code:** VS Code is a popular source code editor developed by Microsoft. It is widely used by developers for various programming languages and platforms. VS Code offers a lightweight yet powerful environment with features like syntax highlighting, code completion, debugging, and Git integration. It supports a wide range of extensions that enhance functionality, allowing developers to customize their workflow. With its user-friendly interface and extensive community support, VS Code has become a preferred choice for many developers seeking a versatile and efficient code editor [18].
3. **Android Studio:** Android Studio is the official integrated development environment (IDE) for Android app development by Google. It's built on IntelliJ IDEA, uses the Gradle build system, and supports a visual UI designer. With features like an emulator, code analysis, and Google Play integration, Android Studio streamlines app development. It's regularly updated, supports Kotlin, and has a rich plugin ecosystem. Android Studio offers a feature-rich experience, including a visual UI designer, emulator support, and seamless integration with the Android SDK [19].
4. **Version Control System – GIT**: Git is a decentralized version control system designed for collaborative software development. Git tracks changes in source code, allowing developers to work on projects simultaneously. Key features include commits for

tracking changes, branching for independent development, and merging for combining changes. Git repositories can be local or hosted remotely on platforms like GitHub. Its popularity is attributed to its efficiency, flexibility, and essential commands like: init, add, commit, push, and pull. Git is integral to modern development, streamlining collaboration and ensuring codebase integrity [20].

3.1.4 Development

Mobile Road Maintenance Complaint System project, utilized the following technologies:

1. **Dart Programming Language:** Dart is a versatile programming language for building web, mobile, and server applications. Known for its strong typing and object-oriented structure, Dart is particularly popular in conjunction with Flutter, allowing developers to create apps for multiple platforms from a single codebase. It is used to build native mobile apps for Android or iOS, desktop apps, and servers. It uses a source-to-source compiler to arrange codes more quickly. Hence, it has a more efficient UI in comparison to other programming languages [21].

2. **Flutter SDK:** Flutter SDK facilitates cross-platform app development. It uses Dart as its programming language and offers a rich set of customizable widgets for building expressive user interfaces. Key features include Hot Reload for real-time code changes, a single codebase for iOS and Android, and seamless integration with native features. With a vibrant community and regular updates, Flutter is known for its versatility in creating visually appealing and high-performance applications across mobile, web, and desktop platforms [17].

3.1.5 Launch and Execution

Once the development of the Mobile Road Complaint Maintenance System is complete, it will be launched for real-world usage. Users will be able to access the system, submit

complaints, and interact with its features. Compatibility will be ensured, testing conducted, and valuable user feedback gathered to make necessary improvements.

3.1.6 Performance and Control

The system's speed, stability, and scalability will be continuously monitored. Regular performance tests will be conducted to ensure it meets project goals. Measures for data backup and security will also be implemented to maintain control and ensure a seamless user experience.

3.2 System design

After gathering and analyzing the requirements, the Mobile Road Maintenance Complaint System was given a solid structure. During this phase, the project's architecture was designed based on the collected requirements. Creative and intuitive diagrams such as system flow, ER diagrams, system architecture, DFDs (Data Flow Diagrams), and use cases were created.

Those visual representations helped in visualizing the system's structure, data flow, and interactions. By carefully designing the architecture, the foundation was set for the successful development and implementation of the road complaint maintenance system.

3.2.1 System Flow Diagram

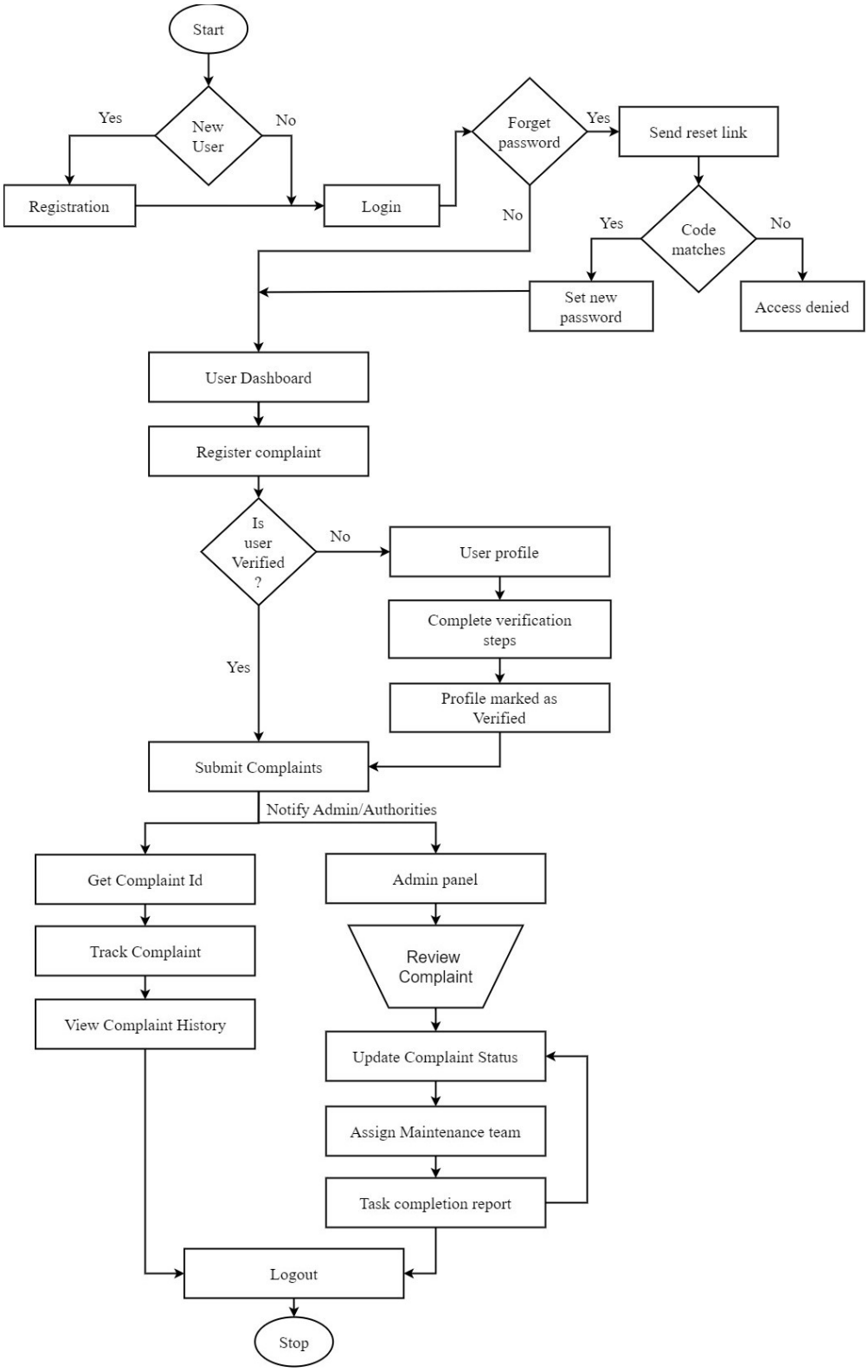

Figure 3.2.1: System Flow Diagram for AKAR (Group Study, 2024)

