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Geo Tagged Road Damage Reporting System with Citizen Evidence Attached Progress Alerts

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ABSTRACT

Urban road infrastructure plays a vital role in ensuring safe, efficient, and reliable transportation while supporting economic growth and sustainable urban development. However, the increasing number of vehicles, aging road networks, changing weather conditions, and heavy traffic loads have significantly contributed to the deterioration of road surfaces, resulting in potholes, cracks, and various forms of infrastructure damage. Conventional road maintenance systems primarily rely on periodic field inspections, manual surveys, and informal citizen complaints, which often lead to delayed identification of road defects, inconsistent reporting procedures, poor coordination among maintenance departments, and inefficient allocation of repair resources. These shortcomings increase the risk of road accidents, vehicle damage, traffic congestion, higher maintenance costs, and reduced public satisfaction with municipal services. To overcome these challenges, this research proposes a web-based Pothole and Infrastructure Damage Reporter that provides a centralized digital platform for reporting, monitoring, and managing road defects. The system enables citizens to submit infrastructure damage reports with relevant information, while municipal authorities can review complaints, assign maintenance tasks, update repair progress, and monitor service performance through an integrated management interface. Developed using a responsive web architecture with a scalable backend and centralized database, the platform supports efficient data management, real-time status tracking, and structured maintenance workflows. Furthermore, the collected infrastructure data facilitates performance analysis, resource optimization, and evidence-based urban planning. By digitizing the complete reporting and maintenance lifecycle, the proposed system enhances transparency, improves operational efficiency, strengthens citizen participation, accelerates road repair activities, and contributes to safer, smarter, and more sustainable urban infrastructure management.

Keywords: Pothole Detection, Infrastructure Damage Reporting, Smart Road Maintenance, Web-Based Management System, Citizen-Centric Urban Infrastructure.

1. INTRODUCTION

Road transportation infrastructure forms the backbone of economic development and urban mobility by enabling the efficient movement of people, goods, and public services. Well-maintained road networks are essential for providing reliable access to employment opportunities, educational institutions, healthcare facilities, commercial centers, and emergency services, thereby contributing significantly to social and economic growth. As urbanization and vehicle ownership continue to increase worldwide, road networks experience higher traffic volumes and greater mechanical stress, accelerating the deterioration of pavement quality. Numerous transportation studies have emphasized that the quality of road infrastructure directly influences travel efficiency, vehicle operating costs, fuel consumption, and commuter satisfaction [1]. Despite continuous investments in transportation infrastructure, many cities continue to face serious challenges in maintaining road conditions due to aging pavements, limited maintenance resources, adverse weather conditions, and increasing traffic loads. Consequently, road surface defects have become a common problem that negatively affects transportation safety and infrastructure reliability.

Among various forms of road deterioration, potholes represent one of the most frequent and hazardous pavement defects encountered in urban and rural road networks. Potholes are generally formed through the combined effects of repeated traffic loading, water infiltration, temperature fluctuations, and gradual pavement degradation over time. If left unattended, they continue to expand in size and depth, posing significant risks to motorists, cyclists, and pedestrians [2]. Vehicles travelling over potholes may experience damaged tires, bent wheel rims, suspension failures, steering misalignment, undercarriage damage, and increased maintenance expenses. Beyond the financial burden imposed on vehicle owners, potholes also contribute to traffic congestion, reduced travel comfort, and a higher probability of road accidents. According to the Fact Sheet of Pothole Damage, motorists in the United States collectively spent approximately USD 15 billion on repairing vehicle damage caused by potholes between 2012 and 2016, demonstrating the substantial economic impact of inadequate road maintenance [3]. Furthermore, deteriorated road infrastructure significantly reduces the resilience and operational efficiency of transportation systems, making timely maintenance an essential component of sustainable urban development [4].

Efficient monitoring, reporting, and maintenance of potholes remain major challenges for municipal authorities due to the large geographical coverage of road networks and the continuous emergence of new road defects. Traditional maintenance approaches primarily rely on periodic inspections, manual surveys, or citizen complaints, which often result in delayed identification, inconsistent reporting, inefficient resource allocation, and prolonged repair cycles. Such limitations not only compromise road safety but also hinder effective infrastructure planning and maintenance management. Moreover, the growing adoption of intelligent transportation systems, autonomous vehicles, and smart city technologies has increased the demand for accurate, real-time information regarding road conditions. Reliable detection and continuous monitoring of potholes have therefore become increasingly important for supporting traffic safety, optimizing maintenance operations, enhancing navigation systems, and enabling autonomous driving in complex urban environments [5]. Consequently, modern digital road monitoring and reporting systems are becoming essential for improving infrastructure management, reducing maintenance delays, and promoting safer, more efficient, and sustainable transportation networks.