3.2.2 E-R diagram

E-R Diagram stands for Entity Relationship Diagram, also known as ERD, which is a diagram that displays the relationship of entity sets stored in a database. In other words, ER diagrams help to explain the logical structure of databases. ER diagrams are created based on three basic concepts: entities, attributes, and relationships. ER Diagrams contain different symbols that use rectangles to represent entities, ovals to define attributes, and diamond shapes to represent relationships [22].

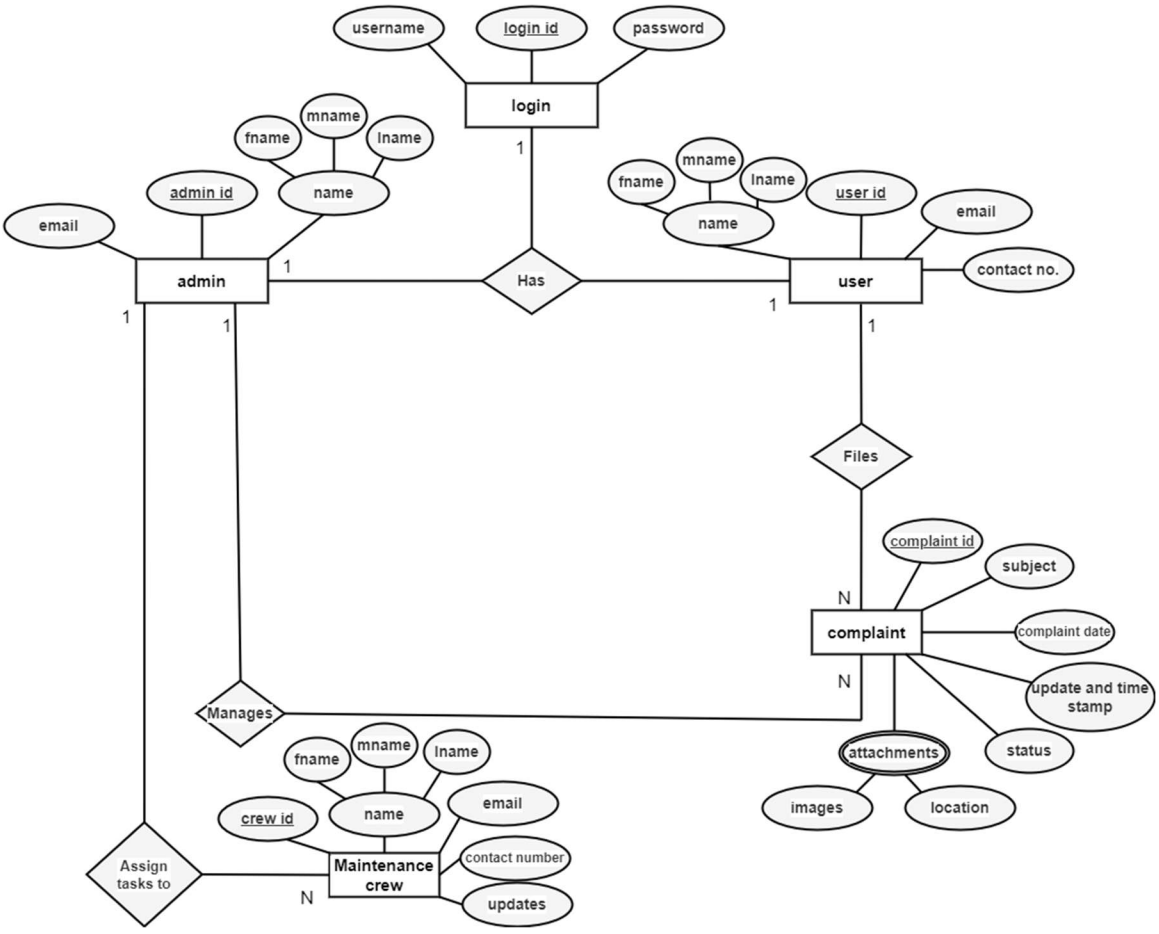

Figure 3.2.2: E-R Diagram for Road Maintenance System (Group Study 2024)

3.2.3 DFD (Data Flow Diagram)

Data Flow Diagrams (DFDs) were important tools for our Road Complaint Maintenance System project. DFDs visually showed how data moved in our system, helping us find and fix issues to make it work better. They gave us a clear picture of how our system was built and what it did, making it easier for our team to work together. DFDs could be used at different levels, from big pictures to small details, to help us design and improve our system.

They also helped us understand how data connected and moved, ensuring everything worked smoothly. Using DFDs in the project improved the understanding, design, and implementation of the Road Maintenance Complaint System [23].

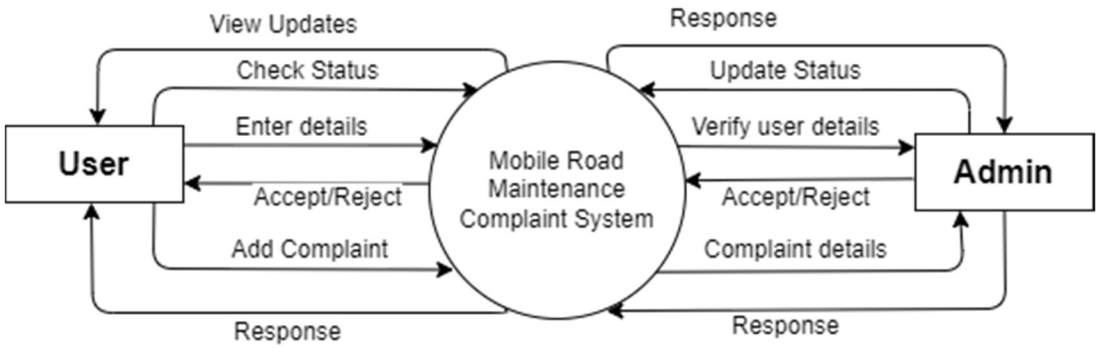

Figure 3.2.3: Level 0 DFD (Group study, 2024)

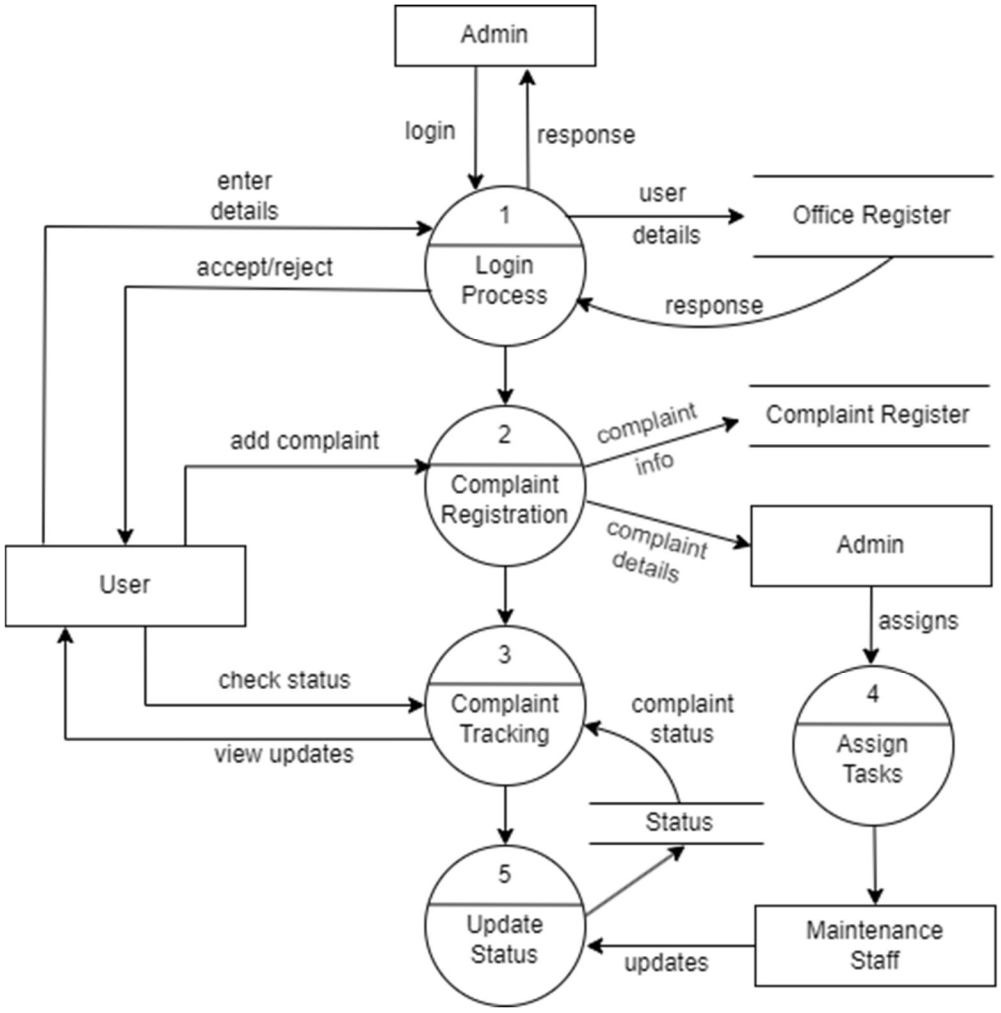

Figure 3.2.4: Level 1 DFD (Group study, 2024)

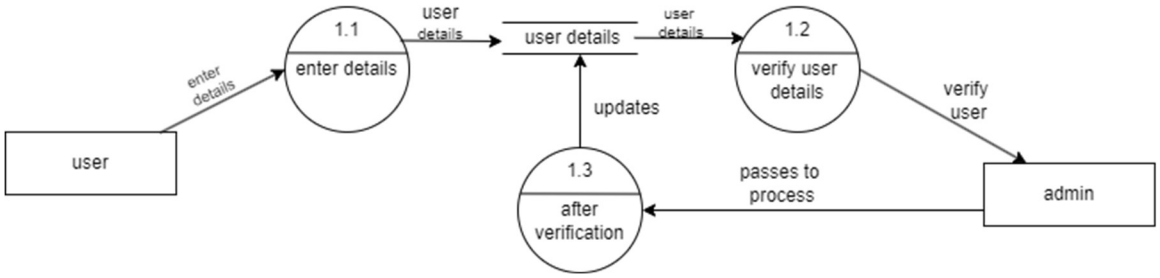

Figure 3.2.5: Level 2 DFD for Login process (Group study, 2024)

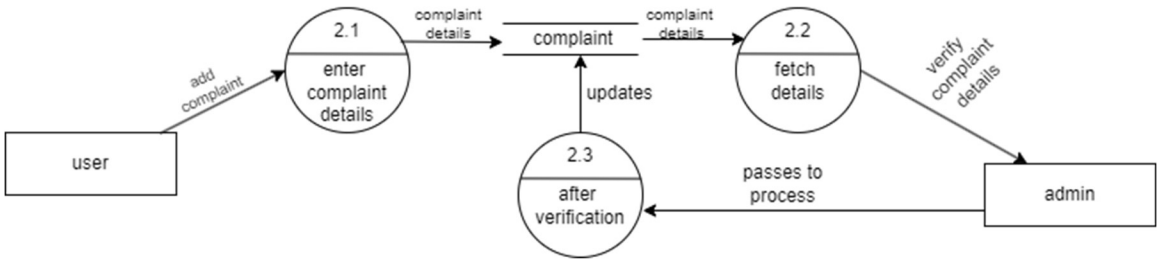

Figure 3.2.6: Level 2 DFD for Complaint Registration process (Group study, 2024)