2. LITERATURE SURVEY

Anupama Jawale and Amiya Kumar Tripathy, et al. [6] proposed a road quality assessment framework aimed at improving transportation safety and enhancing the overall commuting experience by systematically evaluating road disruptions in urban and semi-urban regions of Maharashtra, India. The study quantified the occurrence and severity of road defects to assess pavement conditions and support infrastructure maintenance planning. By analysing road quality using structured assessment techniques, the proposed approach enabled transportation authorities to prioritize repair activities, improve road maintenance efficiency, and minimize accident risks associated with deteriorating road infrastructure. Tejas Randive, et al. [7] developed an intelligent Pothole Detection and Reporting System that integrated computer vision, sensor technologies, and mobile communication to automate the identification of potholes. The system processed road images using image processing and machine learning algorithms to detect road anomalies in real time, while GPS technology was employed to accurately geo-tag each pothole. The detected information, including location and severity level, was transmitted to a centralized database, enabling municipal authorities to monitor road conditions continuously, reduce manual inspection efforts, and accelerate maintenance planning.

RISHI RAJ SAHOO, et al. [8] introduced a smart governance platform that connected road infrastructure monitoring with contractor management through a secure web-based interface. The proposed system linked individual road segments with contract information and automatically generated alerts whenever pavement conditions deteriorated beyond predefined thresholds. By providing maintenance notifications, road health analytics, and contract-based accountability, the platform supported evidence-based repair scheduling, warranty enforcement, budget allocation, and transparent infrastructure management. CH. Pravalika Reddy, et al. [9] proposed Road Guard, an Artificial Intelligence (AI)-powered road damage detection system that utilized the YOLO v4 object detection model together with high-definition cameras, AMD Kria 260 embedded hardware, and Global Positioning System (GPS) technology for automatic pothole detection. The system performed real-time identification of road defects while simultaneously recording accurate geographical coordinates, allowing maintenance authorities to rapidly locate damaged road segments. The integration of AI-based computer vision with embedded hardware significantly improved detection accuracy, minimized human intervention, and supported large-scale road monitoring applications.

Amxson Sminage, et al. [10] proposed an automated pothole verification mechanism that continuously validated previously reported road defects after maintenance activities were completed. Once a damaged road segment was repaired, the system analysed newly captured dashcam images from subsequent vehicle journeys to determine whether the potholes had been successfully eliminated. If no defects were detected, the repair status was automatically updated, thereby reducing manual verification efforts and improving the accuracy of maintenance records. M. Pagani, et al. [11] presented a comprehensive Pothole Management System (PMS) that combined smartphone sensors, Internet of Things (IoT) devices, cloud computing infrastructure, and Machine Learning (ML) algorithms to automate pothole detection, severity classification, and maintenance management. The framework collected real-time road condition data using GPS, accelerometers, and embedded sensing devices before transmitting the information to cloud servers for centralized processing and predictive maintenance analysis. The proposed system enabled efficient infrastructure monitoring, optimized resource allocation, supported proactive maintenance planning, and improved overall road safety through intelligent data-driven decision-making.

3. PROPOSED METHODOLOGY

The research implements a web-based civic platform designed to support structured reporting and monitoring of road damage in urban environment as shown in Fig. 1. The system enables citizens to actively participate in identifying potholes and infrastructure issues by submitting damage reports through a digital interface. These reports are centrally managed, allowing authorities to review, prioritize, and monitor repair activities in a transparent and organized manner. By digitizing the reporting process, the platform addresses inefficiencies associated with manual complaint handling and fragmented record-keeping.

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Fig. 1: System architecture for proposed potholes and infrastructure damage reporting

The system follows a modular architecture that integrates a user-friendly frontend, a scalable backend, and a centralized relational database. The frontend facilitates interaction for citizens and administrators, while the backend manages authentication, data processing, and workflow control. All damage reports, task assignments, and status updates are securely stored in the database, ensuring consistency and reliability of information. This structured design enhances maintainability and scalability, providing a foundation for efficient infrastructure monitoring and data-driven maintenance management.

4. RESULTS AND DISCUSSION

The image as shown in Fig. 2, displays the user's management section of the admin module. It lists registered citizens along with their personal details and approval status. The admin can review pending citizens/sanitization officer registrations and approve them directly from this interface. This functionality enables controlled user management and ensures only verified sanitizer officer access the system.

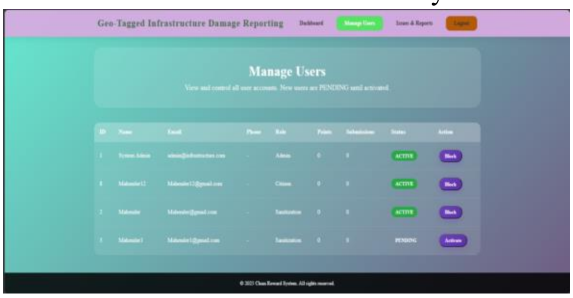

Fig. 2: Admin page for GTIDRAMD.

The image as shown in the Fig. 3, displays the Worker Reports and Issues module accessible to the Admin. It allows the admin to review the reports. This data is shared by the workers regarding issues to resolve the infrastructure needs.