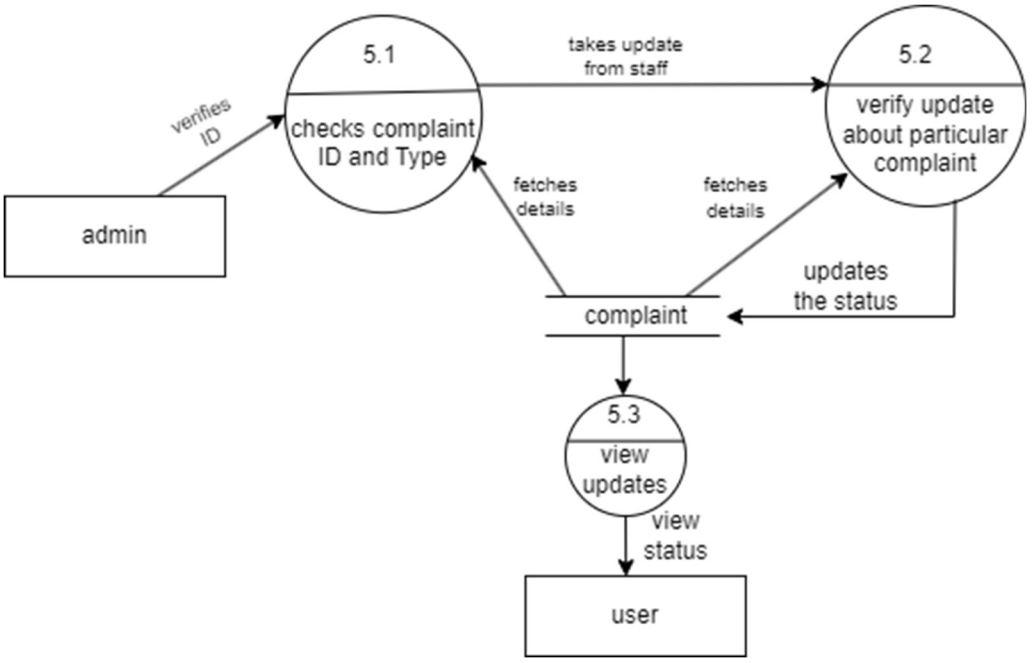

Figure 3.2.7: Level 2 DFD for Update Status process (Group study, 2024)

3.2.4 Use case Diagram

A use case diagram is a graphical depiction of a user's possible interactions with a system. A use case diagram shows various use cases and different types of users the system has and will often be accompanied by other types of diagrams as well [24].

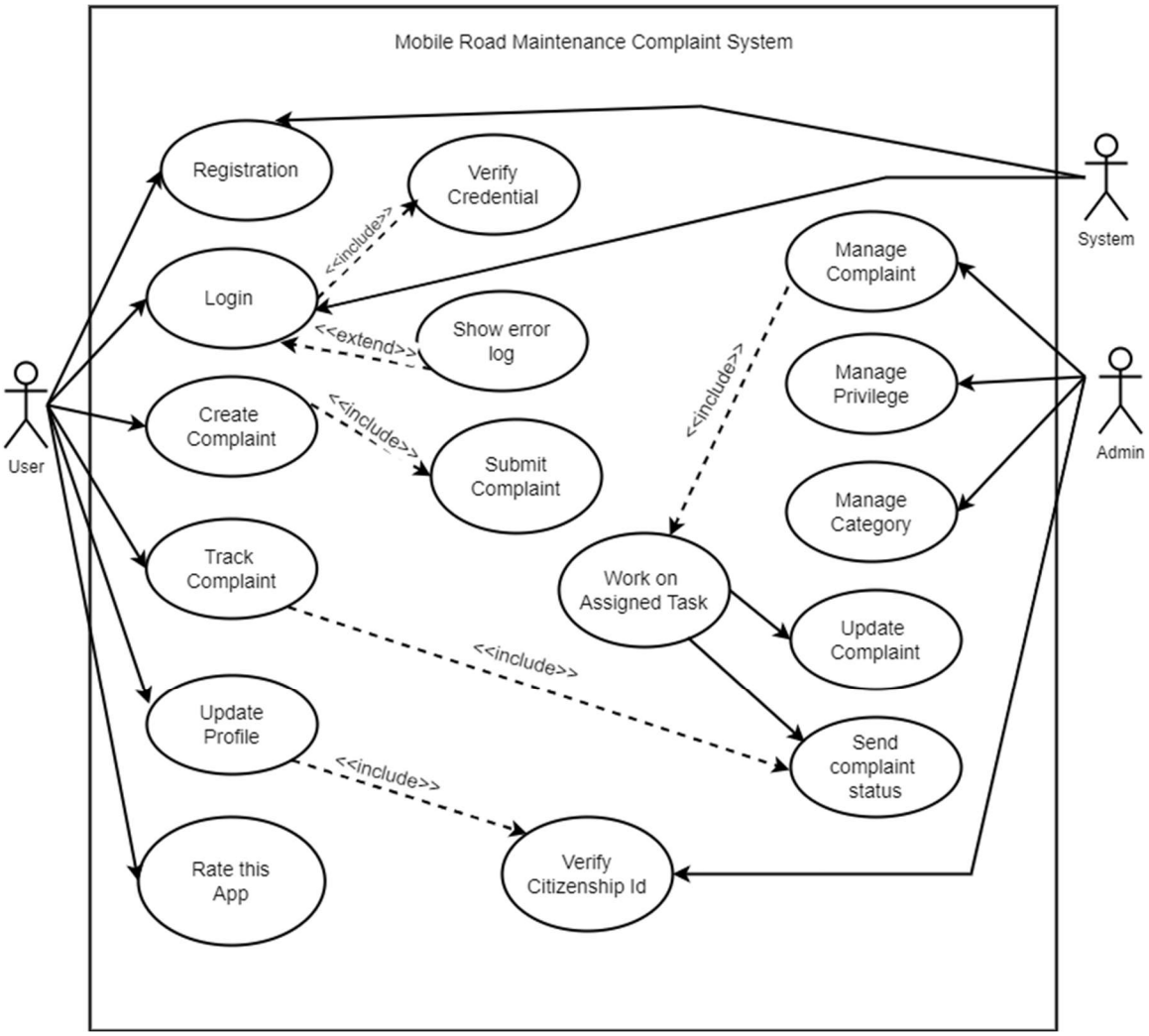

Figure 3.2.8: Use case Diagram (Group study, 2024)

3.2.5 Software Development Model

The Agile model is a flexible and iterative approach to software development that emphasizes collaboration, customer feedback, and small, incremental releases. Instead of planning the entire project upfront, Agile breaks down the work into smaller, manageable chunks called "sprints," typically lasting 1-4 weeks. Each sprint results in a potentially shippable product increment, allowing teams to adapt to changing requirements and deliver value to customers continuously. Agile encourages close collaboration between developer

teams and stakeholders, ensuring that the final product closely aligns with user needs and business goals [25].

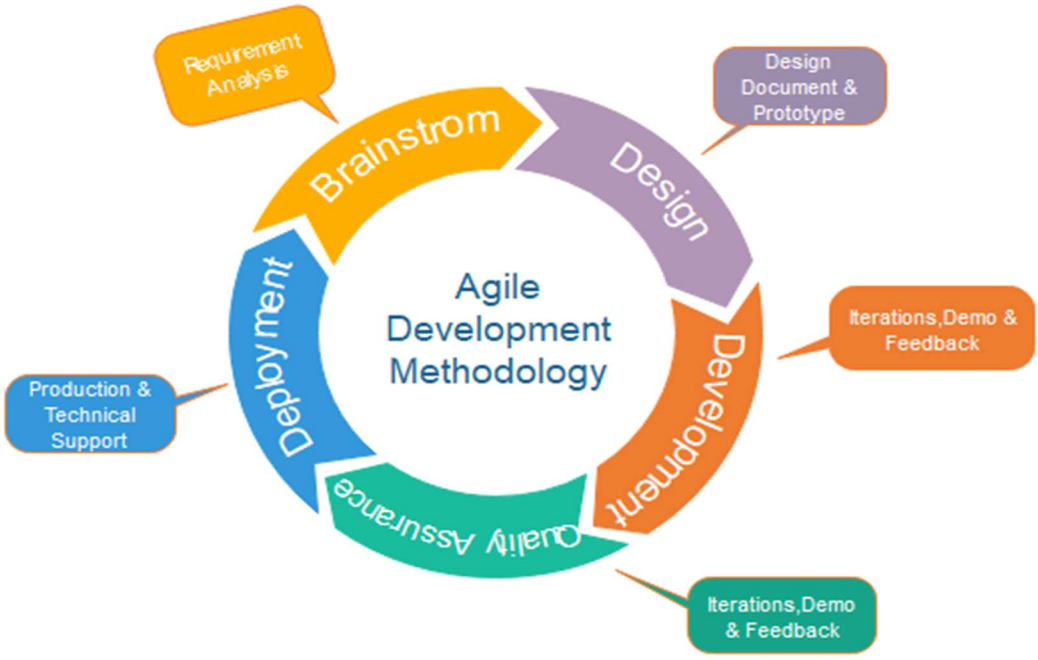

Figure 3.2.9: Agile Development Model (Group Study, 2024)

3.3 Testing for Road Maintenance Complaint App

Conducted these tests for our "Road Maintenance Complaint App" developed in Flutter:

Unit Testing:

- Utilized Flutter's built-in testing framework to write and run unit tests for critical functions such as user authentication, complaint submission, and status updates.
- Unit tests were written and executed using the test package provided by Flutter.

Widget Testing:

- Employed Flutter's support for testing individual widgets to verify their rendering and behavior.
- Tests were created for key widgets like login forms, complaint forms, and status tracking screens.
- User interactions such as filling forms, tapping buttons, and checking widget states were simulated.
- Widget tests were written and run using the flutter test package.

Manual Testing:

- Various test devices or emulators/simulators with different screen sizes, resolutions, and operating system versions were set up.
- The app was manually tested on these devices, encompassing different scenarios and user flows.
- Special attention was paid to areas like input validation, error handling, and usability.

3.4 App Maintenance for Road Maintenance Complaint App

Maintaining app involves regular updates, monitoring, and responding to user feedback. Here are some practical and feasible maintenance practices:

Monitoring and Analytics

- **Purpose:** Track app performance and user behavior to identify and fix issues.
- **Tools:** Firebase Analytics, Firebase Crashlytics.
- **Practice:**
    - Integrate Firebase Analytics to monitor user interactions and app usage.
    - Use Firebase Crashlytics to track and diagnose crashes.
    - Regularly review analytics and crash reports to identify trends and issues.

User Feedback

- **Purpose:** Gather and respond to user feedback to improve the app.
- **Practice:**
    - Provide an in-app feedback mechanism for users to report issues and suggest features.
    - Monitor app store reviews and ratings.
    - Actively respond to feedback and inform users about updates based on their input.

Codebase Management

- **Purpose:** Ensure the codebase remains clean, organized, and maintainable.
- **Practice:**
    - Use version control systems like Git for code management.
    - Perform regular code reviews to maintain code quality.
    - Refactor code periodically to improve structure and readability.

Documentation

- **Purpose:** Maintain comprehensive documentation for easier future maintenance and onboarding of new developers.
- **Practice:**
    - Document code, APIs, and development processes.
    - Keep documentation up to date with each release.

Chapter 4: Result and Discussion

4.1 Work Completed

Key features:

1. GitHub setup for effective teamwork and version control.
2. Detailed project planning to ensure structured development.
3. Exploration of Flutter resources and Material Design guidelines.
4. Kick-off of user interface design using Canva and Figma.
5. Creation of polished and user-friendly app interfaces.