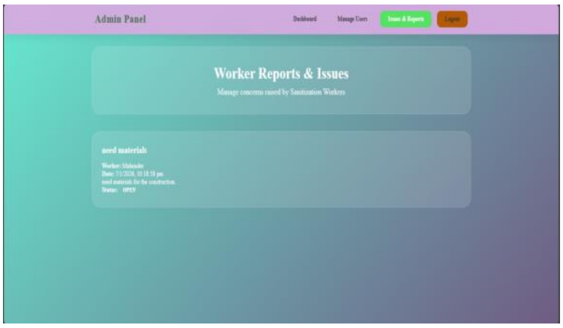

Fig. 3: Admin page for GTIDRAMD.

The image as shown in the Fig. 4, displays the citizen damage reporting module. It shows damage type which can selected by draw menu option and along with Location address in text field.

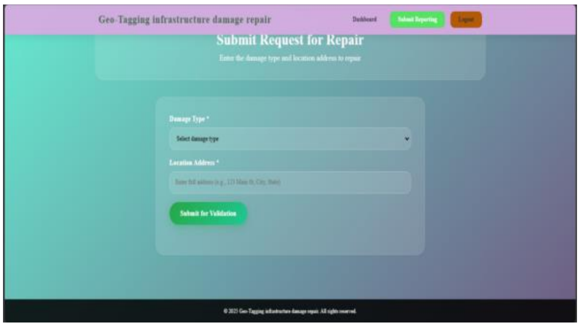

Fig. 4: Citizen page for GTIDRAMD.

The image as shown in the Fig. 5, displays the citizen damage reporting module. It shows damage type which can selected by draw menu option and along with Location address in text field. Which is submitted to the sanitizer dashboard.

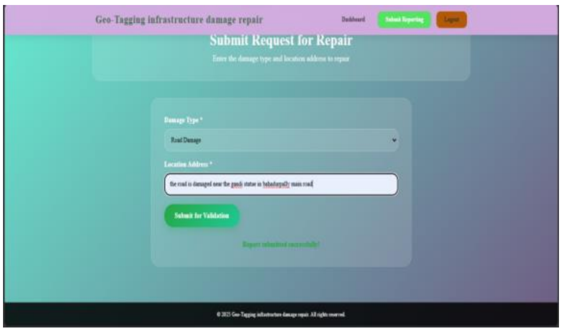

Fig. 5: Citizen page for GTIDRAMD.

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The image as shown in the Fig. 6, the Pending Damage submissions module of the system. It shows registered details such as Issued damage details like Citizen(name), Type (type of damage), Location, submitted (date and time). In this module the Sanitizer worker checks the location and review the issue by accept/ work done/ reject.

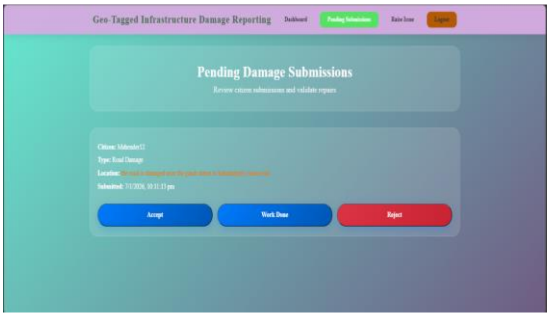

Fig. 6: Sanitizer worker page for GTIDRAMD.

The image as shown in the Fig. 7, displays the Raise an Issue module for Sanitizer workers. They can enter the subject or summary of the issue in Issue title and enter the detailed details of the Issue facing by the Workers are entered in the Description. This data is forwarded to admin dashboard.

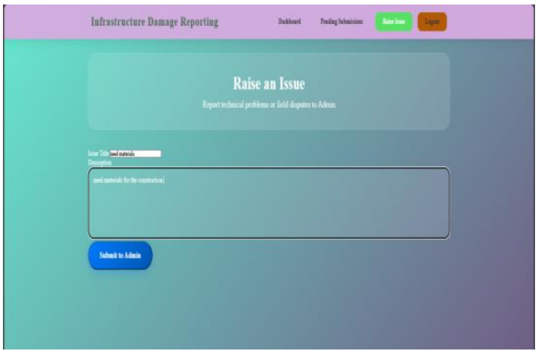

Fig. 7: Sanitizer worker page for GTIDRAMD.

5. CONCLUSION

This study demonstrates the effectiveness of a centralized digital platform in improving the reporting, monitoring, and management of road infrastructure issues. By integrating structured damage reporting, task assignment, and repair status tracking into a single system, the study addresses key limitations of traditional manual and complaint-driven maintenance practices. The implementation highlights how transparent workflows, centralized data storage, and role-based access control can enhance coordination among citizens, authorities, and repair teams. Overall, the system contributes to improved road safety, timely repairs, and more accountable infrastructure maintenance operations.

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