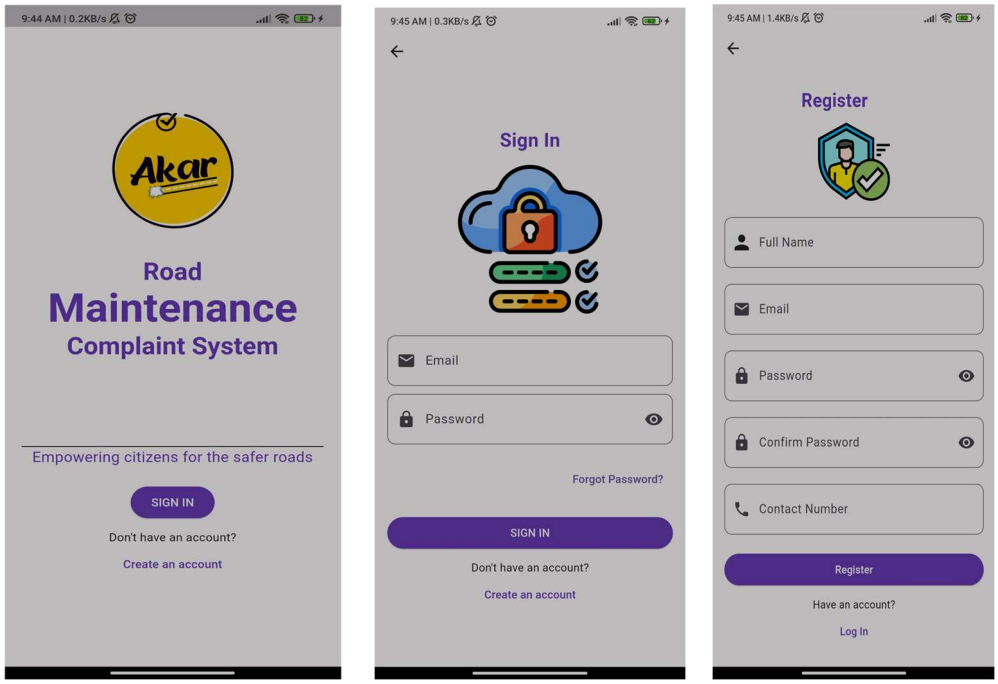

Figure 4.1.1: AKAR Home, Sign In, Log In Screens

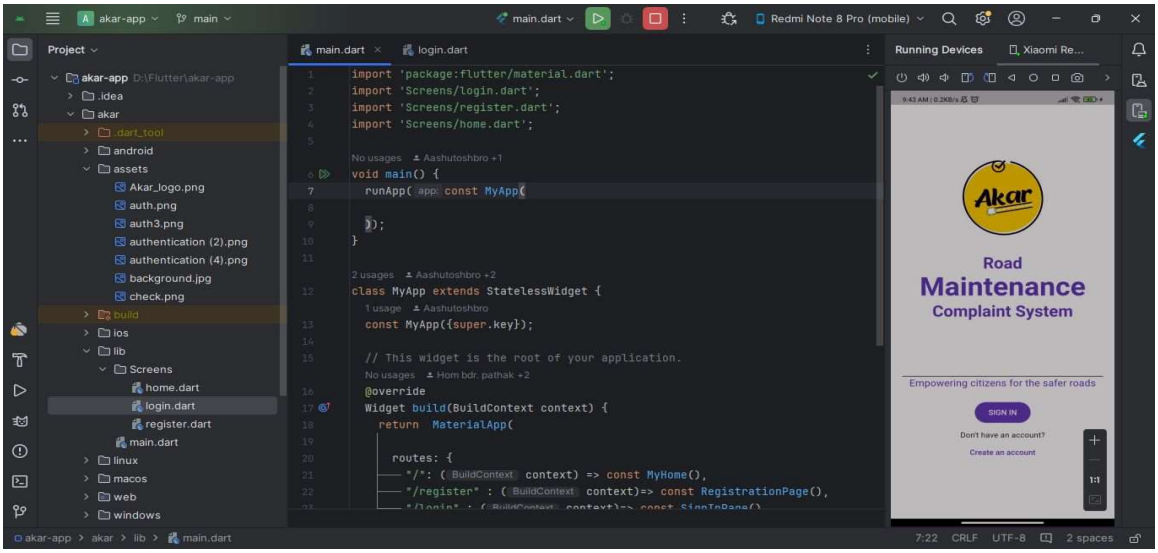

Figure 4.1.2: Main Screen Working Environment

Key Features:

1. Established connection with Firebase for backend services.
2. Developed functions for login, registration, and password recovery, all connected to Firebase.
3. Created Splash Screen, Account Recovery page, and User Pages for enhanced user experience.
4. Started developing the Admin Login screen and Admin Homepage.
5. Began designing the Home screen and implemented navigation for both User and Admin roles.

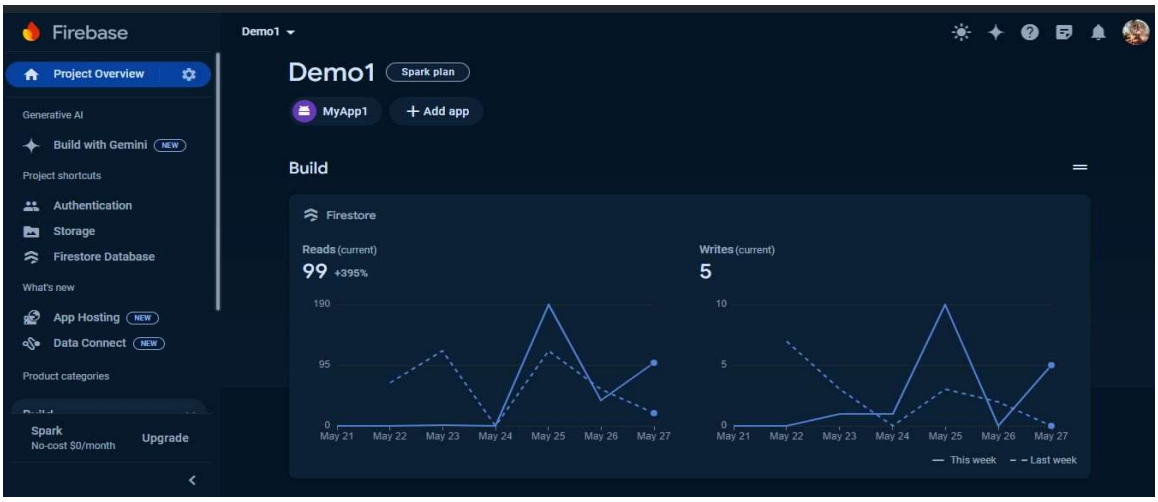

Figure 4.1.3: Firebase Connection

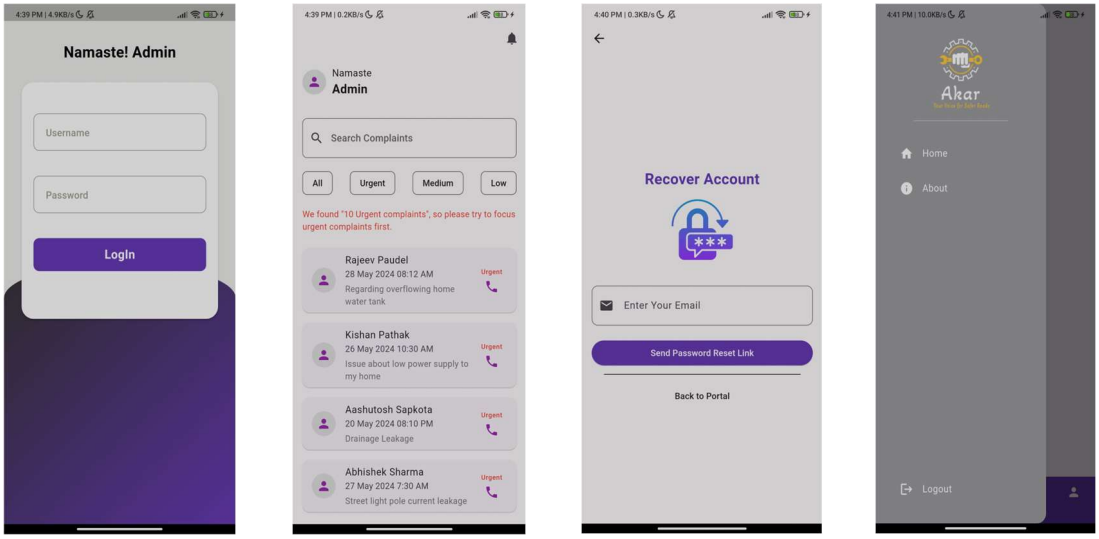

Figure 4.1.4 : Admin Login, User details, Recovery Account Screens

Key Features:

1. Developed key Admin pages including Dashboard, Users List (Firebase-connected), Manage Complaints, side drawer, and navigation buttons.
2. Fully functional page with address input via OSM map, photo uploads (up to 3), and user verification.

3. Users can enter and edit their details.
4. Track Complaint and Complaint History pages (connection pending).
5. Enabled partial offline access, with ongoing enhancements for better offline capabilities.
6. Maintained collaboration and proper project planning via GitHub.

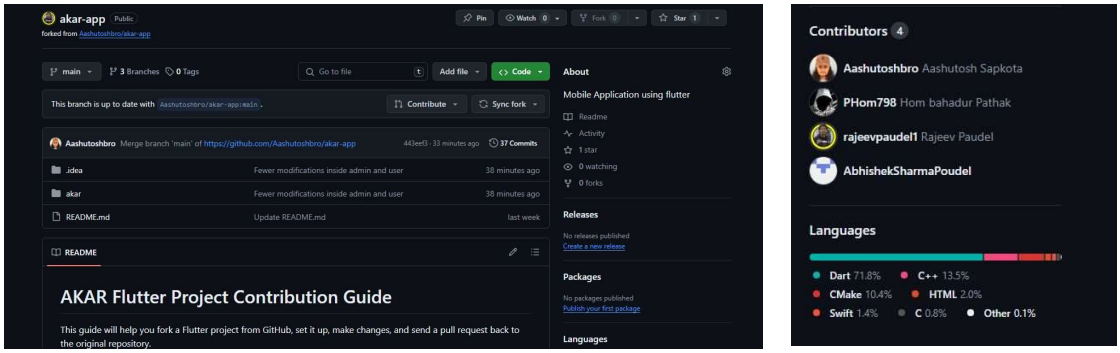

Figure 4.1.5: GitHub Collaboration Stats

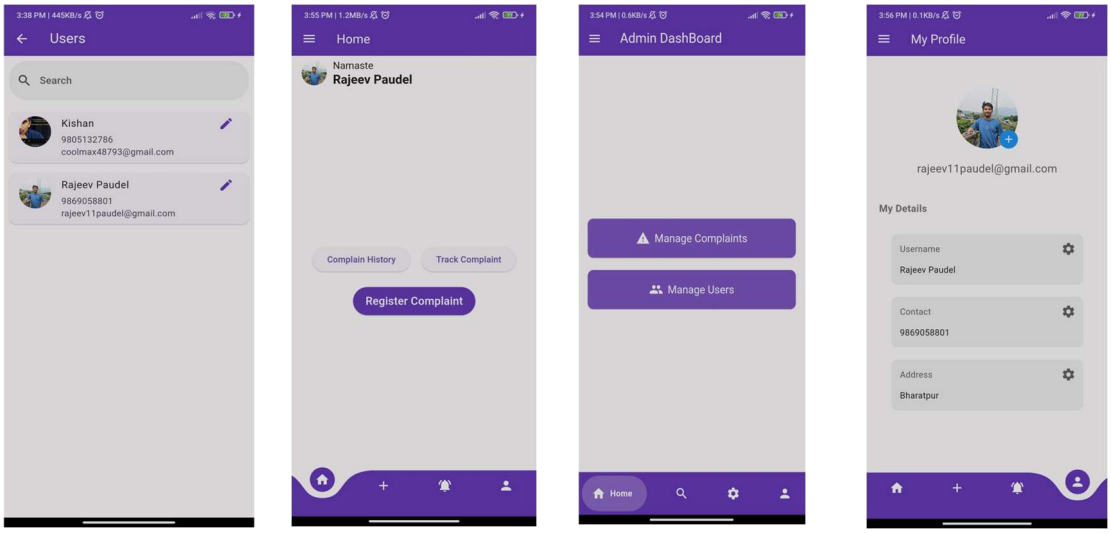

Figure 4.1.6: User Details, Register Complaint, Admin Home, User Profile Screens

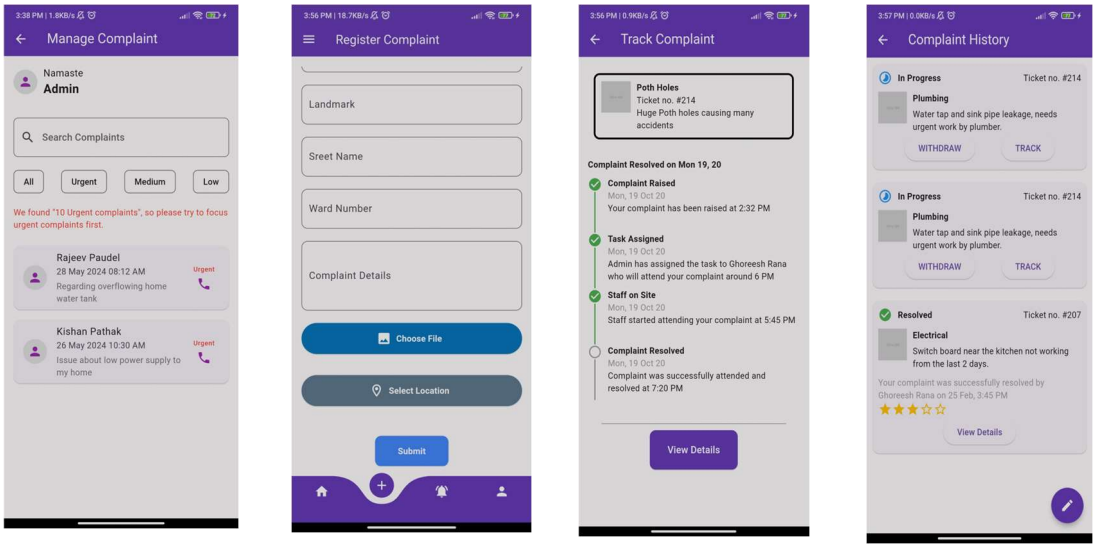

Figure 4.1.7: Manage, Register, Track Complaints, Complaint History Screens

Key Features:

1. Significant progress made on the core functionalities for the admin section.
2. The Manage Complaint page is now fully operational, allowing the admin to filter tasks by "Pending" or "Resolved" and view complaint statuses directly.
3. Improved the Complaint Details page by adding features to view complaint images. The track location feature with an embedded OSM map is still under development.
4. Admin can now update complaint statuses to “Complaint Raised,” “Task Assigned,” “Staff on Site,” or “Complaint Resolved,” with the ability to add notes to each complaint.

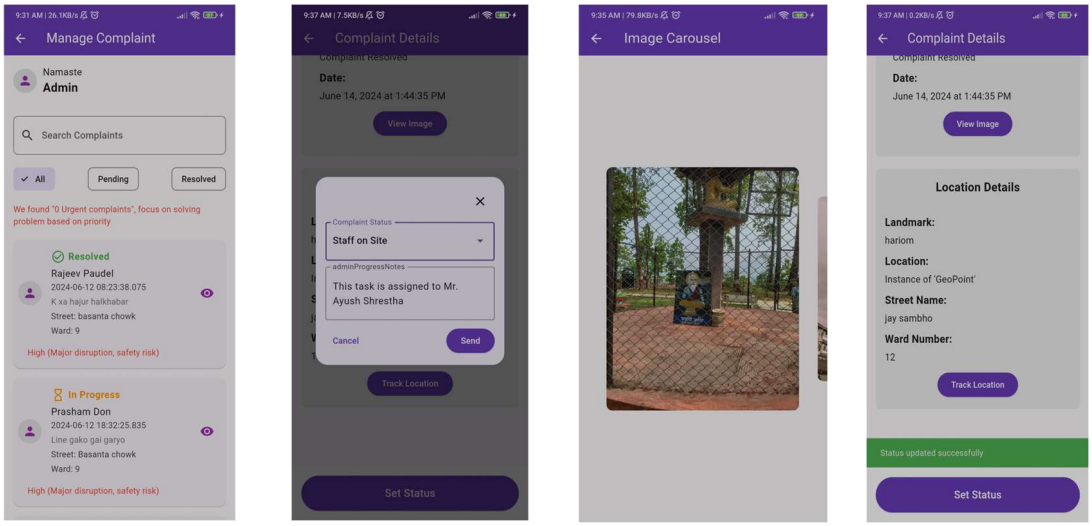

Figure 4.1.8: Track Complaint, Complaint Details, Complaint Details Screen

4.2 Challenges Encountered

- **State Management:** One of the key challenges during the development of the road maintenance complaint app was managing the application state effectively. Due to the dynamic nature of user interactions and the need to update the UI based on user actions, a robust state management solution was required to ensure the application's responsiveness and consistency. This involved designing a state management architecture that could efficiently handle data updates, user inputs, and synchronization across different components of the application.

- **Security and Data Privacy:** Ensuring the protection of user data and the confidentiality and integrity of sensitive information, such as personal details and reported road maintenance issues, was a critical challenge. To address this challenge, we designed and implemented a comprehensive access control system that allows for granular management of user permissions and privileges. This enables us to restrict access to sensitive data and functionalities based on the user's role and authorization level, minimizing the risk of unauthorized access or misuse of information.

- **Real-Time Synchronization:** Implementing real-time updates and synchronization of user-reported issues, status changes, and notifications across the app and backend systems was a key challenge. Ensuring users had access to the most current information was crucial for the app's effectiveness. To address this challenge, we leveraged the real-time capabilities of Firebase, a comprehensive application development platform.

4.3 Budget Estimation

Development Activity/Task	Status	Estimated Days	Estimated Hours	Estimated Budget (NPR)
Requirement Analysis	Complete	7	45	0
Walk-through & Correction	Complete	5	10	0
DB Design	Complete	7	30	0
UI/UX Design	Complete	6	20	0
Testing the App	Complete	5	15	0
Report writing and final report	Complete	10	10	2150
Total		40	130	2150

Table 4.3.1: Budget Estimation (Group Study, 2024)

Chapter 5: Conclusion & Future Enhancement

5.1 Conclusion

The Road Maintenance Complaint App empowers citizens to become active participants in improving their communities by providing a seamless platform for reporting road issues. By fostering a direct line of communication with road maintenance authorities, the app helps ensure that concerns such as potholes, broken signs, and other infrastructure problems are addressed in a timely and efficient manner. This not only enhances road safety and driving experiences but also contributes to the overall well-being of the community by promoting accountability and transparency in the maintenance process.

Furthermore, the app encourages civic engagement by giving users a voice in the public service domain, allowing them to directly contribute to improving the quality of public infrastructure. The built-in features, such as real-time complaint tracking, notification updates, and verified user submissions, ensure that the process is not only user-friendly but also reliable.

5.2 Scope of Future Enhancement

Our app has great potential for future enhancements and improvements. Here are some areas where we can expand and enhance the system:

- **Gamification Elements:**

  As our app continues to evolve, incorporating gamification elements could help to further engage users and incentivize participation. Gamification refers to the application of game-like mechanics and designs to non-game contexts, to enhance user experience and motivation.

- **Analytics and Reporting Dashboard:**

  As our app grows in usage and impact, integrating a comprehensive analytics and reporting dashboard would be a valuable addition to the platform. This dashboard

would provide users, administrators, and stakeholders with valuable insights and data-driven decision-making capabilities.

- **Expansion to Other Geographic Areas:**

  As our app gains traction and popularity within its initial deployment area, a logical next step would be to expand the platform to other geographic regions. This expansion strategy could help to broaden the app's reach, impact, and user base, ultimately contributing to a more comprehensive and effective road maintenance ecosystem.

- **Community Engagement Features:**

  Implement features for community engagement, such as forums, community voting on issues, and volunteer coordination for minor road repairs. Allow users to share complaints and updates on social media to raise awareness.

- **AI and Machine Learning Integration**

  Use AI to categorize complaints automatically and prioritize them based on severity or frequency. Implement predictive analytics to foresee potential road issues based on historical data and trends.

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